Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE

Department of Microbiology

Syllabus
for
T. Y. B. Sc. (Microbiology)

To be implemented
From Academic Year
2021-22

Fergusson College (Autonomous), Pune- 04
Structure of T. Y. B. Sc. (Microbiology)
Under CBCS pattern (2019) ***effective from June 2021***

Sem.	Paper No.	Course code	Title	Credits	CE maximum Marks	ESE maximum Marks	Total maximum Marks
V	DSE-1A	MIC3501	Medical Microbiology	2	50	50	100
	DSE-1B	MIC3502	DNA functioning and transfer in bacteria	2	50	50	100
	DSE-2A	MIC3503	Enzymology	2	50	50	100
	DSE-2B	MIC3504	Fundamentals of Immunology	2	50	50	100
	DSE-3A	MIC3505	Principles of fermentation technology	2	50	50	100
	DSE-3B	MIC3506	Agricultural Microbiology and Bio nanotechnology	2	50	50	100
	DSE-1	MIC3507	Microbiology Practical I	2	50	50	100
	DSE-2	MIC3508	Microbiology Practical II	2	50	50	100
	DSE-3	MIC3509	Microbiology Practical III	2	50	50	100
	SEC-1*	MIC3511	Clinical Biochemistry and Diagnostic Microbiology	2	50	50	100
	SEC-2*	MIC3512	Epidemiological Principles and Experimental Analysis	2	50	50	100
			Total Credits	**22**			**1100**
VI	DSE-4A	MIC3601	Metabolic activities of Microorganisms	2	50	50	100
	DSE-4B	MIC3602	Immunological processes	2	50	50	100
	DSE-5A	MIC3603	Large scale bioprocess	2	50	50	100
	DSE-5B	MIC3604	Food and dairy Microbiology	2	50	50	100
	DSE-6A	MIC3605	Antimicrobial Therapy and	2	50	50	100

			Prevention				
	DSE-6B	MIC3606	Recombination and gene manipulation	2	50	50	100
	DSE-4	MIC3607	Microbiology Practical IV	2	50	50	100
	DSE-5	MIC3608	Microbiology Practical V	2	50	50	100
	DSE-6	MIC3609	Microbiology Practical VI	2	50	50	100
	SEC-3*	MIC3611	Marine Microbiology	2	50	50	100
	SEC-4*	MIC3612	Prebiotics and Probiotics	2	50	50	100
			Total Credits	**22**			**1100**

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Medical Microbiology MIC3501**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe in details different human body systems, defence mechanisms associated with human body systems.	
CO2	Give examples of pathogenic organisms affecting human body systems, differentiate between different types of pathogenic organisms, and explain in details pathogenicity, diagnosis of pathogenic organisms.	
CO3	Interpret the possible suggested preventive and treatment methods for human pathogens.	
CO4	Classify pathogenic organisms based on their morphological and biochemical characteristics and distinguish between based on clinical samples from which pathogens can be isolated.	
CO5	Compare different determinants of pathogenicity, Evaluate effect of these determinants on disease causation.	
CO6	Write different resistance mechanisms of pathogens to human body system, Make comparative chart for types of toxins and its mode of action.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Physiology and anatomy of human body systems and defence mechanisms. Representative bacterial, fungal and viral infectious diseases of the systems (General and biochemical characters, diagnosis, prevention, treatment)** Skin: *Pseudomonas aeruginosa*, *Staphylococcus aureus*,**)** Respiratory system: *Mycobacterium, tuberculosis*, Influenza virus, Corona virus, Gastrointestinal tract: Hepatitis virus, *Entamoeba histolytica*, Central nervous system: *Clostridium tetani*, Polio virus, Urogenital system: *Treponema pallidum*, *Candida, HIV*	**18**
II	**Determinants of pathogenicity** A stepwise process in infection: Adhesion, Colonization, and invasion of host tissues with detailed accounts of virulence factors of pathogenic Organisms, Evasion mechanisms of pathogenic organisms Mechanisms of bacterial resistance to host cellular and humoral defences, Toxigenesis: Exotoxins, enterotoxins and endotoxins, role in pathogenicity, PIAs and its role in bacterial virulence	**18**

References:

1. Tortora, G.J., Funke, B.R., Case, C.L, 2016. Microbiology: An introduction. 12th Edition, Benjamin Pub. Co. NY
2. Indira T. Kudva, Nancy A. Cornick, Paul J. Plummer, Qijing Zhang, Tracy L. Nicholson, John P. Bannantine, Bryan H. Bellair 2016. Virulence mechanisms of bacterial pathogens. 5th edition. ISBN: 978-1-555-81927-9.
3. Ananthnarayan, R. and C.E, Jayaram Panikar, 2020. Ananthnarayan and Panikar's Textbook of Microbiology, 10th edition, Universities Press.
4. Cruickshank K.R., 2005, Medical Microbiology Vol I & II Livingstone, Longman. (Topic II AND IV)
5. Chakraborty P. 2009, Textbook of Medical Parasitology, Central Publications, Kolkata, India.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**DNA Functioning & Transfer in Bacteria MIC3502**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the detailed mechanism of DNA replication in eukaryotic cells	
CO2	Compare the DNA repair mechanisms functioning in bacteria	
CO3	Illustrate the steps of gene expression in bacteria	
CO4	Order the chemical reactions leading to DNA damage	
CO5	Determine the modes of genetic recombination in bacteria	
CO6	Design experiments to perform gene mapping using the knowledge of genetic recombination found in bacteria	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Central Dogma, DNA damage and repair** DNA replication – Overview of prokaryotic DNA replication, Eukaryotic DNA replication, multiple replicons, pre-priming & priming eukaryotic DNA polymerases, ARS in yeast, origin recognition complex (ORC), Regulation of replication, Prokaryotic Transcription – Structure of promoter, Structure and role of RNA polymerases, Initiation, elongation and termination, Concept of operon – Lac operon**,** Prokaryotic Translation - Structure & role of mRNA, tRNA and ribosomes in translation, Activation of tRNA, Initiation, elongation, translocation and termination of translation**,** DNA damage by hydrolysis,	**18**

	deamination, alkylation, oxidation and radiation, DNA repair mechanisms – Mismatch repair, Nucleotide excision repair, Photo reactivation, SOS response	
II	**Gene Transfer in bacteria.** Transformation- Development of competence in Gram positive and Gram negative bacteria, Process of transformation in Gram positive and Gram negative bacteria Factors affecting transformation, Mapping of chromosome by co-transformation Conjugation- Properties of F plasmid, F^+, F^-, Hfr and F' strains, Process of conjugation between F^+ and F^- and Hfr and F^-. Interrupted mating experiment. Transduction- Process of generalized transduction, Process of specialized transduction, Mapping by co-transduction.	**18**

References:

1. Pierce, Benjamin A. Genetics: A Conceptual Approach. New York: W.H. Freeman, 2012.
2. Strickberger, M. W., 1985 Genetics, 3rd edition Macmillan Pub. Co. NY.
3. Stanier, R. Y., 1985, General Microbiology, 4th edition and 5th edition, MacMillan Pub. Co. NY.
4. Hayes, William, 1984, The Genetics of Bacterial and their Viruses, CBS Pub, New Delhi.
5. Peter J. Russell, iGenetics: A Molecular Approach, 3rd edition, Pearson
6. Lewin Benjamin, 1994, Genes II, VII and VIII, Oxford University Press.
7. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. M. (2004). Molecular biology of the gene.
8. Burton E. Tropp, 2012, Molecular Biology: Genes to Proteins, 3th edition. Jones & Bartlett Publishers.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Enzymology MIC3503**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	List micronutrients required for cellular activities and their correlate their biochemical activity and deficiency disorders.	
CO2	Associate the presence of specific amino acids at the active site of enzymes with the 3D structure and function of the enzyme.	
CO3	Outline from a variety of protein purification methods the correct procedures in order to purify a single protein/enzyme based on its properties and compare the use of these methods for lab level and large scale purification of proteins.	
CO4	Explain the effect of enzyme inhibitors on the kinetic parameters of an enzyme catalyzed reaction and differentiate between enzyme inhibitors based on graphical representation.	
CO5	Compare between enzyme regulatory mechanisms used by prokaryotic and eukaryotic systems and evaluate the importance of these mechanisms.	
CO6	Combine a variety of purification methods to achieve maximum purity and yield of a single protein.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**A. Modern methods to determine amino acid composition at active site**: NMR spectroscopy XRD, and basic concept of Protein sequencing, Structure function homology and prediction of 3D motifs. **B. Enzyme cofactors**: Biochemical function of water soluble and fat soluble vitamins in central energy yielding and biosynthetic pathways: Pyridine and flavin nucleotides, Vit B6, Vit A and Vit D **C. Methods / Techniques in Enzymology** A. Enzyme Assays, calculation of enzyme activity, specific activity and fold purification based on the principles of: Spectrophotometric methods, Coupled Enzyme assays (Luminescence based assays) B. Principles and methods of Enzyme purification: Methods of cell fractionation, Methods of Enzyme concentration: Ultrafiltration, Dialysis, Salt and solvent precipitation, Methods of Enzyme purification: Principle, Materials used and Applications:	**18**

	Based on differences in molecular size (Gel filtration), Based on differences in charged properties (Ion exchange Chromatography, Gel Electrophoresis) Based on differences in solubility (Isoelectric focusing and Isoelectric Precipitation) Based on differences in ligand affinity and selective adsorption (Metal affinity Ligand chromatography) Characterization of enzymes using Criteria of purity: Sedimentation analysis, concept of purity check using 2D electrophoresis.	
II	**A. Regulation of Enzyme activity**: Concept of Enzyme compartmentation at Cellular level Feedback Inhibition with examples from amino acid biosynthesis, Feedback Repression with example of Tryptophan operon, Allosteric enzymes, Isoenzymes Covalently modified regulatory enzymes **B. Enzyme Kinetics**: Concept of Initial velocity Michaelis Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction, Briggs and Haldane modification of the Michaelis, Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction. Michaelis Menten plot, Significance of kinetic constants Plotting Kinetic data using transformations of MM plot Lineweaver Burke plot, Hanes plot, Eadie Hofstee plot Eisenthal Cornish Bowden plot Concept, Types of enzyme inhibitions and Derivation of the Michaelis Menten Equation for the initial velocity of single substrate enzyme catalyzed reaction in the presence of the inhibitors, LB plots and Secondary plots for Enzyme catalyzed reactions in the presence of Enzyme inhibitors.	**18**

References:

1. Nelson D. L. and Cox M. M. (2017). Lehninger's Principles of Biochemistry 7th Edition, WH Freeman Macmillan Worth Pub. Co., New Delhi.
2. Segel Irvin H. (2010). Biochemical Calculations. 2nd edition, John Wiley and Sons, New York.
3. Garrett, R. H. and Grisham, C. M. (2009) Biochemistry. 4th Edition, Brooks / Cole, Publishing Company, California.
4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (2006) Outlines of Biochemistry 5th edition, John Wiley and Sons, New Delhi.
5. Palmer Trevor (2008). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry 2nd Edition, Horwood Pub. Co., Chinchester, England.
6. White David (2006). Physiology and Biochemistry of Prokaryotes. 3rd Edition. Oxford University Press, New York.
7. 7.
9. Harvey Lodish et. al (2016), Molecular Cell Biology 8th Edition W. H. Freeman Macmillan Worth Pub. Co., New Delhi.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Fundamentals of Immunology MIC3504**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe and classify isotypes of antibodies on the basis of their structure and biological properties and explain the molecular basis of their diversity.	
CO2	Articulate concepts of defense mechanisms of human body, types of immunity and different cells and organs involved in combating pathogens.	
CO3	Demonstrate different types of antigen-antibody interactions and their application in diagnosing different infections.	
CO4	Differentiate types of antigens and explain their destruction by different types of immune cells.	
CO5	Compare polyclonal and monoclonal response of immune system against antigen.	
CO6	Design an experimental protocol to produce monoclonal antibodies and study their applications.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Overview of Immune system** **Three lines of defense mechanisms**: physical chemical and biological barriers **Types of immunity**: active and passive, specific and non-specific, Humoral and cell mediated **Cells and organs of the immune system:** Haematopoiesis and its kinetics: Formation of myeloid and lymphoid cell lineages, Lymphatic system Primary lymphoid organs: Thymus and Bursa Secondary lymphoid organs: Spleen, Lymph nodes, lymphoid tissues	**18**
II	**Antigens and Immunoglobulins** **Antigens:** Concept, Factors affecting immunogenicity, Antigenic epitope and paratope, Haptens and Adjuvants Types of antigens: thymus dependent and thymus independent, Autoantigens, super antigens, Iso-antigens MHC antigens, MHC gene locus in mouse and man Structure and functions of MHC Class-I and class- II Molecules, Antigen Processing and presentation: MHC class I and class II restriction pathway **Immunoglobulins:** Structure of basic unit, chemical and biological properties Classification into isotypes, Antigenic nature of	**18**

	immunoglobulins Molecular basis of antibody diversity: light chain diversity and heavy chain diversity Concept of monoclonal antibodies: hybridoma technology and applications of monoclonal antibodies	

References:

1. Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology Interactive, 2005. Garland Science Publishing, USA.
2. Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th edition, W. H. Freeman and Co., New York.
3. Pathak S. S. and Palan V. (1997). Immunology - Essential and Fundamental, Pareen Publications, Bombay.
4. Roitt Evan, Brostoff J. Male D. (1993). Immunology 6th edition, Mosby and Co., London.
5. Roitt I. M. (1988). Essentials of Immunology, ELBS, London.
   Roitt M. (1984). Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Principles of Fermentation Technology MIC3505**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe a large number of substrates that are used for the industrial fermentation process.	
CO2	Explain different types of reactors or fermenters which are used for laboratory, pilot and industrial scale fermentation and their process parameters.	
CO3	Illustrate the detailed knowledge of the quality control procedures and how to apply them at industrial scale, the principles of IPR and their application in fermentation industry.	
CO4	Analyse the given pharmaceutical product for its sterility, microbiological assay procedures to determine the potency of the products like antibiotics and vitamins	
CO5	Evaluate the quality of fermentation products by carrying out the test for sterility, carcinogenicity, pyrogenicity, toxicity and shelf life of the product.	
CO6	Synthesize different products with the upstream and several downstream processes carried out in fermentation industry	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Media optimization** Classical Approach-one factor at a time. Full factorial design Plackett Burman Design, Response surface methodology (RSM) **Scale up and scale down** Objective of scale up, Levels of fermentation (Laboratory, pilot plant and production levels), Scale down **Principles and methods of downstream processing** Cell Disruption, Filtration, Centrifugation, Liquid liquid extraction Distillation, Ion exchange chromatography, Drying.	**18**
II	**Fermentation economics** Contribution of various expense heads to a process (Recurring and non-recurring expenditure) citing any suitable example **Quality Assurance of fermentation product:** Detection and quantification of the product by physicochemical, biological and enzymatic methods, Sterility testing Pyrogen testing- Endotoxin detection**,** Ames test and modified Ames test, Toxicity testing **vi.** shelf life determination **Introduction to intellectual property rights** Patents, Trade mark**,** Copy right, Indian patent act	**18**

References:

1. Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
2. Peppler, H. L 1979, Microbial Technology, Vol I and II, Academic Press.
3. Stanbury, P. F. and Whittaker, A. (1984) Prionciples of Fermentation technology, Pergamon press
4. Prescott. S.C and Dunn, C. G., 1983 Industrial Microbiology, Reed G. AVI tech books.
5. H. Patel. (1985), Industrial Microbiologu, Macmillan India Ltd
6. Indian Pharmacopia and British Pharmacopia (Latest Edn).

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Agricultural Microbiology and Bio nanotechnology MIC3506**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe different methods of plant disease control.	
CO2	Articulate the important developments in Plant growth improvement.	
CO3	Infer soil health improvement with respect to microorganisms.	
CO4	Explain characteristics and application of nanoparticles and nanomaterials.	
CO5	Justify Structural and functional principles of nanotechnology.	
CO6	Synthesize metal nanoparticles using biological entity.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Agriculture Microbiology** **Plant growth improvement with respect to-** Disease resistance, Environmental tolerance **Soil health improvement –** Phosphate solubilisation, Potassium mobilization, Iron chelation **Methods of plant disease control** Chemical control, Eradication, Biological control (employing bacterial and fungal cultures), Integrated pest management Development of insect resistant plants (BT crops), Mycoviruses acting against fungal plant pathogens, Role of noncoding RNA in plant disease control **a**. RNA interference (RNAi), Antisense RNA	**18**
II	**Bio nanotechnology** Introduction to nanotechnology, terminologies, needs, historical perspectives, Opportunities and challenges of nanotechnology, Structural and functional principles of nanotechnology Synthesis of metal nanoparticles using plants, bacteria and fungi, Synthesis of magnetic nanoparticles using Magnetotactic bacteria, Characteristics and applications of quantum dots and fullerenes, Applications of nanotechnology in environment and medical field.	**18**

References:

1. David S. Ingram, N. F. Robertson (1999). Plant Disease.1st Edn.: Collins George Nicholas Agrios (2005). Plant Pathology. 5th Edn. Academic Press Inc.
2. Matthew Dickinson, (2003). Molecular Plant Pathology. Garland Publishing Inc.
3. N. S. Subba Rao. (1995). Soil Microorganisms and Plant Growth. 3rd Edn. Science Pub Inc.
4. Christof M. Niemeyer and Chad A. Mirkin (2006). Nanobiotechnology, John Wiley & Sons.

5. Daniel L. Feldheim and Colby A. Foss, Jr. (2002). Metal Nanoparticles Synthesis, Characterization and Applications, Marcel Dekker, Inc.
6. Mahendra Rai and Nelson Duran (2011). Metal Nanoparticles in the Microbiology, Springer Verlag Berlin Heidelberg.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical I MIC3507**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Outline basic knowledge of isolation of different types of lactic acid bacteria from the curd samples.	
CO2	Discuss the effect on spoilage causing bacteria by testing the antifungal activity of the lactic cultures.	
CO3	Calculate minimal inhibitory concentration and minimal bactericidal concentration to the standard antibiotic streptomycin.	
CO4	Analyze the potency of antibiotics and vitamins using bioassay technique.	
	Test the antifungal activity of these lactic cultures and understanding its effect on spoilage causing bacteria.	
CO5	Evaluate the quality of pharmaceutical products like surgical cotton and water for injection	
CO6	Synthesize ethanol using Saccharomyces cerevisiae cultivated in jaggery medium	

Sr. No.	**Title of Unit and Contents**	**No. of Practicals**
1	**a)** Isolation and identification of Lactic culture up to genus level. **b)** Antifungal activity of Lactic acid bacteria. **c)** Screening and isolation of pesticide degraders from soil. **d)** Isolation and identification of Aspergillus sp. From onions infected with black mold. **e)** Isolation and identification of *Xanthomonas* sp from infected sample. **f)** Biosynthesis of silver nanoparticles.	**5**
2	**a)** MIC and MBC of antibacterial compounds **b)** Microbiological assay of antibiotic (agar gel diffusion echnique) **c)** Microbiological assay of Cyanocobalamin (agar gel diffusion technique **d)** Sterility testing of pharmaceutical products by direct inoculation method. **e)** Sterility testing of pharmaceutical product by membrane filtration method **f)** Visit to a Dairy/ Fermentation industry/ Agriculture college and preparation of visit report	**5**

References:

1. Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
2. Peppler, H. L 1979, Microbial Technology, Vol I and II, Academic Press.
3. Indian Pharmacopeia and British Pharmacopeia (Latest Edn).

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical II MIC3508**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall the laws pertaining to transmission and absorbance and their mathematical expression and correlate these to determination of absorption maxima and molar absorptivity	
CO2	Extrapolate data to quantify samples by preparing standard dose responses made using quantitative biochemical estimation methods.	
CO3	Examine quantitative enzyme assays for degradative extracellular enzymes such as Amylase	
CO4	Detect the presence of amino acids and sugars using paper chromatography by resolving mixtures	
CO5	Assess the use of neutral bivalent salts to concentrate proteins from natural samples	
CO6	Formulate a combination of chemicals to produce a buffer of desirable pH, strength and quantity	

Sr. No.	**Title of Unit and Contents**	**No. of Practicals**
1	**a)** Determination of ƛ max of biological compounds **b)** Determination of Molar Extinction coefficient of biological compounds **c)** Preparation of Buffers: Calculations using the Hendersen - Hasselbach Equation **d)** Paper Chromatography of sugars: Resolution of mixture use of locating agents Iodine, Methanolic H_2SO_4 **e)** Paper Chromatography of amino acids: Resolution of mixture using locating agent Ninhydrin **f)** Thin layer chromatography of biomolecules.	**5**
2	**a)** Preparation of SDR for reducing sugars using DNS protocol **b)** Preparation of SDR for total carbohydrate content using Anthrone/ Phenol sulphuric acid protocol **c)** Preparation of SDR for proteins using Folin Lowry protocol **d)** Screening and Isolation of Amylase producers from soil samples	**5**

	e) Amylase concentration using salt/solvent precipitation **f)** Amylase assay and establishment of purification chart	

References:

1. An Introduction to practical biochemistry (2nd edition) David T. Plummer. McGraw-Hill Book Company (U.K.) Ltd., London 1978.
2. Principles and Techniques of Practical Biochemistry (6th Ed.), Wilson, K., Walker, J. (eds.); Cambridge University Press, Cambridge, 2000,
3. Biochemical calculations: how to solve mathematical problems in general biochemistry, Irwin H Segel, Wiley,1976.
4. Trinder P. Annals. Clin. Biochem. 6, 24 (1969)
5. Bergmayer, HV.,"Methods of Enzymatic Analysis", A.P.N.Y. (1974). Page 1196.
6. M. Dashora, Proceeding of XIII Annual Conf. ACNI, page 17.
7. Dumas, B.T.et al,Clin. Chem. Acta, 31,87(1971).
8. Young, D.S. et al.21, D (1975)
9. Sadasivam, S. and Manickam, A. (2005) Biochemical methods. 2nd Edition, New age International, New Delhi.
10. Laboratory manual in biochemistry, J Jayaraman, Wiley Eastern, 1981.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical III MIC3509**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Identify the pathogenic organisms associated with clinical samples	
CO2	Conclude the observations of urine analysis with respect to body disorder such as diabetes, kidney malfunctioning etc.	
CO3	Carry out physical, chemical, and microscopic tests of the urine sample	
CO4	Classify human pathogens into different groups based on morphological and biochemical tests.	
CO5	Determine sensitivity of pathogenic organisms to various antimicrobials	
CO6	Write differences in the growth characteristics of pathogens on different media	

Sr. No.	**Title of Unit and Contents**	**No. of Practicals**
1	a) Physical and Microscopic examination of clinical sample - urine b) Chemical analysis of urine sample c) Isolation, Identification of pathogens from urine sample d) Isolation, Identification of pathogens from stool sample	**5**

	e) Isolation, Identification of pathogens from pus sample **f)** Biochemical characterization of the isolates using identification keys as well as Bergey's Manual	
2	a) Demonstration of egg inoculation technique b) Antibiotic sensitivity testing of Gram-positive isolates c) Antibiotic sensitivity testing of Gram-negative isolates d) Study of growth characteristics of human pathogens on selective media- Cetrimide agar e) Study of growth characteristics of human pathogens on differential media- SS agar, MSA f) Study of growth characteristics of human pathogens on enrichment media and special- Tetrathionate broth, Selenite F	**5**

References:

1. Cruckshank R and J.P. Duguid (1980) Medical Microbiology Volume II, 12th Edition. The Practice of Medical Microbiology, Chruchill Livingstone Edinburgh, London and New York
2. Dubey, R.C. and Maheshwari, D. K. (2002). Practical Microbiology. S Chand and Company Pvt Ltd.
3. Mukherjee K.L. Medical Laboratory Technology – A practical Manual for routine diagnostic tests – Volume I to Volume III. Tata Mac Graw Hill Company.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Clinical Biochemistry and Diagnostic Microbiology MIC3511**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall key indicators of organ damage associated with lifestyle disorders and methods to quantify the damage	
CO2	Illustrate the data obtained from biochemical analyses of samples such as whole blood, serum, urine etc. with clinical symptoms and possible pathologies	
CO3	Calculate the severity of the tissue damage or lifestyle disorder based on data generated through clinical biochemistry	
CO4	Analyse load of pathogens from various samples such as food, water and bodily fluids using rapid diagnostic tests	
CO5	Compare the efficiency, cost and use of routine lab procedures for isolation of bacterial, fungal and viral pathogens with rapid tests	
CO6	Specify the use of rapid detection tests under conditions of emergency and unavailability of laboratory resources	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Lifestyle disorders & clinical biochemistry** Kidney function tests – Estimation of serum total protein & albumin, estimation of serum urea & calculation of BUN, estimation of uric acid, estimation of serum creatinine, estimation of blood cystatin C, Liver function tests - Bilirubin, SGPT, SGOT, Alkaline phosphatase, Lipid profile - Triglycerides, HDL, LDL, Cholesterol, Ions - Magnesium, Calcium, Sodium, Phosphorous, Chloride	**18**
II	**Diagnostic Microbiology focussing on rapid detection of common pathogens from various samples** Hepatitis B surface antigen, C Reactive protein, Syphilis Test /RPR, *Salmonella* (O and H antigen), *influenzea, Listeria monocytogenes, E. coli* (From food samples) *Neisseria meningitides*, Rotavirus, *Candida albicans*	**18**

References:

1. Practical Clinical Biochemistry, Harold Varley4th Edition CBS Publishers and Distributors Pvt. Ltd. New Delhi
2. Textbook of Biochemistry with clinical correlations Thomas Devlin (Editor); John Wiley and Sons
3. Biochemistry by U. Satyanarayana and U. Chakrapani 5th Edition; Elsevier Publications
4. Clinical Biochemistry by Nanda Maheshwari 2nd edition Jaypee Brothers Publications
5. Medical Physiology by John E. Hall and Michel E. Hall 3rd South Asia Edition, Elsevier Publications

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Epidemiological Principles and Experimental Analysis MIC3512**	**Number of Credits :2**
Course Outcomes (COs) **On completion of the course, the students will be able to:**		
CO1	Describe the disease distribution based on time, place and person	
CO2	Give the examples of different sources and reservoirs of infection	
CO3	Calculate incidence, prevalence, morbidity, mortality rate.	
CO4	Explain types of modes of disease transmission, distinguish between methods of disease prevention and control	
CO5	Evaluate and interpret the epidemiological data using different methods like case control study, cohort study	
CO6	Write the differences between descriptive, analytical, and experimental epidemiology	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Epidemiological principles** Definition, scope and applications, Incidence and prevalence rates, mortality and morbidity rates, Disease distribution based on time, place and person, Types of epidemiological methods Descriptive epidemiology, Analytical epidemiology Experimental epidemiology Case control and cohort studies – study design and application Epidemiology of infectious diseases, Sources and reservoirs of infection, Modes of transmission of infections, Prevention and treatment measures, Emerging infectious diseases.	**18**
II	**A) Experimental epidemiology** Randomized controlled trials: Types of Randomized controlled trials**:** Clinical trials, Preventive trials, risk factor trials, cessation experiments, Trial of etiological agents, Evaluation of health services Nonrandomized controlled trials: Types of non- Randomized controlled trials: Uncontrolled trials, Natural experiments, Before and after comparison studies Concept of association and causation **B) Epidemiological survey** Development of hypothesis, Data collection and organization Statistical analysis, Graphical representation using computers and its interpretation, Preparation of report	**18**

References:

1. Park and Park, Preventive and Social medicine. 2013, Publisher: Banarsidas Bhanot, Jabalpur.

T. Y. B.Sc. Semester VI		
Title of the Course and Course Code	**Metabolic activities of microorganisms MIC3601**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Recall key bio catalytic agents involved in the biochemical synthesis and degradation of biomolecules in microbial systems and focus on their regulatory significance	
CO2	Outline the composition of biological membranes to their structure and function differentiating cellular and subcellular systems on the diversity of membrane components	
CO3	Calculate the energy requirements or energy output of biochemical pathways and grade these pathways for their use and indispensability	
CO4	Analyse the free energy change occurring during the progress of a biochemical reaction and correlate it to the feasibility of the reaction in biological systems	
CO5	Compare the use of multiple transport processes and their use under differing cellular conditions	
CO6	Specify the use of certain groups of high energy compounds as common currency used by cellular systems	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**A. Role of Membrane structure and function in metabolism** Membrane Structure and Specificity Concept of polar and nonpolar biomolecules transported across biological membranes, Membrane potential and its significance Structure of lipid bilayer and the Fluid Mosaic model with components: Glycerophospholipids, Sterols and Proteins Differences in membranes of subcellular compartments and the plasma membranes of animal and plant cells Membrane Transport: Revise concepts of mathematical expressions and examples for Diffusion, Osmosis, Passive Transport, active transport and facilitated transport, Primary active transport with examples, Secondary active Transport with examples, Examples for multiple transport mechanisms for a single solute: Group translocation, Sodium Glucose symporter and GLUTS **Bioenergetics** Revision of Fundamentals Concepts Laws of Thermodynamics free energy considerations in biological systems, Concept of enthalpy, entropy and free energy, activation energy, feasibility of reactions, coupled reactions High energy compounds Hierarchy amongst high energy compounds, Common high energy compounds used in biological systems:	**18**

	Reasoning, structure and utilization. Pyrophosphates, enolic phosphates, Thioesters Energy conservation Coupling of PMF and ATP synthesis, Structure and function of ATP synthase, Inhibitors and uncouples of ETC and oxidative phosphorylation.	
	Biosynthesis and Degradation of Biomolecules through metabolic pathways Biosynthesis: Concept of polymerization Polysaccharides: Starch, Glycogen and Peptidoglycan Lipids: Fatty acids, Triacylglycerols and phospholipids Degradation of Macromolecules Polysaccharides: Starch, Cellulose and Glycogen, Lipids: Beta Oxidation of fatty acids, Protein Urea cycle Photosynthesis in Bacteria Concept of bacterial photosynthesis: Habitats and examples of photosynthetic bacteria, Photosynthetic apparatus, Oxygenic and anoxygenic mechanisms, Synthesis of reserve food material through photosynthesis, Cyclic and Non-cyclic photophosphorylation and conservation of energy	

References:

1. Nelson D. L. and Cox M. M. (2017). Lehninger's Principles of Biochemistry 7th Edition, WH Freeman Macmillan Worth Pub. Co., New Delhi.
2. Segel Irvin H. (2010). Biochemical Calculations. 2nd edition, John Wiley and Sons, New York.
3. Garrett, R. H. and Grisham, C. M. (2009) Biochemistry. 4th Edition, Brooks / Cole, Publishing Company, California.
4. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (2006) Outlines of Biochemistry 5th edition, John Wiley and Sons, New Delhi.
5. Palmer Trevor (2008). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry 2nd Edition, Horwood Pub. Co., Chinchester, England.
6. White David (2006). Physiology and Biochemistry of Prokaryotes. 3rd Edition. Oxford University Press, New York.
7. David A. Hall & Krishna Rao (1999). Photosynthesis (Studies in Biology) 6th edition, Cambridge University Press, London
8. Harvey Lodish et. al (2016), Molecular Cell Biology 8th Edition W. H. Freeman Macmillan Worth Pub. Co., New Delhi.

T. Y. B.Sc. Semester VI		
Title of the Course and Course Code	**Immunological Processes MIC3602**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe different types of mechanisms in the activation of innate immune response	
CO2	Classify and compare major histocompatibility complex molecules and their role in transplantation of grafts	
CO3	Demonstrate and classify hypersensitivity reactions and outline their mechanisms	
CO4	Explain and identify the role of immunological mediators in innate immune response and cell-cell interactions	
CO5	Compare the role of cytokines and categorize them according to their function in cell mediated immune response	
CO6	Specify and analyse the pathways of antigen processing and presentation	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Regulation and activation of immune response** **Cytokines:** Types, General characters and role in immune activation - Interferons, Interleukins and TNFs **Non-specific defence mechanisms**: **Humoral components:** Defensins, pattern recognition proteins (PRP) and pathogen associated molecular patterns (PAMPs), kinins, acute phase reactants **Phagocytosis** (oxygen dependent and independent systems) **Complement** and its activation (Classical, Alternative and lectin pathway), Coagulation system **Inflammation** (cardinal signs, mediators, vascular and cellular change, toll like receptors **Cell mediated Immune response:** Activation and differentiation of T cells, Mechanism of CTL mediated cytotoxicity, ADCC	**18**
II	**Clinical and diagnostic Immunology** **Antigen-Antibody interactions** Concept of antibody avidity, affinity and cross-reactivity, Precipitation reactions, Agglutination reactions, Immunofluorescence, ELISA and its modifications **Transplantation:** Types of Grafts, Allograft rejection mechanisms, Prevention of allograft rejection; Immunosuppression, HLA typing **Hypersensitivity**: Immediate and delayed type of hypersensitivity, Gell and Coombs classification of	**18**

	hypersensitivity, mechanism with examples for type I, II, III and IV **Autoimmunity**: Types, Immunopathological mechanisms, Theories of origin of autoimmunity, Pathophysiology (mechanism of symptom generation) of Myasthenia gravis and Rheumatoid arthritis, Therapeutic immunosuppression for autoimmunity	

References:

1. Janeway Charles A., Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology Interactive, 2005. Garland Science Publishing, USA.
2. Kindt T. J., Goldsby R. A., Osborne B. A., 2007, Kuby Immunology 6th edition, W. H. Freeman and Co., New York.
3. Pathak S. S. and Palan V. (1997). Immunology - Essential and Fundamental, Pareen Publications, Bombay.
4. Roitt Evan, Brostoff J. Male D. (1993). Immunology 6th edition, Mosby and Co., London.
5. Roitt I. M. (1988). Essentials of Immunology, ELBS, London.
6. Roitt M. (1984). Essentials of Immunology, P. G. Publishers Pvt. Ltd., New Delhi.

T. Y. B.Sc. Semester VI		
Title of the Course and Course Code	**Large Scale Bioprocess MIC3603**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe different types of commercially important fermentation products.	
CO2	Explain how antibiotics, vitamins, enzymes, amino acids, organic acids are manufactured at industrial scale with the help of microorganisms.	
CO3	Apply detailed knowledge of the transformation of steroids into pharmacologically active forms with the help of microorganisms	
CO4	Analyze various flow sheets or flow charts used for extraction of different types of fermentation products	
CO6	Evaluate the various methods of immobilization of enzymes and whole cells and change in their activity.	
CO5	Synthesize and apply single cell proteins	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Microbial production of organic acid, solvents and beverages** Organic acid: Acetic acid. Solvents: Acetone butanol Beverages: Beer and wine.	**18**

	Enzymes: Amylase and esterase. Steroids: Microbial transformation with an example of any one steroid in detail	
II	**Microbial production of therapeutic agents** Antibiotics: Streptomycin, Cephalosporin. Vaccines: Polio, Tetanus. Amino acids: Lysine, glutamic acid Vitamins: Cyanocobalamin, Riboflavin Immobilized enzymes, methods and applications.	**18**

References:

1. Casida, L. E., 1984, Industrial Microbiology, Wiley Easterbs, New Delhi
2. Peppler, H. L 1979, Microbial Technology, Vol I and II, Academic Press.
3. Stanbury, P. F. and Whittaker, A. (1984) Principles of Fermentation technology, Pergamon press
4. Prescott. S.C and Dunn, C. G., 1983 Industrial Microbiology, Reed G. AVI tech books.
5. A.H. Patel. (1985), Industrial Microbiology, Macmillan India Ltd.
6. Indian Pharmacopeia and British Pharmacopeia (Latest Edn).

T. Y. B.Sc. Semester VI		
Title of the Course and Course Code	**Food and Dairy Microbiology MIC3604**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage.	
CO2	Articulate the basis of food safety regulations and discuss the rationale for the use of standard methods and procedures for the microbiological analysis of food.	
CO3	Apply knowledge of microbiological methods for their isolation, detection and identification of microorganisms in food and employ in industries.	
CO4	Categorize important pathogens and spoilage microorganisms in foods.	
CO5	Justify the ways to control microorganisms in foods and thus know the principles involving various methods of food preservation.	
CO6	Write the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Food Microbiology:** Introduction: Food as a substrate for microorganisms, importance, classification of foods based on stability. **Food Spoilage** –Chemical and physical properties of food affecting microbial growth, Sources of food spoilage causing microorganisms, Spoilage of Meat and Poultry products, Bread, Fruits and Vegetables, Eggs, Sea foods and Canned foods. **Food preservation –** Principles of food preservation, Thermal destruction of bacteria - use of low temperature and high temperature. Determination of TDP, TDT, D, F, and Z values, Use of chemicals and antibiotics, radiations, additives in preservation of food. **Food borne infections and intoxications –** Food borne disease, Laboratory testing - preventing measures **Applications of genetically modified foods**	**18**
II	**Dairy Microbiology:** **Dairy Development in India:** Role of National Dairy Development Board (NDDB), National Dairy Research Institute (NDRI), Military dairy farm, Indian Dairy Corporation (IDC), Dairy Co-operatives, Milk Grid, Operation Flood. **Milk Chemistry and Constituents: -**Definition and Composition of milk, Types of Milk (skimmed, toned and homogenized), Concept of clean milk, Factors affecting quality and quantity of milk, Physico-Chemical properties of milk **Microbiology of milk: -** Common microorganisms found in milk, Fermentation and spoilage of milk, Milk borne diseases **Methods of Pasteurization:** Principle of Pasteurization - LTH, HTST, UHT **Food sanitation and regulation:** Plant sanitation, Employee's health standards, quality control and HACCP.	**18**

References:

1. Banwart G. J. (1989). Basic Food Microbiology, 2nd Edn. Chapman and Hall, International Thompson Publishing.
2. Clarence Henry Eckles, Willes Barnes Combs, Harold Macy (1943). Milk and milk products, 4th Ed. McGraw-Hill Book Company, Incorporated.
3. James M. Jay, Martin J. Loessner, David A. Golden (2005). Modern Food Microbiology, 7th Edn. Springer Science & Business.
4. Sukumar De (2001). Outlines of Dairy Technology. 1st Ed. Oxford University Press, Delhi.
5. William C. Frazier, Dennis C. Westhoff, N. M. Vanitha (2013). Food Microbiology, 5th Edn. McGraw-Hill Education, India.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Antimicrobial Therapy and Prevention MIC3605**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define MIC, MBC and LD50, Describe desirable properties of chemotherapeutic agents	
CO2	Explain different targets in bacteria and mode of action of different antimicrobial compounds, differentiate between types of antimicrobial compounds	
CO3	Classify drugs based on the site of action, Interpret mode of action of antifungal and antiviral drugs	
CO4	Explain mode of action of antimicrobial compounds, distinguish between antifungal and antiviral drugs	
CO5	Compare different types of vaccines, review different types of antisera, assess the immunization schedules in developed and developing countries	
CO6	Write types of clinical research and scope of clinical research and good clinical practices	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Chemotherapy I** Introduction to chemotherapy: Desirable parameters of chemotherapeutic agent (Selective toxicity, Bioavailability of Drug, LD-50 value, routes of drug administration, MIC, MBC) Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis: Cycloserine, Bacitracin, Carbapenems. Cell membrane functions: Polymyxin B, Monensin, Protein synthesis: Streptomycin, Tetracycline, Nucleic acid synthesis: Nalidixic acid, Rifampicin, Enzyme inhibitors: Trimethoprime, Sulfa drugs.	**18**
II	**Chemotherapy II** **Mode of action of antimicrobial agents on:** **Fungi:** Griseofulvin, Nystatin, Anidulafungin, Voriconazole **Viruses:** Acyclovir, Zidovudine, Oseltamivir **Protozoa:** Metronidazole, Mepacrine **Resistance to antibiotics:** Genetic basis of resistance Biochemical mechanisms of resistance, Development of antibiotic resistance (e.g., VRE, MRSA), Antibiotic misuse **Vaccines and antisera, Developing vaccines.** Immunization schedules: principles, schedules in developing and developed countries	**18**

References:

1. Chakraborty, P., 2003. A textbook of Microbiology, 2nd Edition New Central Book Agency, India.

2. David Greenwood, 2007. Antimicrobial Chemotherapy, 5th Edition, Oxford University Press.

3. Franklin, T.J and Snow, G. A. 2012. Biochemistry of Antimicrobial Action. Springer Science & Business Media

4. R.S. Satoskar, S.D. Bhandarkar, 2007. Pharmacology and pharmacotherapeutics, Popular Prakashan, 20th edition.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Recombination and Gene Manipulation MIC3606**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	List the steps of different models for recombination and describe the role of proteins involved in them	
CO2	Explain the types and use of bacteriophage mutants in the study of genetic complementation	
CO3	Outline the guidelines for setting up a facility for gene manipulation experimentation	
CO4	Explain the basic procedure for generating a recombinant DNA molecule	
CO5	Evaluate the generation of recombinant DNA using basic molecular biology tools	
CO6	Generate a sequence of DNA using the conventional methodologies	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	**Genetic Recombination** Concept of Recombination. Proteins involved in recombination: RecA, B, C, D, Ruv A, B, C Models for homologous recombination: The Holliday model, Double strand break repair model. Homologous and site-specific recombination Genetic Complementation: Cis-Trans test of genetic function, Intercistronic (rII locus of phage), Intracistronic (β galactosidase)	**18**
II	**Basics of rDNA technology** aGuidelines for gene manipulation. Generation of recombinant DNA Enzymes required for cutting and joining the DNA molecules: Restriction endonucleases and DNA ligase Vectors: Plasmids, cosmids, phagemids	**18**

	Methods to transfer recombinant DNA into host, screening of rDNA, Concept of genomic and cDNA libraries, Concept of clone and probe, Isolation & purification of genomic DNA. Isolation of RNA, Agarose Gel Electrophoresis, Blotting: Northern, Southern and Western, Concept of PCR, DNA sequencing - Maxam Gilbert and Sangers	

References:

1. Strickberger, M. W., 1985 Genetics, 3rd Edition Macmillan Pub. Co., NY.
2. Stanier, R. Y., 1985, General Microbiology, 4th Edition, and 5th edition, MacMillan Pub. Co., NY.
3. Hayes, William, 1984, The Genetics of Bacterial and their Viruses, CBS Pub., New Delhi.
4. Peter J. Russell, iGenetics: A Molecular Approach, 3rd edition, Pearson.
5. Lewin Benjamin, 1994, Genes II, VII and VIII, Oxford University Press.
6. Primrose, S. B. and Old. Principles of Gene Manipulation.
7. Dale, J. W., Schantz, M. V., Plant, N., 2012, From Genes to Genomes: Concepts and Applications of DNA technology, 3rd edition, Wiley-Blackwell Pub., UK.
8. Brown T. A., 2010, Gene Cloning and DNA Analysis, 6th edition, Wiley-Blackwell Pub., UK.
9. Brown T. A., 2002, Genomes, 2nd edition, Bios Scientific Publishers Ltd.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical IV MIC3607**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	State the name of the microorganism used in synthesis of nanoparticles and synthesize *metal nanoparticles.*	
CO2	Estimate and grade microbial quality of food and dairy products and name the methods used in testing of microbial quality food items.	
CO3	Carry out isolation and identification of spoilage causing organism from food	
CO4	Detect adulterants in food products.	
CO5	Test and perform enrichment, Isolation, Preparation and Application of Bioinoculants at laboratory scale.	
CO6	Prepare fermented food in the laboratory.	

Unit. No.	Title of Unit and Contents	No. of Practicals
I	**Microbial Testing of Food and Dairy Products** **a)** Phosphatase test. **b)** MBRT test. **c)** Test for detection of Mastitis. **d)** Standard Plate Count (for milk / milk product / food products e.g. milk powder, confectionary products) **e)** Direct Microscopic Count. **f)** Detection of Adulterants in food products.	**5**
II	**a)** Isolation and identification of common microorganisms from spoiled food. **b)** Enrichment, Isolation, Preparation and Application of Bioinoculants (e.g. *Azotobacter-Rhizobium/* Blue Green Algae (Cyanobacteria), Phosphate Solubilizer - any one). **c)** Preparation of fermented food (Sauerkraut or Curd- any one). **d)** Laboratory scale fermentation of Ethanol. **e)** Product recovery by distillation. **f)** Estimation using Cerric Ammonium Nitrate method and yield calculation	**5**

References:

1. Practical Food Microbiology 3rd edi, edited by Diane Roberts and Melody Greenwood, Blackwelll Publishing, 2003.
2. Kalyanaraman Rajagopal and Venkatachalam Deepa Parvathi (2017) A Practical Manual on Synthesis of Nanoparticles and its Applications in Biology. ISBN:978-93-84962-03-2.
   Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. FSSAI: Manual of Simple methods for testing of common adulteration in food. https://archive.fssai.gov.in/dam/jcr:04ddea72-d3a8-4e4e-809e-196d8834b4a8/Manual_Testing_Method_Food_Safety_On_Wheels_30_08_2017.pdf

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical V MIC3608**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Identify the presence of DNA in a sample using basic molecular biology techniques	
CO2	Explain the methodology for isolation of bacteriophages in laboratory	
CO3	Carry out the isolation of genomic DNA	
CO4	Analyse the purity of the isolated DNA using spectrophotometry	
CO5	Determine the competence of bacterial culture necessary for transformation	
CO6	Generate transformants and specify recombinants using popular screening methods	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**a)** Isolation of *E coli* as a host and enrichment of bacteriophage. **b)** Isolation of bacteriophage using *E coli* as bacterial host. **c)** Enumeration of bacteriophages using agar overlay method. **d)** Isolation of genomic DNA by Marmur's method. **e)** Detection and quantitation of DNA using Diphenylamine method. **f)** UV spectroscopy to determine purity of DNA	**5**
II	**a)** Isolation of plasmid DNA by alkaline lysis method. **b)** Agarose gel electrophoresis. ***c)*** Preparation of competent cells of *E coli* ***d)*** Transformation of *E coli* **e)** Screening of recombinant cells **f)** Study tour to a research institute and preparation of visit report	**5**

References:

1. Shende RK, Hirpurkar SD, Sannat C, Rawat N, Pandey V. Isolation and characterization of bacteriophages with lytic activity against common bacterial pathogens. Vet World. 2017;10(8):973-978. doi:10.14202/vetworld.2017.973-978
2. J. Marmur, A procedure for the isolation of deoxyribonucleic acid from micro-organisms, Journal of Molecular Biology, Volume 3, Issue 2, 1961, Pages 208-IN1, ISSN 0022-2836.

3. Burton, K. 1956. A study of the conditions and mechanism of the diphenylamine reaction for the colorimetric estimation of deoxyribonucleic acid. Biochem. J. 62: 315.
4. Dash H.R., Shrivastava P., Das S. (2020) Quantification of DNA by Using UV–Visible Spectrophotometer. In: Principles and Practices of DNA Analysis: A Laboratory Manual for Forensic DNA Typing. Springer Protocols Handbooks. Humana, New York, NY
5. Sambrook, J., & Russell, D. W. (2001). Molecular cloning: A laboratory manual. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Microbiology Practical VI MIC3609**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define and compare different types of haematological indices by using different parameters	
CO2	Articulate the working, handling and storage of blood in blood banks	
CO3	Classify different clinical specimens and to interpret the data obtained using different parameters	
CO4	Organize the data obtained from different haematological tests and predict the clinical condition of the patient	
CO5	Determine the potential blood donors and recipients by categorizing different types of blood groups and blood cells	
CO6	Combine and arrange the haematogical data obtained and prepare the hemogram	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	**a)** Estimation of hemoglobin (Cyan-methemoglobin method) **b)** Counting of RBCs and WBCs using counting chambers **c)** ESR, PCV determination **d)** Calculation of hematological indices **e)** White blood cell differential count from peripheral blood	**5**

	f) Blood group typing for ABO and Rh systems	
II	**a)** Cross-matching **b)** Widal test **c)** Coomb's test **d)** Immunoprecipitation: Double diffusion (Ouchterlony) technique **e)** Demonstrations of RPR test and ELISA (Antigen / Antibody detection **f)** Visit to blood bank and preparation of visit report	**5**

References:

1. Cruickshank K.R.,2005, Medical Microbiology Vol I & II Livingstone, Longman
2. Mukherjee K.L. Medical Laboratory Technology – A practical Manual for routine diagnostic tests – Volume I to Volume III. Tata MacGraw Hill Education

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Marine Microbiology MIC3611**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe experiment physico- chemical parameters of marine water and corelate the knowledge with microbial diversity	
CO2	Explain microbial diversity in oceans and appraise the metabolic differences in marine bacteria	
CO3	Classify the organisms based on their nutritional requirements and determine their growth on different culture media	
CO4	Analyse the ability of microorganisms to produce bioactive compounds useful in day- to- day life	
CO5	Determine about marine biogeochemical cycles and choose correct sampling techniques to collect water samples	
CO6	Create methods to isolate bacteria of medical importance	

Unit. No.	**Title of Unit and Contents**	**No. of Lectures**
I	Introduction to Marine Ecosystem and Marine Biodiversity **Marine environment** Physico-chemical characteristics of marine water: pH, temperature, density, pressure, organic and inorganic composition, Deep sea marine environment **Marine microbial physiology:** Metabolic diversity - fermentation, aerobic respiration, anaerobic respiration in various marine microenvironments Role of microorganisms in biogeochemical cycling in oceans:	**18**

	carbon, nitrogen, phosphorous, sulphur, iron Sampling methods	
II	**Marine Bioprospecting** **Determination of marine biodiversity:** Determination of bacterial diversity and determination of species evenness and species richness from marine water/ marine fishes, Mode of nutrition -autotrophic & heterotrophic modes, defining culture media to support growth Brief account on other marine microbes (Algae, Cyanobacteria, fungi, phytoplanktons, viruses, archaea) Effects of microorganisms in aquafarming, Marine symbiosis Bioprospecting and its roles in ocean processes Extracellular polysaccharide production, Demonstration of antimicrobial activity, Pigment production, Industrially important enzymes: protease and lipase	**18**

References:

1. Belkin, S. and Colwell, R. R., Ocean & Health: Pathogens in the Marine Environment, Springer.
2. Munn, C., Marine Microbiology: Ecology and Applications, Garland Science, Taylor and Francis, N.Y.
3. Jorgensen, B. B., Boetius, A. (2007) Feast and Famine: microbial life in the deep sea bed. Nature Reviews Microbiology, 5: 770-781.
4. Nakagawa, S., Takai, K. (2008) Deep-sea vent chemoautotrophs: diversity, biochemistry and ecological significance. FEMS Microbial Ecology, 68: 1-84.
5. Heni Abida et al. (2013) Bioprospecting Marine Plankton. Marine drugs, 11: 4594-4611

T. Y. B.Sc. Semester V		
Title of the Course and Course Code	**Prebiotics and Probiotics MIC3612**	**Number of Credits :2**
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Define prebiotics, probiotics and functional foods.	
CO2	Discuss about the importance gut microflora in maintaining good health, immune response and prevention of IBD.	
CO3	Infer the characteristics of probiotics for selection.	
CO4	Analyse various fermented products for their probiotics properties	
CO5	Review different mechanisms of probiotic's action	
CO6	Synthesize functional foods by getting the knowledge of prebiotics and probiotics.	

Unit. No.	Title of Unit and Contents	No. of Lectures
I	**Prebiotics:** Concept, definition, criteria, types and sources of prebiotics, prebiotics and gut microflora Prebiotics and health benefits: mineral absorption, immune response, cancer prevention, IBD, elderly health and infant health, prebiotics in foods, Functional Dairy Products: Definition, fermented milk products, functional dairy products, functional Dairy products and therapeutic applications, Health benefits of functional fermented dairy products: such as dahi, lassi, yoghurt, kefir, cheese, kefir, koumiss, Yakult, fermented whey drinks, and dairy based cereal foods, soy based yoghurt containing probiotics**.** Functional dairy ingredients: CPP, Oligosachharides, LAB, CLA, Product development: enhancing functionality of prebiotics and probiotics.	**18**
I	**Probiotics:** Introduction and history of Probiotics, Probiotic microorganisms, safety of probiotic microorganisms, legal status of probiotics, Characteristics of Probiotics for selection: Tolerance to additives, stability during storage, stability during passage to intestinal sites, minimum effective dose, maintenance of probiotic microorganisms, Role of probiotics in health and disease: Prevention and treatment of gastro-intestinal bacterial infection, Mechanism of probiotics: complete exclusion, production of antimicrobial substances, modulation of immune system, alteration of intestinal bacterial metabolite action, alteration of microecology of healthy humans and patients.	**18**

References:

1. Salminen. S and Wright, A. V. 1998. Lactic Acid Bacteria, Marcel Dekker
2. Glenn R. G. Marcel R. 2008. Handbook of Prebiotics CRC press
3. Lee Y K, Salminen S 2009. Handbook of Probiotics and Prebiotics. A John Willey and Sons Inc. Publication
4. Sandholm T. M. Saarela M. 2003. Functional Dairy Products CRC Woodhead Publishing Ltd D