

THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE
DEGREE COURSE
M.Sc. APPLIED MICROBIOLOGY
UNDER CBCS
(with effect from 2017-2018)

The Course of Study and the Scheme of Examinations

S.NO.	Study Components		Ins. hrs /week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
SEMESTER I								
1	MAIN	Paper-1	5	5	General Microbiology and Microbial Physiology	25	75	100
2	MAIN	Paper-2	5	5	Food, Agriculture and Environmental Microbiology	25	75	100
3	MAIN	Paper-3	5	5	Immunotechnology	25	75	100
4	MAIN	Paper-4	4	4	Human anatomy and physiology	25	75	100
5	MAIN PRACTICAL	Paper-1	4	0	(Subjects covering Paper 1, 2 and 3)	-	-	-
6	MAIN PRACTICAL	Paper-2	4	0	(Subjects covering Paper 4, 5 and 6)	-	-	-
7	ELECTIVE	Paper-1	3	3	(to choose 1 out of 3) A. Biofertilizer Technology B. Fundamentals in Biology C. Microbial Biotechnology	25	75	100
			30	18		125	375	500
SEMESTER II								
8	MAIN	Paper-5	5	5	Medical Microbiology	25	75	100
9	MAIN	Paper-6	5	4	Microbial Pharmacology	25	75	100
10	MAIN	Paper-7	5	4	Bioinformatics and Biostatistics	25	75	100
11	MAIN PRACTICAL	Paper-1	5	5	(Subjects covering Paper 1, 2 and 3)	25	75	100
12	MAIN PRACTICAL	Paper-2	5	5	(Subjects covering Paper 4, 5 and 6)	25	75	100

M.Sc. Applied Microbiology: Syllabus (CBCS)

13	Compulsory Paper		2	2	Human Rights	25	75	100
14	ELECTIVE	Paper-2	3	3	(to choose 1 out of 3) A. Food analysis and quality control B. Genetic Engineering C. Microbial Bio nanotechnology	25	75	100
			30	28		175	525	700
SEMESTER III						CIA	Uni. Exam	Total
15	MAIN	Paper-8	6	5	Microbial Genetics and Molecular Biology	25	75	100
16	MAIN	Paper-9	6	5	Recombinant DNA Technology	25	75	100
17	MAIN	Paper-10	5	5	Industrial Biotechnology	25	75	100
18	MAIN PRACTICAL	Paper-3	5	-	(subjects covering Paper 7, 8 and 9)	-	-	-
19	MAIN PRACTICAL	Paper-4	5	-	(subjects covering Paper 10)	-	-	-
20	ELECTIVE	Paper-3	3	3	(to choose 1 out of 3) A. Biological Techniques B. Herbal Technology C. Vaccine Biotechnology	25	75	100
			30	18		100	300	400
SEMESTER IV						CIA	Uni. Exam	Total
21	MAIN	Paper-11	6	4	Research Methodology	25	75	100
22	MAIN	Paper-12	5	5	Project / Dissertation with <i>viva voce</i>	50	150	200
23	MAIN PRACTICAL	Paper-3	5	5	(subjects covering Paper 7, 8 and 9)	25	75	100
24	MAIN PRACTICAL	Paper-4	5	5	(subjects covering Paper 10)	25	75	100
25	ELECTIVE	Paper-4	3	3	(to choose 1 out of 3) A. Bioremediation B. Marine Microbiology C. Clinic Microbiology	25	75	100
			30	26		150	450	600

Subject	Papers	Credit	Total Credits	Marks	Total marks
MAIN	12	4-5	56	100	1300
MAIN PRACTICAL	4	5	20	400	400
ELECTIVE	4	3	12	100	400
COMPULSORY PAPER	1	2	2	100	100
Total	21	-	90	-	2200

**THIRUVALLUVAR UNIVERSITY
M.Sc. APPLIED MICROBIOLOGY
SYLLABUS
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SEMESTER I**

**PAPER – 1
GENERAL MICROBIOLOGY AND MICROBIAL PHYSIOLOGY**

OBJECTIVES

To enable the students to understand the basic knowledge in Microbiology and Microbial diversity.

UNIT-I

Discovery of Microbial world. Controversy over spontaneous generation. Evolutions of Microbiology with its recent developments in Medicine. Modern trends in microbial taxonomy.

UNIT-II

Microscopy - Its principles and applications. Simple - Compound, Dark field, phase contrast, Fluorescent and Electron Microscopes - SEM, TEM. Principles, Operation and maintenance of autoclaves, Ovens, Centrifuges - refrigerated & ultra speed, calorimeters, spectrophotometers, lyophilizers, deep freezer. Staining methods - Gram, Acid Fast, metachromatic, granules, nuclear staining, capsule, silver impregnation, flagella and other special staining methods. Sterilization and disinfection methods and their quality control.

UNIT-III

Bacterial morphology, structure and characterization - cellular components of bacteria - sporulation and its mechanics - growth and nutrition - Nutritional requirements - Autotrophs, heterotrophs - enrichment culture - growth curve - Kinetics of Growth - Mathematical expression of exponential growth phase; Measurement of growth and growth yields - Batch Culture - Synchronous growth - Techniques of pure culture.

UNIT-IV

Classification of bacteria and salient features according to Bergey's manual of determinative Bacteriology. Microbial diversity in different ecosystems. Structure and function of viruses - classification of viruses - replication of viruses - bacteriophages, plant viruses- TMV, CMV, Alfalfa mosaic virus and animal viruses. Specialized somatic Structure and Classification of fungi. Reproduction in fungi - Life cycles of fungi. Structure and Classification of Algae - ultrastructure and life histories of microalgae belonging to various algal classes. Cyanobacteria.

UNIT-V

Basic concepts of metabolism. Carbohydrate metabolism - Glycolysis - HMD, TCA & ED and other pathways. Aerobic and anaerobic respirations - Generation of energy - substrate level and oxidation phosphorylation - Electron transport chain - Lipid metabolism - Beta oxidation - proteins - primary, secondary, tertiary and quaternary structures - Enzymes nomenclatures, classification and general properties - factors affecting enzyme synthesis and activities - Allosteric enzymes - photosynthesis - cyclic and non -cyclic photophosphorylation - Bioluminescence.

TEXT BOOKS:

1. Rajan. S and Selvi Christy (2015). Essentials of Microbiology, Anjanaa Book House Publishers, Chennai.
2. Ananthanarayan and Panikers (2013) Textbook Microbiology 9th edition, Universities Press (India) Private Ltd.
3. Chandar Sbekar, C.N. (2006). Manipal Manual of Physiology, CBS Publishers and distributors Pvt. Ltd., Chennai.
4. Rafi, M.D. (2014). Textbook of Biochemistry. 2nd edition, Universities Press (India) Private Ltd.
5. Channarayappa (2015). Molecular Biology, Universities Press (India) Private Ltd.
6. Dubey RC and Maheswari DK (2005). A text book of Microbiology, Revised Multicolour edition, S.Chand Publishers, New Delhi.
7. Purohit SS (2005). Microbiology - Fundamentals and Applications. Student Edition Publishers, Jodhpur.
8. Pelczar & Kreig (2006). Microbiology 5th edition. Tata McGraw Hill, New Delhi

9. Powar & daginawala (2005). General Microbiology Vol.I & II 8th Edition, Himalaya Publishing House, Mumbai.
10. Salle, AJ (2001). Fundamentals & Principles of Bacteriology. 7th edition. Tata McGraw-Hill, Davis,
11. Chandar Sbekar, C.N. (2006). Manipal Manual of Physiology, CBS Publishers and distributors Pvt. Ltd., Chennai.
12. Pal, G.K and Pravathi Pal. (2016) A text book of Practical Physiology, 4th Edition Universities Press (India) Pvt Ltd,

REFERENCE BOOKS:

1. Delbecco, Eisen & Ginsburg (1990) Microbiology 5th Edition Harper & raw, New York
 2. Gerhardt, Murray, Wood and Kreig 1994. Methods for General and Molecular Bacteriology, ASM Press, Washington.
 3. Alexopoulus CJ and C W. Mims.(1993).Introductory Mycology (3rd edition) Wiley Eastern Ltd, New Delhi.
 4. Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.
 5. Conrat HF, Kimball PC and Levy JA. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.
 6. Roger Hull (2002). Mathews' Plant Virology. (4thEdition).Academic press-A Harcourt Science and technology company, New York.
 7. Nelson D.L. and Cox, M.M. (2001). Lehninger Principles of Biochemistry, 3rd edition, Mac Millan Eworth Publishers.
 8. Raaman, N. 2006. Phytochemical Techniques. New India Publishing Agency, New Delhi
- Stryer L (1995). Biochemistry. W.H. Freeman and Company.
9. Voet D. and Voet J (1995) Biochemistry, 2nd edition, John Wiley and Sons Inc.

PAPER-2

FOOD, AGRICULTURE AND ENVIRONMENTAL MICROBIOLOGY

OBJECTIVES

To enable students to understand the various microbes involved in food, agriculture and environment.

UNIT-I

Importance of studying food and dairy microbiology. Primary sources of microorganisms in foods. Factors influencing microbial growth in foods - extrinsic and intrinsic. Principles of food preservation - preservation methods - irradiations - drying, heat processing, chilling and freezing, high pressure, modification of atmosphere and chemical preservatives. Nutritional value of fermented foods. SCP and their uses - contamination, preservation and spoilage of fruits vegetables, meat and poultry products.

UNIT-II

Microbiology of fermented milk - fermented milk products - Food sanitation in food manufacture and in the retail trade - Food control agencies and its regulations, HACCP Methods. Bacterial pathogens such as Brucella, Clostridium, Bacillus, E. coli, Listeria, Salmonella, Staphylococcus, Vibrio and Yersinia.

UNIT-III

Distribution of soil microorganisms in soil. Factors influencing the soil microflora - Role of microorganisms in soil fertility. Interactions among microorganisms, mutualisms, comensalism, competition, amensalism, parasitism, predation - Interactions between microbes and plants - rhizosphere, phyllosphere, mycorrhizae. Microbial interactions in animals-Rument microbiology - Microbial contribution to food digestion.

UNIT-IV

Biogeochemical - carbon cycle - role of microbes in carbon cycle - trophic relationships - mobilization and immobilisation of carbon with rhizosphere. Nitrogen cycle - mechanism of biological nitrogen fixation - ammonification - nitrification - denitrification and microorganisms involved in such processes. Phosphorous cycle - Sulphur cycle. Biofertilizer for sustainable agriculture *Rhizobium Azospirillum*, *Azotobacter*, *Azolla*, BGA -mass production methods - applications methods of biofertilizers - significance of biofertilizers.

UNIT-V

Air pollution - sources, major pollutants, adverse effect on living organisms -acid rain and its impact on ecosystem-gaseous emission - Green house effect -Global warming - Ozone layer depletion and its effect - Droplet nuclei -Aerosol - Assessment of air quality - Airborne diseases, their symptoms and preventive measures. Types of wastes, characterization of solid and liquid waste. Solid waste treatment - saccharification - pyrolysis - composting. Water pollution - sources and nature of pollutants in water - Sewage - industrial effluent - agrochemicals - Eutrophication - waterborne diseases. Potable water. Assessment of microbiological quality of water. Brief account on bioterrorism.

TEXT BOOKS:

1. Adams MR and Moss MO. (1995). Food Microbiology, The Royal Society of Chemistry, Cambridge.
2. Alexander M. (1977) Introduction to soil microbiology. John Wiley & Sons, Inc., New York.
3. Rajan. S and Selvi Christy (2015). Essentials of Microbiology, Anjanaa Book House Publishers, Chennai.
4. Andrews AT, Varley J. (1994) Biochemistry of milk products. Royal Society of Chemistry.
5. Banwart GJ. (1989), Basic food microbiology, Chapman & Hall, New York.
6. Ec Eldowney S, Hardman DJ, Waite DJ, Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.
7. Frazier WC and Westhoff DC. (1988) Food microbiology, TATA McGraw Hill Publishing Company Ltd. New Delhi.
8. Grant WD, Long PL. (1981) Environmental Microbiology. Blackie Glasgow and London.
9. Hobbs BC and Roberts D. (1993) Food poisoning and food hygiene, Edward Arnold (A division of Hodder and Stoughton), London.
10. Jay JM. (1987) Modern food microbiology, CBS Publishers and distributors, New Delhi.

11. Robinson RK. (1990) The microbiology of milk. Elsevier Applied Science, London.
12. Robinson RK. (1990) Dairy Microbiology, Elsevier Applied Science, London.
13. Rogers JE and Writman WB (1991) Microbial production and consumption and green house gases: Methane: Nitrogen oxides and Halomethanes. American Society for Microbiology, Washington DC.
14. Dirk J, Elas V, Trevors JT, Wellington, EMH (1997) Modern Soil Microbiology, Marcel Dekker INC, New York.
15. Ramanathan, and Muthukaruppan SM (2005) Environmental Microbiology. Om Sakthi Pathipagam, Annamalai Nagar.

PAPER-3
IMMUNOTECHNOLOGY

OBJECTIVES

To enable the students to understand the immunity and immune system.

UNIT-I

Introduction: Infection, immunity, types of immunity - innate and adaptive, phagocytosis and extracellular killing, immunity to specific infection, milestones in immunology - evolution of immunology.

Immune Systems: Anatomy of the lympho - reticular system, primary lymphoid organs - bone marrow & thymus, Secondary lymphoid tissues - spleen, lymph nodes & gut associated lymphoid tissue, immuno reactive cells - T and B lymphocytes, macrophages, granulocyte and NK cells.

UNIT-II

Antigens and Immunogenicity: Terminologies and definitions - antigen, immunogen, haptens, superantigens, tolerogen, epitope, paratope and antigenic determinants. Features associated with antigenicity and immunogenicity. Basis of antigen specificity.

Antigen receptors: Cell surface proteins of Major Histocompatibility Complex (MHC): types, - class I, II and III distribution and function, MHC in relation to transplantation and HLA typing. T cell receptor complex (TCR).

UNIT-III

Antibodies - B cell receptors. Three dimensional structure of immunoglobulin molecule - Types of immunoglobulins. Biological and chemical properties of immunoglobulin. Antigen, antibody attraction - forces, affinity, avidity and specificity. Monoclonal antibody production - Hybridoma technology.

Complement system: Basics of complement protein - different pathways of complement activation - the pathway of membrane attack (common pathway), classical and alternate.

UNIT-IV

Acquired immune response: Humoral immune response - various phases of humoral immune response. Cell mediated immune response - cell mediated cytotoxicity, delayed type hypersensitivity.

Immune regulation: Immune response - various events in induction of immune response. Means of immunosuppression - physical, chemical and biological. Tolerance - auto and acquired. Immunopotentialiation - specific and non specific potentiations (adjuvants). Cytokines, Lymphokines and Chemokines.

UNIT-V

Prophylaxis: Vaccines - heat killed, attenuated, rDNA vaccine, synthetic peptide vaccine, plasma derived vaccine, anti - idiotypic vaccine and DNA vaccine. Active immunization - vaccines & toxoids – bacterial and viral. Passive immunization - antitoxins, immunoglobulin, specific immuno-globulin, hyper immuno-gamma globulin. Immuno Pathology - A brief account: Immunology of infectious diseases. Immunodeficiency disorders - primary and secondary. Autoimmune diseases.

TEXT BOOKS:

1. Sudha Gangal and Shubhangi Sontakke (2013) Textbook of Basic and Clinical Immunology, Universities Press (India) Private Ltd.
2. Ajoy Paul (2016). Text Book of Immunology, Books and Allied (P) Ltd, Kolkatha.
3. Ananthanarayan and Panikers (2013) Textbook Microbiology 9th edition, Universities Press (India) Private Ltd.
4. Chapel H and Halbey M (1986) Essentials of Clinical Immunology, ELBS.
5. Donal M. Weir, John Steward. (1993). Immunology VII edition. ELBS, London
6. Ivan M. Roit. (1994) Essential Immunology - Blackwell Scientific Publications, Oxford.

REFERENCE BOOKS

1. Jacqueline S, Williams and Wilkins A. (1998) Basic Immunology - Waverly Company.
2. Janeway Travers. (1997). Immuno biology - The immuno system in health and Disease. 3rd edition Current Biology Ltd., London, New York.
3. Lydyard P, Whelan A and Fanzer MW (2000) Instant notes in Immunology, Edited By Hames BD, Viva Books Private Ltd.
4. Mark Reakman Diego Vergani. Basic and clinical immunology, Longman Asia Ltd., Hong kong.
5. Paul (1998) Fundamental Immunology. III Edition.
6. Peter J. Delves, Ivan M. Roit (eds) (1998) Academic Press - Encyclopedia of Immunology - 2nd edition.
7. Richard M. Hyde. (1995). Immunology III edition. National Medical series, Williams and Wilkins, Harward Publishing Company.
8. Clark WR (1991). The experimental foundations of modern immunology, John Wiley and Sons Inc. New York.

PAPER-4

HUMAN ANATOMY AND PHYSIOLOGY

OBJECTIVES

To enable the students to understand the importance of human anatomy

UNIT-I: Respiratory System (RS) and Special Sensory Organs (SSS)

Introduction to applied human anatomy and physiology.

Respiratory System (RS): Different organs of the Respiratory System. Functions of the different organs of the Respiratory System.

Special Sensory Organs (SSS): Introduction to special sensory organs. Function and functions of eye, ear, nose, tongue, and skin.

UNIT-II: Gastro Intestinal (GI) System and Lympho-reticular System (LRS)

Gastro Intestinal (GI) System: Different organs associated with the Gastro Intestinal system: (Salivary glands, Pancreas, Liver and Gall bladder and others).

Lympho-reticular System (LRS): Different organs of LRS (Lymph, Lymphatic vessels and Lymph nodes), Functions of the different organs of Lympho-reticular system.

UNIT-III: Musculoskeletal System (MSS), Skin and Nervous System (NS)

Musculoskeletal System (MSS) and Skin: Introduction of musculo-skeleton system. Different parts of involved in skeleton system. Function of muscular system. Parts and function of skin.

Nervous System (NS): Introduction to nervous system. Central nervous system (CNS) and peripheral nervous system PNS and related to infection

UNIT-IV: Circulatory System (CS) and Endocrine System (ES)

Circulatory System (CS): Blood: Site of formation, composition, functions of blood cells, Different parts of the circulatory system and its function.

Endocrine System (ES): Introduction to endocrine system, Different organs and Functions of endocrine system.

UNIT-V: Reproductive System (RS) and Urinary System (US)

Reproductive System (RS): Introduction Male reproductive system – physiological anatomy, spermatogenesis and its regulation, testicular hormones, composition of semen
Female reproductive system – menstrual cycle, pregnancy and parturition, lactation and family planning.

Urinary System (US): Different organs and Functions of Urinary System. Mechanism of urine formation and composition of urine.

TEXT BOOKS:

1. Sampath Madhyastha, (2016) Manipal Manual of Anatomy, 3rd Edition, CBS Publishers and Distributors Pvt Ltd. Chennai.
2. Chandar Sbekar, C.N. (2006). Manipal Manual of Physiology, CBS Publishers and distributors Pvt Ltd., Chennai.
3. Chaurasia, B.D, (2005) Handbook of Human anatomy 3rd Edition, CBS Publishers and Distributors Pvt Ltd. Chennai.
4. Human physiology, 2nd edition- BJ Mejer, HS Meij, AC Meyer, AITBs publishers and distributors.

REFERENCES BOOKS:

1. Srivastava, (2013), Text book of Anatomy, Books and Allied (P) Ltd, Kolkatha.
2. Suresh.R, (2012), Essentials of Human Physiology, Books and Allied (P) Ltd, Kolkatha.
3. Asis Das (2006), Medical Physiology, Books and Allied (P) Ltd, Kolkatha.
4. Cell physiology by Giese, 5th edition, W.B Saunders Company, Tokyo, Japan.
5. A text book of animal physiology, KA Goel, KV Sastri, Rastogi publications Meerut.
6. Animal physiology and Biochemistry- RA Agarval, Anil. K, Srivastava, Kausshal Kumar, S. Chand & Co.
7. A Hand Book of Basic Human physiology- K. Saradha subramanyam, S. Chand & Co., Ltd.
8. Guide to physiology- Y. Rajakshmi, S. Chand & Co., Ltd. Cathleen JW Wilson OBE Anne Wangh: Anatomy and physiology in Health and illness. Churchill Livingstone Publication, UK, NK, 1996.
9. Waugh A., Grant, A Ross and Wilson's Anatomy and Physiology in Health and Illness, 9th Edition, Churchill Livingstone, London.2001.
10. Guyton AC and Hall JE. Guyton Human Physiology and Mechanisms of Disease. Hartcourt Publishers, Limited, 1996.
11. Williams PL (Ed). Gray' anatomy, Churchill Livingstone, London.

**ELECTIVE
PAPER-1
(to choose 1 out of 3)
BIOFERTILIZER TECHNOLOGY**

OBJECTIVES

To make the students to understand the microorganisms as potential biofertilizer, the technology of inoculums production and to make the students entrepreneurs.

UNIT-I

Introduction to biofertilizers - Structure and characteristic features of the following biofertilizer organisms: Bacteria: *Azospirillum*, *Azotobacter*, *Bacillus*, *Pseudomonas*, *Rhizobium* and *Frankia*. Cyanobacteria: *Anabaena*, *Nostoc*, *Hapalosiphon*. Fungi: *Glomus*, *Gigaspora*, *Sclerocystis*, *Amanita*, *Laccaria*.

UNIT-II

Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting. Mechanism of phosphate solubilization and phosphate mobilization. Nitrogen fixation - Free living and symbiotic nitrogen fixation. Biotechnological application in nitrogen fixation.

UNIT-III

Nitrogenous Biofertilizers I: Bacteria - Isolation and purification of *Azospirillum* and *Azotobacter*, mass multiplication of *Azospirillum* and *Azotobacter*, formulation of inoculum of *Azospirillum* and *Azotobacter*, application of inoculants of *Azospirillum* and *Azotobacter*. Isolation and purification of *Rhizobium*, mass multiplication and inoculum production of *Rhizobium*, Methods of application of *Rhizobium* inoculants.

UNIT-IV

Isolation and purification of Cyanobacteria. Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; methods of application of cyanobacterial inoculum. *Azolla* - mass cultivation and application in rice fields.

UNIT-V

Mycorrhizae - Ecto and endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications. Isolation and Purification of phosphate solubilizers. Mass multiplication and field applications of phosphate solubilizer (*Pseudomonas striata*). Biofertilizers - Storage, shelf life, quality control and marketing.

TEXT BOOKS:

1. Bagyaraj, D.J. and A. Manjunath. 1990. Mycorrhizal symbiosis and plant growth, Univ. of Agricultural Sciences, Bangalore, India.
2. Purohit, S.S., P.R. Kothari and S.K. Mathur, 1993. Basic and Agricultural Biotechnology, Agro Botanical Pub. India.
3. Subba Rao, N. S. 1988. Biological nitrogen fixation: recent developments, Mohan Pramlani for Oxford and IBH Pub. Co. (P) Ltd., India.
4. Subba Rao, N.S., G.S. Venkataraman and S. Kannaiyan 1993. Biological nitrogen fixation, ICAR Pub., New Delhi.
5. Somani, L.L., S.C. Bhandari, K.K. Vyas and S.N. Saxena. 1990. Biofertilizers, Scientific Publishers - Jodhpur.
6. Tilak, K.V.B. 1991. Bacterial Biofertilizers, ICAR Pub., New Delhi.

PAPER-1

B. FUNDAMENTALS IN BIOLOGY

OBJECTIVES

Students completing this paper should be able to understand concepts of fundamentals in biology.

UNIT-I

Biology of cells: Cells as a unit of life, structure of prokaryotic and eukaryotic cells. An overview of organelles (Mitochondria, chloroplasts, ER, Golgi, ribosomes, lysosomes and peroxysomes, nucleus and nucleolus). Differences and similarities in plant and animal cells. Cellular membrane: structure, transport, channels, carriers, receptors, endocytosis, membrane potentials.

UNIT-II

DNA replication; Transcription and Translation.

Cell-cell interactions and signal transductions: Intercellular junctions, signaling by hormones and neurotransmitters; receptors, G-proteins, protein kinases and second messengers. Protein traffic in cells.

UNIT-III

Cell Cycle and regulation - Mitosis, Meiosis.

Mutation - Types of mutations, types of mutagenic agents and their molecular mechanism; DNA repair; Chromosomal types and structure; Mechanism by which genome undergoes changes, recombination, mutation, inversion, duplication, and transposition.

UNIT-IV

Molecules of Life: Introduction to carbohydrates-Monosaccharide and their derivatives, Disaccharides, Polysaccharides.

Proteins - Structure of amino acids, Different levels of organization-Primary, secondary tertiary and quaternary structures.

Nucleic acids - Purines, pyrimidines, Nucleosides and Nucleotides, Different structural form of DNA, denaturation and renaturation of DNA

Lipids-Structure and function of Fatty acids, Triacylglycerols, sphingolipids, steroids and glycerophospholipids.

Water, small molecules-Alkaloids, glycosides, phenols, oligopeptides, Flavonoids, and terpenoids.

UNIT-V

Enzymes: Units of Activity, coenzymes and metal cofactors, temperature and pH effects, Michaelis - Menten kinetics, inhibitors and activators, active site and mechanism of enzyme action, Isoenzymes, allosteric enzymes.

Metabolism of glucose: glycolysis, TCA cycle, glycogenesis, glycogenolysis and gluconeogenesis, pentophosphate shunt, ETC. Digestion of protein and protein metabolism, nitrogen balance: transamination, oxidative deamination and urea cycle. Lipid metabolism: beta oxidation. Interconnection of pathways, metabolic regulations.

TEXT BOOKS:

1. Rafi, M.D. 2014. Textbook of Biochemistry. 2nd edition, Universities Press (India) Private Ltd.
2. Channarayappa 2010. Cell Biology, Universities Press (India) Private Ltd.
3. Ajoy Paul (2007). Textbook of Cell and Molecular Biology, Books and Allied (P) Ltd, Kolkatha.
4. Lehninger, A. L. 1984. Principles of Biochemistry. CBS publishers and distributors, New Delhi, India
5. Horton, Moran, Ochs, Rawn, Scrimgeour Principles of Biochemistry Prentice Hall Publishers.
6. David. E. Sadava Cell Biology: Organelle Structure and Function Jones & Bartlett publishers.
7. Shanmughavel, P. 2005. Principles of Bioinformatics, Pointer Publishers, Jaipur, India.

PAPER-1
C. MICROBIAL BIOTECHNOLOGY

OBJECTIVES

To enable the students to understand the basic knowledge in Microbial Biotechnology

UNIT-I

Definition, Concepts - biotechnological potentials of microalgae - food - feed - Colourant - fuel and pharmaceutically valuable compounds.

UNIT-II

Production of microbial biofertilizers - Mass cultivation of cyanobacteria (*Spirullina*), *Azolla* and other N₂ fixers (*Azospirillum*, *Azatobacter* & *Rhizobium*)

UNIT-III

Basic principle - antagonism, amensalism, parasitism, nematophagy. Microbial herbicides, microbial insecticides - bacterial insecticide *Pseudomonas*, *Bacillus* sp. - *Bacillus thuringiensis* - toxins - BT cotton - viral insecticide - entomopathogenic fungi.

UNIT-IV

Production microbial products - malt beverages - alcohol - vinegar - lactic acid- citric acid- penicillin - streptomycin- L-lysine- L-glutamic acid - protease - lipase - pectinase and riboflavin.

UNIT-V

Microbes in abatement of heavy metal pollution - heavy metal tolerant microbes - Mechanism of heavy metal and antibiotic resistance - role of biosorption - biotransformation of Xenobiotics - Superbug - rDNA application. Biodegradation of oil and petroleum products. Microbial leaching - Copper - Uranium.

TEXT BOOKS:

1. Satyanarayana.U (2005) Biotechnology, Books and Allied (P) Ltd, Kolkatha.
2. Raledge C and Kristiansen B Eds (2001). Basic Biotechnology, 2nd edition, Cambridge University Press.
3. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, Jayaraman K. (1996). Concepts in Biotechnology University Press, India.
4. Borowitzka MA, Borowitzka LJ (1989). Microalgal Biotechnology, Cambridge University Press.
5. Alan T. Bull. Microbial Diversity and Bioprospecting. ASM press. Washington, D.C Gerbardt P, Murray RG, Wood WA, Kreig NR. (1994) Methods for General and Molecular Bacteriology - American Society for Microbiology Washington D.C.
6. Glazer AN, Nikaido H. (1994) Microbial Biotechnology - Fundamentals of Applied Microbiology WH Freeman and Company, New York.
7. Pnolella P (1998) Introduction to Molecular Biology, WCB Mc Graw Hill, Boston, Massacheutts.
8. Walsh G, Headon DR. (1994). Protein Biotechnology, John Wiley & Sons, New York.
9. Ellyn Daugherty (2008) Biotechnology, CBS publishers and distributors Pvt. Ltd., Chennai.
10. Arumugam, N. and Kumaresan, V. (2016) Fundamentals of Biotechnology, Saras Publication, Nagercoil.

**SEMESTER II
PAPER-5
MEDICAL MICROBIOLOGY**

OBJECTIVES

To create awareness of microbial diseases of human beings and causes and cures.

UNIT-I

Basics in Medical microbiology - Infectious diseases overview. Medically important microbes. Microbial diseases - sources, route of transmission. Pathogenesis - adhesion, invasion, host cell damage, release of pathogens. Microbial virulence and virulence factors - Signs and symptoms of microbial diseases. Treatment, Prevention and control of microbial infections. Immunity of microbial diseases.

UNIT-II

Diagnosis of microbial diseases - Collection, transport and preliminary processing of clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.

UNIT-III

Bacteriology - Characteristics, classification, pathogenesis, pathology, diagnosis, treatment, prevention and control of diseases caused by *Staphylococci*, *Streptococci*, *Bacillus*, *Clostridium*, *Corynebacterium*, *Escherichia*, *Salmonella*, *Shigella*, *Klebsiella*, *Proteus*, *Vibrio*, *Pseudomonas*, *Mycobacteria*, *Spirochaetes*, *Rickettsia*.

UNIT-IV

Virology - Structure, multiplication, classification and medical importance of DNA viruses - Pox, Herpes, Hepatitis, Adeno; RNA viruses - Picorna, Orthomyxo, Paramyxo, Rabdo and HIV virus. Viral vaccines and antiviral agents.

UNIT-V

Mycology - Human mycotic infections caused by Dermatophytes, *Histoplasma*, *Cryptococcus*, *Candida*, opportunistic mycoses. Mycotoxins. Parasitology - Medical importance of *Entamoeba*, *Giardia*, *Plasmodium*, *Taenia*, *Ascaris*, *Wucherhiria*. Laboratory techniques in parasitology.

TEXT BOOKS:

1. Ananthanarayan and Panikers (2013) Textbook Microbiology 9th edition, Universities Press (India) Private Ltd.
2. Balasubramanian, A. and Senthil kumar, P.K, (2017) Medical Microbiology. Darshan Publication, Rasipuram.
3. Rajesh P. Karyakarte and Ajit S. Damle. (2003). Medical Parasitology, Books and Allied (P) Ltd, Kolkatha.
4. Chaechter M. Medoff G. and Eisenstein BC. (1993) Mechanism of Microbial Diseases 2nd edition. Williams and Wilkins, Baltimore.
5. Collee, JG. Duguid JP, Fraser AG, Marimon BP. (1989) Mackie and Mc Cartney Practical Medical Microbiology, 13th Edition. Churchill Livingstone.
6. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.

REFERENCE BOOKS:

1. Hugo WB and Russell AD. (1989) Pharmaceutical Microbiology IV edition. Blackwell Scientific Publication, Oxford.
2. Joan Stokes E, Ridgway GL and Wren MWD. (1993). Clinical Microbiology, 7th edition. Edward Arnold. A division of Hodder and Stoughton.
3. Ronald M. Atlas. (1989) Microbiology. Fundamentals and Applications. II edition, Maxwell Macmillan international editions.
4. Topley & Wilson's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.

PAPER-6

MICROBIAL PHARMACOLOGY

UNIT: I General principles of Microbial Pharmacology

Principles of pharmacokinetics and pharmacodynamics. Principles of toxicology and treatment of poisoning. Gene based therapy.

UNIT: II Systemic Pharmacology including recent advances of drug affecting:

Autonomic Nervous System- Neurohumoral transmission, Agonists and antagonist of cholinergic and adrenergic systems. Cardiovascular system- Cardiac electrophysiology, Drugs used in ischemic heart diseases, Hypertension C.C.F, Arrhythmias and Hyperlipoproteineas. Renal- function, Physiology of urine formation. Diuretics and antidiuretics.

Central Nervous System- Neuro transmission in the central nervous system. General anaesthetics, Local anaesthetics, Sedatives and hypnotics, Antiepileptics, Analgesics- opioids non-opioids, Psychopharmacological agents, Drugs for CNS degenerative disorders and migrane.

UNIT: III Gastro Intestinal System- Drugs for peptic ulcer, Cathartics abd antidiarrhoeal agents, Emetics and antiemetics. Blood- Drugs affecting haemopoeitic system, Haematinics, coagulants, anticoagulants, fibrinolytics, antiplatelets. Autocoids- Histamine and antihistamine, 5-HT and its antagonists, Eicosanoides. Respiratory system - Drugs used for bronchial asthma and cough. Drugs affecting- uterine motility, Oxyocics and tocolytics. Heavy metals and chelating agents- Lead, mercury, iron, copper and arsenic. Drugs used for immunomodolation- Immunostimulants, Immunosuppresants.

UNIT: IV Hormones and Hormone Antagonists- Hypothalamic and pituitary hormones, Thyroid hormones and antithyroid drugs, Sex hormones and their antagonists, Adrenocorticosteroids and their antagonists, Antidiabetic drugs, Vit-D3. Chemotherapy of Microbial Diseases- Antimicrobial agents general considerations, Antimicrobial agents sulfonamides, Quinolones, β -lactum antibiotics, Aminoglycosides, Tetracyclines, chloramphenicol, Macrolide antibiotics, Miscellaneous antibiotics, Antimycobacterial agents, Antifungal agents, Antiviral agents, Antimalarial agents, Antiamoeibic agents, Antiprotozoal agents, Drugs for helminthiasis.

UNIT: V Chemotherapy of Neoplastic Diseases- Antihypertensives – Analgesics. Antiepileptics - Antiulcer drugs, antiinflammatory drugs, Principles and application of biostatics, Essential drug concepts, Drug addiction and drug abuse, important interactions and their mechanisms.

REFERENCE BOOKS:

1. Vyas, S.P. (2009). Theory and Practice in Novel Drug Delivery System, CBS publishers and distributors Pvt. Ltd., Chennai.
2. Text Book of The Therapeutics drugs and diseases management ED by Eric Harfindal, Dick R. Gourley.
3. Principles of drugs action by Glodstein, aranow and Kolman.
4. Herbal drug treatment by Agarwal.
5. Clinical pharmacology by D.R. Lawrence and P.N.Bennette.
6. The Pharmacology basis of Therapeutics by. Louis.S.Goodman and Alfred Gillman.
7. Handbook of experimental Pharmacology by S.K. Kulkarni, Vallabh Prakashan, Delhi.
8. ICH of technical requirements for registration of pharmaceutical for human use, ICH harmonized tripartite guidelines – guidelines for good clinical practice, E6, May 1996.
9. Good clinical practice – Guidelines for clinical trice on pharmaceutical products in India, central drugs standard control organization, New Delhi minister of health - 2001

**PAPER-7
BIOINFORMATICS AND BIostatISTICS**

OBJECTIVES

To enable the students to make use of the tools of bioinformatics and biostatistics to solve microbiological problems.

UNIT-I

Biology in the computer age - Computational Approaches to Biological questions.

Basics of computers - servers, workstations, operating systems, Unix, Linux. World Wide Web. Search engines, finding scientific articles - Pubmed - public biological databases.

UNIT-II

Sequence analysis - pairwise sequence comparison. Protein Data Bank, Swiss-prot, Genbank - sequence queries against biological databases - BLAST and FASTA - multifunctional tools for sequence analysis. Multiple sequence alignments, Phylogenetic alignment - profiles and motifs.

UNIT-III

Genomics and Proteomics - Sequencing genomes - sequence assembly - genome on the web - annotating and analysing genome sequences. Proteomics - biochemical pathway databases.

UNIT-IV

Predicting Protein structure and function from sequence - Determination of structure - feature detection - secondary structure prediction - predicting 3 D structure. Protein modelling.

UNIT-V

Biostatistics: Measures of Central tendency - mean (arithmetic, harmonic and geometric) median and mode; Correlation Co-efficient, Simple linear regression; basic idea of Significance Test, hypothesis tests, levels of significance, Student 't', 'Chi' square and goodness of fit.

TEXT BOOKS:

1. Ruchi singh and Richa Sharma (2010). Bioinformatics Basics, Algorithms and Applications. Universities Press (India) Private Ltd.
2. Cynthia Gibas & Per Jambeck (2001). Developing Bioinformatics Computer Skills: Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai.
3. H.H. Rashidi & L.K Buehler (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
4. Des Higgins & Willie Taylor (2002). Bioinformatics: Sequence, structure and databanks, Oxford University Press.
5. Baxevanis A.D & Ouellette B.E.F (2001) Bioinformatics: A practical guide to the analysis of genes and proteins, Wiley Interscience - New York
6. Arora P.N & Malhon P.K (1996). Biostatistics Imalaya Publishing House, Mumbai.
7. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
8. Stanton A & Clantz, Primer of Biostatistics - The McGraw Hill Inc., New York.
9. Chavali (2009). Bioinformatics and Bioprogramming in C. Universities Press (India) Private Ltd.

**MAIN PRACTICAL
PAPER-1
(Subjects covering Paper 1, 2 and 3)**

OBJECTIVES

To enable the students to get hands-on training on various aspects of general, food, agricultural and environmental microbiology and immunotechnology.

UNIT-I

1. Cleaning of glassware and sterilization.
2. Preparation and use of glassware cleaning solutions, sterilization.
3. Micrometry - counting and measurements.
4. Isolation of anaerobic and aerobic bacteria - cyanobacteria, actinomycetes and fungi.
5. Pure and axenic culture techniques - serial dilution - pour plate, spread plate, streak plate methods and stab culture techniques.

UNIT-II

1. Bacterial Staining methods - simple, Gram's, acid fast, flagella, capsule and spore.
2. Fungal Staining methods - Lacto-phenol cotton blue.
3. Motility of bacteria.
4. Determination of growth - growth curve - generation time - synchronous and asynchronous growth - estimation of growth - microscopic - plate - membrane filter - turbidometry - dry weight - wet weight - chlorophyll.
5. Study of virus infected plant samples

UNIT-III (Microbial Physiology)

Isolation and Colorimetric estimation of

Hands on:

1. Amino acids - ninhydrin method

2. Protein - Biuret method/Lowry's method
3. Carbohydrate reducing sugars - Anthrone method/Benedicts method.

Isolation and Colorimetric estimation of

Hands on:

1. DNA - Diphenylamine method
2. RNA - Orcinol method
3. Pigments (chlorophyll - carotenoids - phycobiliproteins)

(Human anatomy and physiology)

1. Absolute Eosinophil Count. Demonstration of ECG/Echo and its interpretation techniques. Demonstration of lymphoid organs. Determination of Erythrocyte Sedimentation Rate. Determination of Specific Gravity of Blood.
2. Hair perforation Test. Measurement of Pulse, BP. Preparation and Examination of Blood smear. Blood Sugar analysis. Study of different histological slides. Total Platelet count

UNIT-IV

1. Microbial analysis of food products - bacterial and fungal
2. Microbial spoilage of refrigerated food
3. Extracellular enzyme activities - cellulase, protease, lipase and phosphatase
4. Milk microbiology - direct microscopic count - standard plate count - reductase test (resazurin/methylene blue) - isolation of microbes from yoghurt, curd.
5. Quantification of microorganisms in air - solid and liquid impingement techniques
6. Microbial flora from different soil types and habitats - isolation of nitrogen fixing bacteria, cyanobacteria and phosphate solubilizing organisms- development of Winogradsky Column
7. Field trip to dairy, food industries, sewage treatment plants.

UNIT-V

1. Precipitation techniques

Hands on: Agar gel diffusion - Ouchterlony's method.

Theory: Single radial immunodiffusion - staining.

Counter immuno electrophoresis & Rocket Immuno Electrophoresis.

2. Agglutination techniques

Hands on: Blood grouping and Rh factor - Latex agglutination - RF & ASLO. Theory:

Heme agglutination RPHA / IHA.

TEXT BOOKS:

1. Rajan. S and Selvi Christy (2015). Experimental Procedures in Life Sciences, Anjanaa Book House Publishers, Chennai.

2. Ponmurugan, (2012) Experimental procedures in bioprocess technology, Anjanaa Book House Publishers, Chennai.

3. Aaronson S. (1970) Experimental Microbial Ecology, Academic Press, New York

4. Bhatia A (2000). Manual of Practical Immunology, Aruna Bhatia 1st Edition, Palani Paramount Publication

5. Benson H.J (1994). Microbiological Applications, WmC Brown Publishers, Oxford.

REFERENCE BOOKS:

1. Clesceri L.S, Greenberg A.E, Eaton AD. (1998) Standard methods for examination of water & waste water American Public Health Association.

2. Collins C.H, Lyne P.M, (1985). Microbiological methods. Butterworths, London.

3. Gerhardt P, Murray R.G, Wood W.A, Kreig, N.R. (ed) (1994). Methods of General and Molecular Bacteriology. American Society for Microbiology, Washington DC

4. Holt J.S, Kreig N.R, Sheath P.H.A, Williams S.T. (1994) Bergey's Manual of Determinative Bacteriology (9th ed.), Williams & Wilkins, Baltimore.

5. Hudson L and Henry FC (1999) Practical Immunology, 3rd edition, Blackwell Scientific Publishers, Oxford, London.

6. Miller L.E, Luke H.R, Peacock J.E and Tomar R.H (1990). Manual of Laboratory Immunology, 2nd edition, Lea and Febiger - London.

7. Official Methods of Analysis (1995), Arlington, Virginia, USA.

8. Patrick R. Murray. (editor chief) (1999) Manual of clinical microbiology, 7th edition, ASM Press, Washington D.C.
9. Prakash M., Arora, C.K. (1998) Pathological techniques - Anmol Publications Pvt. Ltd. N.D.
10. Rhodes P.M, Stanbury P.F. Applied Microbial Physiology - A practical approach. IRL Press, Oxford University Press, Oxford.
11. Talwar GP (ed). (1982) A handbook of Practical Immunology, Vikas Publishing House Pvt. Ltd.
12. Talwar GP (1983). Microscopic Immunoassays and Applications, Vikas International Students Edition, Vikas Publishing House Pvt. Ltd.
13. Tuffery AA (ed) (1996) Laboratory Animals - An Introduction, 2nd edition, John Wiley and Sons, New York.
14. Wilson K, Walker J. (1995) Practical Biochemistry Principles and Techniques, Cambridge University Press.

**MAIN PRACTICAL
PAPER-2**

(Subjects covering Paper 4, 5 and 6)

OBJECTIVES

To impart knowledge on microbial diseases, metabolism and hands on training on computer applications in biology.

UNIT-I (Medical Microbiology)

1. Collection and transport of pathological specimens for microbiological examinations.
2. Bacteriological methods: Microscopic examination - blood - faeces - pus - sputum - throat swab and nose swab - urine - body fluids
3. Isolation and identification of the pathogen - culture and biochemical tests.

UNIT-II (Medical Microbiology)

1. Mycological methods: Macroscopic observation - microscopic observation - culture
2. Identification of *Mucor*, *Rhizopus*, *Aspergillus*, *Penicillium*, *Candida*, *Trichophyton*, *Microsporum*, *Epidermophyton* - SDA/Corn Meal Agar - Slide culture method - Germ tube method - Sugar assimilation/fermentation tests. Examination of parasites in clinical specimens - ova/cyst in faeces.

UNIT-III (Medical Microbiology)

1. Clinical - observation: Theory: a) X ray chest 2) Mantoux test for *Mycobacterium tuberculosis* infection.
2. Haematology: Total count (TC): RBC and WBC, - Differential count (DC) - Haemoglobin level, - Bleeding time - Clotting time – ESR
3. Biochemical : Serum - SGOT, SGPT, cholesterol, creatinine bilirubin and protein. Urine - colour, turbidity, sugar, albumin, bile salt, - phenylketone urea, bence Jones protein, RBC, pus cells, pH, acidity and alkalinity.

UNIT-IV (Microbial Pharmacology)

Antimicrobial assay - sensitivity test - Stokes and Kirby Bauer methods - Disc diffusion - agar dilution - broth dilution - MBC/MIC. Quality control for antibiotics.

UNIT-V (Bioinformatics - Demonstration only)

1. Basics of computers - basic commands - file creation, copying, moving & deleting in Linux & Windows. Using email - Using browsers - search engines, - Pubmed.
2. Using biological databases - Swissprot - Protein Data Bank and Genbank.
3. Different types of sequence analysis queries in BLAST and FASTA.
4. Multiple sequence alignments and Phylogenetic alignments.
5. Protein structure prediction software.
6. Genomes and Proteomes available on the web and their use.
7. Statistical software available on the web and their use.

TEXT BOOKS:

1. Rajan. S (2013) Manual for medical lab technology, Anjanaa Book House Publishers, Chennai.
2. Rajan. S and Selvi Christy (2015). Experimental Procedures in Life Sciences, Anjanaa Book House Publishers, Chennai.
3. Atlas RM (1993). Handbook of Microbiological Media, (ed) Parks L.C, CRC Press, London.
4. Balows A, Hansler Jr K.L, Isenberg H.D, Shalomy H.J (1991). Manual of Clinical Microbiology, American Society for Microbiology, Washington DC.
5. Boyer R (2001) Modern Experimental Biochemistry, 3rd edition: Benjamin / Cummings Publishing Company Inc.
6. Brawshaw L.J. (1988). Laboratory Immunology, Sandders College Publishing.

REFERENCE BOOKS:

1. Clark J.M Jr and Switzer RI (1977) Experimental Biochemistry, 2nd Edition. W.H. Freeman, San Francisco.
2. Gerhardt P, Murray R.G, Wood W.A and Kreig N.R. (ed) (1994) Methods for General and Molecular Bacteriology - American Society for Microbiology, Washington D.C.
3. Jayaraman J (1981). Laboratory manual in Biochemistry, New Age Int. Publishers, New Delhi.
4. Lorian V (1991) Antibiotics in Laboratory Medicine, 3rd edition, Williams and Wilkins, Baltimore.
5. Myers R.M, Koshi G (1982) Diagnostic procedures in medical microbiology. IELC Combodia Press.
6. Plummer D.T (1987) An introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill, New Delhi.
7. Switzer R.L and Garrity L.F (1999) Experimental Biochemistry, 3rd edition, WH Freeman and Co
8. Warton D.C and McCarthy R.E (1972) Experiments and Methods in Biochemistry. MacMillan, New York.
9. Wilson K and Walker J (2000) Practical Biochemistry Principles and Techniques, 5th Edition, Cambridge University Press.
10. Work T.S and Work E (1972) Laboratory Techniques in Biochemistry and Molecular Biology. Vol. 3 - North-Holland, Amsterdam
11. Ruchi singh and Richa Sharma (2010). Bioinformatics Basics, Algorithms and Applications. Universities Press (India) Private Ltd.
12. Pal, G.K and Pravathi Pal (2016), A text book of Practical Physiology, 4th Edition Universities Press (India) Pvt Ltd,

ELECTIVE

PAPER - 2

(to choose 1 out of 3)

A. FOOD ANALYSIS AND QUALITY CONTROL

OBJECTIVES: The paper focuses on physical, chemical, microbial and sensory analysis of food, concepts of quality control and quality management, national and international food loss and adulterants in various food products

UNIT-I

Sampling – Sampling techniques and preparation of food samples.

Techniques used in food analysis – Chromatography, Electrophoresis, Electrometric determinations, Refractometry and Polarimetry Spectrophotometry, Fluorimetry, Radio - active tracer techniques, Atomic absorption

UNIT-II

Physico chemical methods for food analysis - Moisture and Total solids, Carbohydrates, Proteins, Fats, Fiber, Ash and its types, Minerals, Vitamins. Enzymatic methods

Biological methods of food analysis - Standard plate count; Plate loop method; Spiral plate; Droplet technique; Dye reduction; Catalase test and ELISA. Testing of food for organisms such as *B. cereus*, *C. botulinum*, *E. coli*, *L. monocytogenes*, *S.aureus*, *Salmonella* and *Shigella*.

UNIT-III

Sensory assessment of food quality –Appearance of food, Flavor of food, Texture of food. Sensory Tests – Difference, Rating and Sensitivity tests. Types of panels, Testing area and schedule.

Quality control of following food products – Milk and milk products, Oils and Fats, Cereal grains and flours, Fruits and vegetable products, Canned foods, Egg and egg products, Meat and Meat products

UNIT-IV

Food quality management – Objectives, Importance and Functions of quality control. Total quality, management, Good manufacturing practices, seven principles of HACCP and codex in food. Quality control, methods of – a. raw materials, b. manufacturing process and c. finished products.

UNIT-V

Food Safety – Role of voluntary agencies and legal aspects of consumer protection. National and International food laws – PFA, FDA, BIS, AGMARK, Essential Commodity Act, Export (quality and inspection act, Consumer protection act), Nutritional labeling requirements of foods. Food adulteration.

INDUSTRIAL VISIT: Food and Pharmaceuticals Industry and Report.

TEXT BOOKS:

1. Yeshajahu Pomeranz and Clifton E. Meloan (1996), Food Analysis, CBS publishers and distributors Pvt. Ltd., Chennai.
2. Rajan. S and Selvi Christy (2010). Experimental Procedures in Life Sciences, Anjanaa Book House Publishers, Chennai.
3. Adams, M.R and Moss M.O (1995) Food Microbiology, New Age International (p) Limited Publishers.
4. Ananthanarayanan R and CK Jayaram Panicker, 1994, Textbook of microbiology Orient Longman.
5. Chakraborty P 1995, A Text book of microbiology, New Central Book Agency Pvt Ltd. Calcutta.
6. Debnath, 2005, Tools & Techniques of Biotechnology, Pointer Publishers, Jaipur.
7. Frazier, W.C and Westhoff, D.C (1988). Food microbiology, 4th edition, Tata Mac Graw Hill, New Delhi.
8. Jacobs.M.B., 1999, Chemical Analysis of Food & Food Products, CBS Publiishers, New Delhi.
9. Jay.J.M, 1996, Modern Food Microbiology, CBS Publishers, New Delhi.
10. Nielsen, S.S, 2004, Introduction to chemical Analysis of foods, CBS Publishers, New Delhi.
11. Pomeranz.Y, Meloan.C.E, 1996, Food Analysis – Theory & Practice, CBS Publiushers, New Delhi.
12. Ranganna. S., 2001, Handbook of Analysis & Quality control for Fruit & Vegetable Products, Tata McGraw Hill, New Delhi.
13. Robinson R.K (1990) Dairy Microbiology, Elsevier Applied science, London.
14. Salle, A.J. (1992). Fundamental Principles of Bacteriology. 7th Edition, Mc. Graw Hill Publishing Co. Ltd., New York.

PAPER - 2

B. GENETIC ENGINEERING

OBJECTIVES

To enable the students to understand the basic knowledge in Genetic Engineering.

UNIT-I

Gene as a unit of mutation and recombination. Mutagenesis, mutations and mutants - biochemical basis of mutations, spontaneous and induced mutations, isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants. Recombination methods

- conjugation and transformation.

UNIT-II

Enzymes in Genetic Engineering - DNA Polymerase, Polynucleotide kinase, T4 DNA ligase, Nick translation system, Terminal deoxynucleotidyl transferase, Reverse transcriptase Restriction endonucleases Type I & II. Vectors - plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome.

UNIT-III

Strategy of recombinant DNA technology; Gene library - Genomic library, cDNA library - Cloning strategies - Use of linkers, adaptors, homopolymer tails - Nucleic acid hybridization - Colony hybridization, plaque hybridization; Blotting techniques - Southern, Northern, Western and dot blotting.

UNIT-IV

PCR - principles, techniques and applications. Gene isolation, cloning and expression, DNA sequencing, oligonucleotide synthesis, Southern and Northern hybridization, FISH, RAPD, PCR-RFLP, STRR, LTRR. DNA fingerprinting and their applications for diagnosis of disease, site-directed mutagenesis, Gene silencing, Gene transfer technologies.

UNIT-V

DNA chips and microarray gene screen technology; site directed mutagenesis, transgenic animals and gene knockout techniques, cell culture based techniques Genetic diagnosis. Applications in medical field, biology, transgenic plants, transgenic animals, Recombinant vaccines development. Gene therapy; Molecular basis of genetic diseases, genetic counseling.

TEXT BOOKS:

1. Molecular biology and Microbial genetics (1994) David Frifielder, Stanely R. Maloy, 2nd edition Jones and Barlett Publishers.
2. Channarayappa (2015). Molecular Biology, Universities Press (India) Private Ltd.
3. Genetics by Peter J Russell (1997) 5th edition Benjamin-Cummings Publishing Company.
4. Molecular Biotechnology (2003) Bernard R. Glick and Jack J.Pasternak., 2nd edition by ASM press.
5. Gene Cloning and DNA analysis (2004) T.A.Brown 2nd edition. By ASM press.

REFERENCES BOOKS:

1. Ajoy Paul (2011). Text Book of Genetics- from Genes to Genomes, Books and Allied (P) Ltd, Kolkatha.
2. Principles of Gene Manipulation and Genomics (2006) Sandy Primrose. 7th Edition, Black Well Publishers.

PAPER - 2
C. MICROBIAL BIONANOTECHNOLOGY

OBJECTIVES

To enable the students to understand the basic knowledge in Microbial Bionanotechnology.

UNIT-I

History - bionanotechnology - concept and future prospects - application in Life Sciences. Terminologies - nanotechnology, bionanotechnology, nanomedicine, nanowires, quantum Dots, nanocomposite, nanoparticles.

UNIT- II

Molecular nanotechnology - nanomachines - collagen. Uses of nanoparticles - cancer therapy - manipulation of cell and biomolecules. Cytoskeleton and cell organelles. Types of nanoparticles production - physical, chemical and biological. Microbial synthesis of nanoparticles

UNIT-III

Nanoparticles - types, functions - Silver, Gold and Titanium. Physical and chemical properties of nanoparticles. Characterization of nanoparticles - UV-Vis spectroscopy, Electron Microscopy - HRTEM, SEM, AFM, EDS, XRD.

UNIT-IV

Uses of nanoparticles in biology: Drug delivery - protein mediated and nanoparticle mediated. Uses of nanoparticles in MRI, DNA and Protein Microarrays. Nanotechnology in health sectors. Toxicology in nanoparticles - Dosimetry.

UNIT-V

Advantages of nanoparticles - drug targeting, protein detection, MRI, development of green chemistry - commercial viability of nanoparticles. Disadvantages - health risk associated with nanoparticles, inadequate knowledge on nanoparticles research.

TEXT BOOKS:

1. Parthasarathy, B.K. (2007). Introduction to Nanotechnology, Isha Publication.
2. Elisabeth Papazoglou and Aravind Parthasarathy (2007). Bionanotechnology. Morgan & Claypool Publishers.
3. Bernd Rehm (2006). Microbial Bionanotechnology: Biological Self-assembly Systems and Biopolymer-based Nanostructures. Horizon Scientific Press.
4. David E. Reisner, Joseph D. Bronzino (2008). Bionanotechnology: Global Prospects. CRC Press.
5. Ehud Gazit (2006). Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press.

**SEMESTER III
PAPER-8
MICROBIAL GENETICS AND MOLECULAR BIOLOGY**

OBJECTIVES

To enable the students to understand the basic and applied aspects of molecular biology and microbial genetics.

UNIT-I

Introduction to identification of Genetic Material (Griffith, Avery and Hershey and Chase Experiments). Gene as a unit of mutation and Recombination. Mutagenesis, Mutations and Mutants - Biochemical basis of Mutation, Spontaneous and induced mutations, Isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants.

UNIT-II

Gene Transfer Mechanisms - Transformation - competence cells, regulation, general process; Transduction - general and specialized; conjugation - Hfr, Triparental mating, self transmissible and mobilizable plasmids, pili.

UNIT-III

Biology of Plasmids - Extrachromosomal heredity - biology of bacterial plasmids, structure of the plasmids, F1, ColE1, pSC101 and Ti plasmids, - replication, control, partitioning, incompatibility and gene transfer.

UNIT-IV

Transposable genetic elements and Gene Mapping - Introduction - Discovery, insertion sequences, complex and compound transposons - T10, T5, and retroposon. Genetic mapping - E. coli - Virus T4 phage – using rII system.

UNIT-V

Concept of gene and Gene regulation - Organization of gene in prokaryotes and Eukaryotes - Introduction, Operon concept, lac and Trp operons, promoters and repressors, regulation of gene expression - Transcriptional control - promoters, terminators, attenuators and anti terminators; Induction and repression; the lac operon - catabolite repression; Biosynthesis; trp operon - upstream activator sequences and enhancers, two component regulatory systems. Translational control - ribosome binding, codon usage, antisense RNA; post-translational modification (epigenetics).

TEXT BOOKS:

1. Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002). Modern Genetic Analysis, Integrating Genes and Genomes, 2nd edition, WH Freeman and Company, New York.
2. Blackburn GM, Gait MJ. (1996). Nucleic acids in chemistry and biology. Oxford University press.
3. Friedberg EC, Walker GC, Siede W. (1995). DNA repair and mutagenesis. ASM press.
4. Malacinski GM and Freifelder D (1998) Essentials of Molecular Biology, 3rd edition, John and Bartlett Publishers.
5. Lewin B. (2000). Genes VII. Oxford University press
6. Maloy SR, Cronan Jr. JE, Freifelder D (1994). Microbial genetics. Jones and Bartlett publishers.
7. Singer M, Berg P. (1991). Genes and Genomes. University Science Books.
8. Stryer L. (2002). Biochemistry. 5th edition, W.H.Freeman and company.

REFERENCE BOOKS:

1. Watson JD, Hopkins NH, Roberts JW, Steitz JA, Weiner AM. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.
2. Ajoy Paul (2011). Text Book of Genetics- from Genes to Genomes, Books and Allied (P) Ltd, Kolkatha.
3. Basu. S.B and Hossain. M (2016), Principles of Genetics, Books and Allied (P) Ltd, Kolkatha.

PAPER-9
RECOMBINANT DNA TECHNOLOGY

UNIT-I

Basics of DNA cloning: Simple cloning and cloning using linkers and adaptors. Cloning into various kinds of vectors – plasmids, phages lambda and M13, phagemids, cosmids, BACs and YACs. Selection and screening of clones.

UNIT-II

Methods of DNA and protein analysis: Isolation and purification of DNA. Agarose, polyacrylamide and pulsed field gel electrophoresis of DNA. Southern and Northern Blotting. Radiolabelling probes. RFLP analysis. DNA fingerprinting and its application in forensic sciences. Native PAGE, SDS-PAGE and two-dimensional PAGE analysis of proteins. Blotting techniques.

UNIT-III

Polymerase Chain Reaction: Concept of PCR and various thermophilic enzymes used in PCR. Gradient PCR versus Touchdown PCR. Designing primers. Cloning PCR products. Differential Display PCR, RAPD fingerprinting of micro-organisms, Overlap PCR, Rolling Circle Amplification Technology.

Construction of cDNA and genomic DNA libraries: Vectors used in the construction of cDNA versus genomic DNA libraries. Steps and enzymes involved in the construction of cDNA versus genomic DNA libraries.

UNIT-IV

Genome sequencing: DNA sequencing by Enzymatic and chemical method – traditional and cycle sequencing. STS mapping. E-PCR. Whole genome shotgun cloning methods. Clone-by-clone shotgun sequencing of genome map construction, clone selection, Transcriptional analysis of gene expression and transcriptomics: Gene expression analysis by Northern Blotting, RT-PCR, EST analysis and the use of reporter genes. Enzymatic and bioluminescent reporters. Reporters used in protein localization and trafficking studies. Transcriptome analysis by DD-PCR and EST analysis, DNA microarrays (cDNA arrays and oligo arrays), Serial Analysis of Gene Expression (SAGE).

UNIT-V

Protein engineering and proteome analysis: Proteome analysis by 2D gel electrophoresis coupled to mass spectrometric analysis. Protein arrays and their applications.

Pharmaceutical products of DNA technology: Human protein replacements – insulin, hGH and Factor VIII. Human therapies – TPA, interferon, antisense molecules. Vaccines – Hepatitis B, AIDS, and DNA vaccines. Good hygienic procedure (GHP), Good manufacturing procedure (GMP), Good laboratory procedure (GLP) and ISO-9000-HACCP.

Transgenics and animal cloning: Creating transgenic animals and plants. Animal cloning.

TEXT BOOKS:

1. Molecular Biology by David P. Clarke, 1st edition; Elsevier Academic Press; 2005.
2. Satyanarayana.U, Biotechnology, Books and Allied (P) Ltd, Kolkatha: 2005.
3. Molecular Cloning: A laboratory manual by Joseph Sambrook & David Russell, 3rd edition; CSHL Press; 2001.
4. DNA Technology: The Awesome Skill by I. Edward Alcamo, 2nd edition; Hardcourt Academic Press; 2001.
5. Molecular Biology of the Gene by James Watson, Tania Baker, Stephen Bell, Alexander Gann, Michael Levine & Richard Losick , 6th Edition; CSHL Press; 2007

PAPER-10
INDUSTRIAL BIOTECHNOLOGY

OBJECTIVES

To enable the students to understand the microbial processes applicable in industries and scale-up processes.

UNIT-I

Industrially important microorganisms: Screening techniques - Detection and assay of fermentation products - Strain improvements - Mutations, protoplast fusion and rDNA techniques for strain development.

UNIT-II

Industrial fermentation : Primary and secondary metabolites; Microbial Growth kinetics; Basic functions of fermenter - body construction, aeration, agitation, theories of aeration, oxygen transfer kinetics; Concepts of Newtonian and non - newtonian fluids - antifoam - Submerged and solid state fermentation - Scale up; Fermentation Biosensors; Downstream Processing.

UNIT-III

Industrial Production: Typical Fermentation processes for the industrial production of Wine, Beer, Bacitracin, Streptomycin, Riboflavin, B-carotene, Gibberellins, glutamic acid and surfactants. Commercially useful non-microbial products produced through microbes - insulin, interferons, B-cell growth factors, tissue plasmonogen activator. Microbial Enzymes - Enzyme immobilization, Microbial Insecticides. Production of SCP - Spirulina and yeast.

UNIT-IV

Algal biotechnology: Biotechnological potential of microalgae, food, feed and fuel production - pharmaceutically valuable of microalgae, pigments and H₂ gas from BGA.

UNIT-V

Nanobiotechnology: Introduction - history and recent developments - sources of nanoparticles - microbial producers of nanoparticles -advantages of microbial nanoparticles - applications - social and ethical implications - ethical concerns about patenting of living organisms and genetic materials.

TEXT BOOKS:

1. Balasubramanian D, Bryce CFA, Dharmalingam K, Green J, Jayaraman K. (1996). Concepts in Biotechnology, University Press, India.
2. Satyanarayana.U, Biotechnology, Books and Allied (P) Ltd, Kolkatha: 2005.
3. Glazer AN, Nikaido H. (1994) Microbial Biotechnology - Fundamentals of Applied Microbiology WH Freeman and Company, New York.
4. Glick BR, Pasternak JJ. (1994) Molecular Biotechnology, ASM Press, Washington DC.
5. Arumugam, N. and Kumaresan, V. (2016) Fundamentals of Biotechnology, Saras Publication, Nagercoil.
- 6.

REFERENCE BOOKS:

1. Baxevanis AD and BFF Ouellette, Wiley O, (2001). Bioinformatics - A practical guide to the analysis of genes and proteins. Interscience, New York.
2. Borowitzka MA, Borowitzka LJ (1989) Microalgal Biotechnology, Cambridge University Press.
3. Doolittle RF. (1990). Molecular evolution. Computer Analysis of Protein and Nucleic acid Sequences Methods in Enzymology. Academic Press, New York.
4. Faber K. (1992), Biotransformation in Organic Chemistry Springer Vulag.
5. Gerbardt P, Murray RG, Wood W A., Kreig NR. (1994), Methods for General and Molecular Bacteriology - American Society for Microbiology Washington D.C.
6. Glick BR, Pasternak JJ (1998), Molecular Biotechnology - Principles and Applications of Recombinant DNA, ASM Press, Washington DC.
7. Higgins D, Taylor W. (2000). Bioinformatics, sequence, structure and databanks A practical approach. Oxford University Press.
8. Gibas C and P. Jambek. (2001). Developing Bioinformatics computer skills O'Reilly, USA.
9. Misener S, Krawetz SA. (2000) Bioinformatics Methods and Protocols. Humana Press, Totowa, New Jersey.
10. Miyamoto MM, Cracraft JL. Phylogenetic Analysis of DNA sequences. Oxford University Press. Oxford.
11. Pnolella P (1998) Introduction to Molecular Biology, WCB Mc Graw Hill, Boston, Massacheutts.
12. Rashidi HH, Buehler LK. (2000) Bioinformatics Basics. Applications in Biological Science and Medicine. CRC Press, Washington DC.
13. Raledge C and Kristiansen B Eds (2001) Basic Biotechnology, 2nd edition, Cambridge University Press.
14. Walsh G, Headon DR. (1994). Protein Biotechnology, John Wiley & Sons, New York.

ELECTIVE

PAPER - 3

(to choose 1 out of 3)

A. BIOLOGICAL TECHNIQUES

OBJECTIVES

To enable the students to understand the basic biological techniques.

UNIT-I

Microscopy and Related Techniques - Light Microscopy : Microscopic optics, components of microscopes. Basic principles and method of Bright field, Dark field, Phase contrast. Fluorescence, Polarization and confocal microscopes. Applications of various types of microscopy such as immunofluorescence - In situ hybridization. Electron Microscopy - Principle, Techniques and applications of Transmission Electron microscope (TEM) and Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM). Photomicrography and Video micrography Developing and printing of microphotographs.

UNIT-II

Analytical Techniques - Spectroscopic methods - UV-Visible, Atomic Absorption Spectrophotometer, Atomic Emission Spectroscopy. Centrifugation - Principles, various types including centrifugation Electroanalytical methods - electrolytic all 4 galvanic cell - Potentiometric, conductimetric, coulometric & voltametric analysis. Biosensors. Radioactive Analysis : Principles of radioactivity, GM counter & LS counter.

UNIT-III

Principles & Applications of Chromatographic Techniques : Adsorption - Ion exchange and gel permeation - affinity chromatography for separation of compounds including GC and HPLC.

UNIT-IV

Electrophoresis Techniques - protein - nucleic acid - immuno - two dimensional electrophoresis.

UNIT-V

Molecular Biological Techniques

a) Microbiological techniques - purification, storage, measurement of microbial growth rate.

b) Isolation and amplification of nucleic acid - Plasmid isolation, chromosomal DNA isolation.

Polymerase chain reaction

c) Gene cloning techniques - Restriction digestion and Phosphatase treatment of cloning vectors. Cloning technique, separation and staining of DNA, qualification of DNA, gene transfer mechanisms - chemical and electroporation.

d) Methods of detection of clones - Nucleic acid transfer by blotting, Hybridization plaque, colony hybridization, histochemical detection of A -galactosidase, antibody screening including colour development reaction.

TEXT BOOKS:

1. Lodish, H. Baltimore Daerk . A. Zipsury, S.L. Marsudaisa. P. Darnel. J. (1995) Molecular cell biology.
2. Old, R.S. and Primrose, S.B. (1995) Principles of Gene manipulation. An introduction to genetic Engineering. 5th Edition. Blackwell Scientific Publication, London.

REFERENCE BOOKS:

1. Cynthia Gibas & Per Jambek (2001). Developing Bioinformatics Computer Skills, Shroff Publishers & Distributors Pvt. Ltd., O'reilly) Mumbai.
2. Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology & Biotechnology, ASM Press.
3. Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press.
4. John G. Webster. (2004). Bioinstrumentation. University of Wisconsin, John Wiley & Sons, Inc.
5. Misener, S. and Krawetz, S.A. (2000). Bioinformatics Methods and Protocols. Human Press, Totowa, New Jersey.
6. Rashidi, H.H., and Buehler, L.K. (2002). Bioinformatics Basics: Applications in Biological Science and Medicine, CRC Press, London.
7. Sambrook, J. and Ruseell, D.W. (2001) Molecular Cloning – A Laboratory Manual (3rd edition, Vol. 1,2,3) Cold Spring Laboratory Press, New York.
8. Savile Pradbury. (1991). Basic measurement techniques for light microscopy, Oxford University Press, Royal Microscopical Society.
9. Surzeki, S. (2000). Basic Techniques in Molecular Biology, Springer.
10. Westermeier, R (1993). Electroporesis in practice – VCH – Federal Republic of Germany. 11. Willett, J.E. (1991). Gas Chromatography, John Wiley & Sons. 12. Wilson, K. and Walker (1995). Practical Biochemistry Principles and Techniques, Cambridge University Press.

PAPER - 3
B. HERBAL TECHNOLOGY

OBJECTIVES

To enable the students to understand the basic knowledge in Herbal technology.

UNIT - I

Pharmacognosy: Pharmacology - Definition and history, Indian systems of medicine - Siddha, ayurvedha, and Unani systems. Taxonomy of locally available medicinal plants, their chemical constituents and medicinal uses - Classification of Crude drugs - Chemistry of Drugs - Future of pharmacognosy.

UNIT - II

Classification of medicinal plants - Vernacular name and family - Geographical source, cultivation, collection, and processing for market and commerce in crude drugs. Morphological and histological studies, chemical constituents - Therapeutic and other pharmaceutical uses. Underground stem - ginger, Alpinia - Roots - Rauolfia - Belladonna - Aerial parts - Bark - Cinchona.

UNIT - III

Leaves - Aethiops, Eucalyptus - Flower - Clove fruits seeds - Nux vomica Nutmegs, Gooseberry - unorganized drugs - Gum - Acacia - Resin - Turpentine, fixed oil - castor oil.

UNIT - IV

Herbal medicines for Human ailments - Drugs acting on cardiac diseases, cerebral diseases, Nasal, diseases - Blood pressure Drugs acting on Nervous system - Depressants. - stimulants - Respiration and Drugs - Urogenital system and drugs - Psychoactive plants.

UNIT - V

Propagation of medicinal plants - Micro and macro propagation conservation of rare medicinal plants Role of biotechnology in medicinal plants banks - cultivation of medicinal and aromatic plants - Drug adulteration - methods of Drug evaluation, Herbal food - Food processing - packaging - Herbal sale and Export of medicinal plants - marketing - Intellectual property rights - Export laws.

TEXT BOOKS:

1. Agarwal and Paridhavi, (2007) Herbal Drug Tecnology, 2nd Edition. Universities Press (India) Private Ltd.
2. Wallis, T.E, Text book of pharmacognosy by 5th edition. CBS publishers and distributors Chennai.
3. Kuntal Das (2014). Herbal Plants and their Applications in Cosmeceuticals, CBS publishers and distributors Pvt. Ltd., Chennai.

REFERENCE BOOKS:

1. George Edward Trease and W.C. Evans - Pharmacognosy 12th edition, English Language Books Society, Baelliere Tindall.
2. Handa, S.S. and Kapoor, V.K. Pharamcognosy by 2nd Edition, Vallabh Prakashan Publishers, New Delhi.
3. Jain, S.K (1980) Indian Medicinal plants.
4. Kokate, C.K., Durohit, A.P. and Gokhale, S.R., Pharmacognosy by 12th edition - Nirali Prakasham Publishers, Pune.
5. Kumar N.C. (1993) An Introduction to Medical Botany and Pharmacognosy.
6. Nadkarni (1981) Indian Materia Medica.
7. Shah, S.C. and Qudary (1990) A text book of Pharmacognosy.

PAPER - 3
C. VACCINE BIOTECHNOLOGY

OBJECTIVES

To enable the students to understand the basic knowledge in Vaccine Biotechnology.

UNIT-I

Immune system - recognition of nonself and self ; Humoral Immunity - immunoglobulins, basic structure, classes and subclasses; Cellular Immunity, lymphocytes, lymphokines, cytokines and interferon; Antigen Recognition-membrane. Receptors for antigens, MHC classification and functions, super antigen.

UNIT-II

Recombinant vaccines; polynucleotide as vaccines; vector vaccines; naked DNA vaccines; biosynthetic and chemically synthesized vaccines; subunit vaccine; antiidiotype vaccines; fusion vaccines; mixed particle vaccines; human mucosal vaccines; Combination vaccines; Edible vaccines produced in transgenic plants and microencapsulation.

UNIT- III:

EPI vaccines - production and testing of tetanus toxoid, diphtheria toxoid, pertussis vaccine, BCG vaccines; preparation of Hepatitis B vaccine and tissue culture derived rabies vaccine and AIDS vaccine.

UNIT-IV

Adjuvants - classification and properties; carriers - types and functions - vehicles - types, functions and mode of action ; biodegradable polymers - microspheres, liposomes and ISCOM ; immunostimulators (IS) - classification and mechanism of action of IS.

UNIT-V

Germ free, Axenic, Monoxenic, dixenic, Gnotobiotic, conventional, xyloxic, SPF; isolators, Gnotobiotic technique, gene knockout mice; transgenic and SCID mouse; Athyric nude mouse; animal models of human diseases and techniques of experimentations.

TEXT BOOKS:

1. Ajoy Paul (2016). Text Book of Immunology, Books and Allied (P) Ltd, Kolkatha.
2. Chapel H and Halbey M (1986) Essentials of Clinical Immunology, ELBS.
3. Donal M. Weir, John Steward. (1993). Immunology VII edition. ELBS, London
4. Ivan M. Roit. (1994) Essential Immunology - Blackwell Scientific Publications, Oxford.

REFERENCE BOOKS:

1. Jacqueline S, Williams and Wilkins A. (1998) Basic Immunology - Waverly Company.
2. Janeway Travers. (1997). Immuno biology - The immuno system in health and Disease. 3rd edition Current Biology Ltd., London, New York.
3. Lydyard P, Whelan A and Fanzer MW (2000) Instant notes in Immunology, Edited By Hames BD, Viva Books Private Ltd.
4. Mark Reakman Diego Vergani. Basic and clinical immunology, Longman Asia Ltd., Hong kong.
5. Paul (1998) Fundamental Immunology. III Edition.
6. Peter J. Delves, Ivan M. Roit (eds) (1998) Academic Press - Encyclopedia of Immunology - 2nd edition.
7. Richard M. Hyde. (1995). Immunology III edition. National Medical series, Williams and Wilkins, Harward Publishing Company.
8. Clark WR (1991). The experimental foundations of modern immunology, John Wiley and Sons Inc. New York.

**SEMESTER IV
PAPER - 11
RESEARCH METHODOLOGY**

OBJECTIVES

To enable the student to understand the principles and applications of classical and modern techniques in Biology develop skill in preparation of reports, writing research communications and thesis interpret and analyze the experimental data using different biostatistical tools.

UNIT-I

Microscopy: light microscope - basic principles, types, (phase contrast, dark field and fluorescent microscope). Electron microscopy - principles, working function, electron probe, transmitted electron, image formation, back scattering, secondary electrons. X-ray diffraction, Auger electron, cathode luminescence. Types of EM: TEM, SEM, STEM - sample preparation for EM analysis. Camera Lucida - Principles and uses.

UNIT-II

Electromagnetic radiation: definition, components, biological effective wavelength (UV and visible), Spectrophotometry: principles and working function of spectrophotometers, types (single beam, double beam, Atomic absorption spectrophotometer, IR and NMR. Applications of various spectrophotometers.

UNIT-III

Radioactivity: nature of radioactivity, types of radioisotopes, half-life, Unit of radioactivity, detection and measurements. Geiger Muller counter, liquid scintillation counter, principles and working function. Autoradiography, application of radioisotopes in biological research. Centrifugation: Basic principles, sedimentation coefficient, centrifugal forces. Types of centrifuges - clinical, high speed, refrigerated, ultra. Types of centrifugation - rotar types, density gradient, differential centrifugation. Applications of centrifugation.

UNIT-IV

Chromatography - Principle, types and working function (Paper chromatography, TLC, GC, GC-MS and HPLC), Applications. Electrophoresis - Principle, types and methods. Horizontal, vertical, PAGE, Agarose electrophoresis, Applications. Pulse Field gel electrophoresis (PFGE) - Principle and applications. Gel documentation and molecular weight analysis.

UNIT-V

Molecular Techniques - DNA and plasmid isolation. Amplification of 16S rRNA or specific genes using PCR techniques, RAPD, STRR and LTRR analysis using PCR, RFLP analysis cloning strategies, DNA sequencing - Sanger's Dideoxy and Maxam and

Gilbert's methods. Automated DNA sequencing, Blotting techniques - southern, western, Dot blot- hybridization. Immunoblotting, ELISA - Applications in biological research. Thesis writing; defining research problem, research design, general format, literature survey, primary source - articles, reviews, abstract, current contents (both text and CCOD), reference card, data analysis, data interpretation, report writing, proof correction.

REFERENCES BOOKS:

1. Wrigglesworth, J.M. 1984, Biochemical research technique - a practical introduction. John Wiley, New York.
2. Patki, L.R., Bhalchandra, L. and Jeevaji, I.H., 1989, An introduction to microtechniques, S. Chand and Company Ltd., New Delhi.
3. Keith Wilson and John Walker, 1994. Practical Biochemistry - principles and techniques, Cambridge Press, New York.
4. Keith Wilson and Goulding, K.H. 1986, a biologists guide to principles and techniques of practical biochemistry, ELBS, London.
5. Kothari, C.R., 1988. Research methodology, Wiley Eastern Ltd., New Delhi.
6. Irfan A. Khan and Atiya Khanum, 1994. Fundamental of Biostatistics, Ukaaz publishers, India.
7. Anderson, J., Durosn, B.H. and Poole, M. 1986. Thesis and assignment writing, Wiley Eastern Ltd., New Delhi.

MAIN PRACTICAL

PAPER-3

(Subjects covering Paper 7, 8 and 9)

OBJECTIVES

To impart practical knowledge on various aspects of molecular biology, microbial genetics, gene technology and industrial biotechnology.

UNIT-I

1. Isolation of DNA and RNA from microbial system - quantification - chemical methods dinitrophenol, orcinol - physical methods - UV absorption.
2. Isolation of plasmid DNA from bacteria (mini preparation).
3. Isolation of plasmid DNA from cyanobacteria (mini preparation)
4. Size characterization of DNA by agarose gel electrophoresis.
5. Enzyme immobilization technique.

UNIT-II

1. Isolation of antibiotic resistant microbes.
2. Induction of mutation by ultra-violet radiation and chemical mutagens.

UNIT-III

1. Protoplast / Spheroplast isolation.
2. Purification of plasmids - large scale.

UNIT-IV

1. Preparation of competent E. coli cells.
2. Transformation of Plasmid DNA to the E. coli cells.
3. PCR amplification - 16S rRNA and RAPD.
4. Southern blotting
5. Northern blotting.

UNIT-V

1. Separation of proteins by coloum chromatography, ion exchange - gel exclusion - adsorption
2. Separation of proteins by SDS - PAGE and native gel.
3. Production of proteases - optimization of conditions - pH - temperature.
4. Antibiotic assays - MIC - antibiotic resistance
5. Lipid separation using TLC.

REFERENCE BOOKS:

1. Ausubel FM, Brent R, Kingston, RE, Moore, D.D, Seidman J.G., Smith J.A and Struhl K. (1994). Current Protocols in molecular biology. Vol. 1 & 2. John Wiley & Sons Inc.
2. Dharmalingam K. (1986). Experiments with M13, Macmillan India Ltd. Chennai.
3. Gerhardt P, Murray RG, Wood WA and Kreig NR. (1994), Methods for general and molecular Bacteriology.
4. Hames BD and Rickwood D. (1990) Gel Electrophoresis - a practical approach (1990), Oxford University Press, New York.
5. Harwod AJ. (1994). Protocols for Gene Analysis. Humana Press.
6. Lorian V. (1991) Antibiotics in Laboratory Medicine Williams & Wilkins.
7. Sambrook J and Russell DW (2001) Molecular cloning - A Laboratory manual (3rd edition, Vols - 1, 2, 3). Cold Spring Harbor Laboratory. Cold Spring Harbor Laboratory Press, New York.
8. Surzyeki S (2000). Basic Techniques in Molecular Biology. Springer.
9. Westermeier R. (1993) - Electrophoresis in Practice - VCH - Federal Republic of Germany
10. Willett JE. (1991) Gas Chromatography, John Wiley & Sons.
11. Wilson K and Walker. (1995) Practical Biochemistry Principles.
12. Rajan. S and Selvi Christy (2010). Experimental Procedures in Life Sciences, Anjanaa Book House Publishers, Chennai.
9. Ponmurugan, (2012) Experimental procedures in bioprocess technology, Anjanaa Book House Publishers, Chennai.

**MAIN PRACTICAL
PAPER-4
(Subjects covering Paper-10)**

OBJECTIVES

To impart practical knowledge on various aspects of research methodology.

1. Analysis of microorganisms using Bright field, Dark field, Phase contrast and Fluorescent microscopy.
2. Microscopic diagram using camera Lucida.
3. Measurement of microbes using micrometry.
4. Preparation of samples for Density gradient.
5. Separation of pigments using paper chromatography.
6. Separation of compounds from crude extracts using TLC.
7. Separation of DNA, proteins using electrophoretic techniques.
8. Molecular weight analysis of DNA and proteins using gel documentation.
9. DNA and plasmid isolation - small scale.
10. RAPD finger printing using PCR.
11. Blotting techniques - Southern and western blotting and hybridization.
12. ELISA test.

ELECTIVE
PAPER-4 (to choose 1 out of 3)
A. BIOREMEDIATION

OBJECTIVES

To enable the students to understand the aspects of bioremediation.

UNIT-I

Definition of Bioremediation - Types of pollution - organic, inorganic in soil, water and air - Remediation by bacteria, fungi, microalgae and green plants.

UNIT-II

Bioaccumulation and biomagnification processes - microbial remediation by natural attenuation - biostimulation - bioaugmentation.

UNIT-III

Application of immobilized microbes in soil decontamination - use of genetically engineered microorganism and bioremediation.

UNIT-IV

Biodegradation of organic compounds - humification and polymerization reaction - bio-transformation of metal and metal compounds - phyto -remediation use of microalgae, green plants to remove pollutants.

UNIT-V

Phyto-extraction - Types of phytoextraction - induced phyto-extraction and continuous phyto-extraction - phyto-degradation - rhizofiltration - phyto-stabilisation - phyto-volatilisation of metals - phyto-remediation of organic. Bioavailability and uptake. Biotransformation and compartmentalisation.

REFERENCE BOOKS:

1. Moo-Young, M., Anderson, W.A. and Chakrabarty, A.M. 1996. Environmental biotechnology: Principles and applications. Boston, Mass.: Kluwer Academic Publishers.
2. Wainwright, M. 1999. An introduction to environmental biotechnology. Boston, Mass. Klumer Academic Publishers.

PAPER-4

B. MARINE MICROBIOLOGY

UNIT-I

Marine environment - see-benthic & littoral zone, saltpan, mangroves and estuarine microbes, microbial loop - marine microbial community - planktons, bacteria, fungi, protozoa.

UNIT-II

Survival at extreme environments - starvation - adaptive mechanisms in thermophilic, alkalophilic, asomophilic and barophilic, psychrophilic microorganisms - hyperthermophiles and halophiles - importance in biotechnology.

UNIT-III

Microbe-microbe interactions - Lichens, antagonistic interactions - amensalism, mycoparasitism - Animal-microbe interaction - Ectosymbiosis of Protozoa, Runinant symbiosis - Plant-microbe interaction - Rhizobium, Mycorrhizae, Anabaena - sponge.

UNIT-IV

Marine food borne pathogens & Water borne pathogens - Aeromonas, Vibrio, Salmonella, Pseudomonas, Leptospira, Cornybacter.

UNIT-V Production and applications of marine microbial products - pigments - Astaxanthin, β carotene - enzyme - antibiotics - polysaccharide - sea food preservation methods.

REFERENCES BOOKS:

1. Prescott, L.M., Harley J.P. Klein (1999). Microbiology, WCB, Mc Grow Hill Publications
2. Raina M. Maier, Ian L. Pepper, Charles, P. Gerba (2006). Environmental Micrology, Academic press.
3. Jamesh W. Nybakker (2001). Marine Biology, Benjamin Cummings
4. Shimshon Belkin and Rita R. Colwell (2005). Ocean and Health: Pathogens in the marine environment. Springer.
5. Scheper, T. (2005). Advances in Biochemical Engineering/Biotechnology-Marine Biotechnology I. Springer
6. Bhakuni, D.S. and Rawat, D.S. (2005). Bioactive marine natural products. Anamaya Publishers, New Delhi.

PAPER-4

C. CLINICAL MICROBIOLOGY

UNIT -I

Infection and Immunity: General principles of Infection, Antigens, Antibodies, Antigen- antibody reactions, complement system

UNIT -II

Immune system - structure and functions, immune response, immunodeficiency disease, hypersensitivity, autoimmunity, Immunology of transplantation and malignancy, immunohematology

UNIT -III

Pathogenic/parasitic organisms: Bacterial, viral and protozoal infections of the gastrointestinal system, nervous system, lung, liver and eye; Sexually transmitted diseases, skin infections, zoonoses, arthropod borne diseases. Transmission and spread of diseases - Disease epidemiology.

UNIT -IV

Control and prevention of infections - drugs and antibiotics - drug resistance, Mycobacteria, leprosy and malarial parasite - importance, lifecycle, spread and control. Biochemical changes due to infections - Blood test and tissue analysis. Isolation and identification of organisms from tissue samples. Disease detection - conventional and molecular techniques.

UNIT -V

Normal microbial flora of human body, Laboratory control of antimicrobial therapy, Immunoprophylaxis. Vaccines - types and methods of action. Biotechnological approaches to disease control and vaccine production. Genetic disorders and Gene therapy. Control of vectors - Mosquito control - Biotechnological approaches.

REFERENCE BOOKS:

1. Ananthanarayanan R. and Jayaram Panicker C.K. (1994). Text book of Microbiology. Orient Longman.
2. Balasubramanian, A. and Senthil kumar, P.K, (2017) Medical Microbiology. Darshan Publication, Rasipuram.
3. Pelczar & Kreig (2006). Microbiology 5th edition. Tata McGraw Hill, New Delhi
4. Ivan M. Roit. (1994) Essential Immunology - Blackwell Scientific Publications, Oxford
5. David Greenwood, Richard CD, Slack, John Forrest Peutherer. (1992) Medical Microbiology. 14th edition. ELBS with Churchill Livingstone.
6. Topley & Wilson's. (1990) Principles of Bacteriology, Virology and Immunity, VIII edition, Vol. III Bacterial Diseases, Edward Arnold, London.
7. Rajesh Karykarte and Ajit Damle (2003). Medical Parasitology, 3rd Edition. Books and Allied (P) Ltd, Kolkatha.

Industrial Visit (IV)

Factory Industrial Visit (M. Sc. Applied Microbiology)

Course Objectives: Students will be exposed to professional work environment to acquire the knowledge, independent working capacity and leadership so that at the end of the course they will be able to manage the laboratory and research work with full responsibility and reliability.

Factory Industrial Visit Guide Line: Internship will be conducted in an institute under the supervision of supervisor/s.

During the **Industrial Visit**, students should his/her visiting work should be submitted to the supervisor/department. A report of an industrial Visit should be submitted to the department after completion of the work should be authorized by the concerned supervisor of the institute/factory.

Project / Dissertation with viva voce (M. Sc. Applied Microbiology)

Course Objectives: This course is designed to provide the knowledge and practice for the students of public health research activity, to enable them to carry out researches and solve research related problems and to help them in writing thesis and defend their work. Upon successful completion of the course, the students shall be able to: 1. Search relevant scientific literature 2. Develop a research proposal 3. They find appropriate data collection techniques and tools 4. Manage collected data 5. Analyze data with appropriate statistical techniques 6. Write thesis 7. Defend the findings

Proposal Development: At the beginning of Second year (Fourth Semester), students should carry out with the consultation of designated faculties. Extensive literature survey will develop research proposal during the initial 3 months period.

Data Collection/ Thesis Writing Students will carry out data collection, data management, data analysis, and thesis writing during the remaining period (Fourth Semester).

The Dissertation should have following format: 1. Title 2. Introduction 3. Materials and Methods 4. Results 5. Discussion 6. Conclusion 7. Recommendation 8. References 9. Appendix

BOOKS

GENERAL MICROBIOLOGY

Bernard D. Davis. Renato Dulbecco. Herman N. Eisen. and Harold, S. Ginsberg. (1990). Microbiology (4th edition). J.B. Lippincott company, New York.

Alexopoulos C.J. and C W. Mims. (1993). Introductory Mycology (3rd edition). Wiley Eastern Ltd, New Delhi.

Mara D and Horan N. (2003). The Handbook of Water and waste water Microbiology. Academic Press-An imprint of Elsevier.

Elizabeth Moore-Landecker. (1996). Fundamentals of the fungi. (4th edition). Prentice Hall International, Inc, London.

Heritage, J. Evans E.G.V. and Killington, R.A. (1996). Introductory Microbiology. Cambridge University Press. Holt, J.S., Kreig, N.R., Sneath, P.H.A and Williams, S.T. Bergey's Manual of Determinative Bacteriology (9th Edition), Williams and Wilkins, Baltimore.

John Webster (1993). Introduction to Fungi. (2nd edition). Cambridge University press, Cambridge.

Prescott L.M. Harley J.P. and Klein D.A. (2003). Microbiology (5th edition) McGraw Hill, New York.

Larry Mc Kane. and Judy Kandel (1996). Microbiology-Essentials and applications. (2nd edition). Mc Graw Hill Inc, New York.

Madigan, M.T. Martinko. J.M and Parker J Brock T.D. (1997). Biology of Microorganisms. (8th edition). Prentice Hall International Inc, London.

Schaechter M and Leaderberg J (2004). The Desk encyclopedia of Microbiology. Elsevier Academic press, California.

Nester, E.W., Roberts, C.V. and Nester, M.T. (1995). Microbiology, A human perspective. IWOA, U.S.A.

Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York.

Salle, A.J. (1996). Fundamental principles of Bacteriology.(7th edition).Tata McGraw-Hill publishing company Ltd, New Delhi.

VIROLOGY

Alan J.Cann (1997). Principles of Molecular virology. (2nd edition). Academic press, California.

Ann Giudici Fettner (1990). The Science of Viruses. Quill William Marrow, New York.

Conrat H.F., Kimball P.C. and Levy J.A. (1988). Virology. II edition. Prentice Hall, Englewood Cliff, New Jersey.

Dimmock NJ, Primrose SB. (1994) Introduction to Modern Virology IV edition. Blackwell Scientific Publications, Oxford

Flint, S.J., Enquist, L.W., Krung, R. Racaniello, V.R. and Skalka, A.M. (2000). Principles of Virology, Molecular Biology, pathogenesis and control, ASM Press, Washinton D.C.

Maloy, S.R, Cronan Jr. J.E, Freifelder, D. (1998). Microbial genetics. Jones and Bartlett publishers.

Nicklin, J.Greame-Cook and Killington, R. (2003). Instant Notes in Microbiology.(2nd edition).Viva Books private limited, New Delhi.

Robert, I. Krasner (2002). The microbial challenge: Human Microbe Interactions. American society for Microbiology, Washington.

Roger Hull (2002). Mathews' Plant Virology. (4thEdition).Academic press-A Harcourt Science and technology company, New York.

Tom Parker, Leslie, M. and Collie, H. (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition).

GENERAL BIOCHEMISTRY

Christopher K. Mathews and Van Holde, K.E. (1996). Biochemistry. (2nd edition). The Benjamin/Cummings publishing company, Inc.

David E. Metzler. and Carol M. Metzler (2001). Biochemistry-The chemical reactions of living cells-Vol 1 & 2.(2nd edition).Harcourt/Academic press, New York.

Donald Voet and Judith G. Voet (1995). Biochemistry – Second Edition. John Willey and Sons, Inc.

Freifelder, D. (1996) Molecular Biology, II Edition, Narosa Publishing House, New Delhi.

Geofferey, L and Zubay (1998). Biochemsitry. (Fourth Edition) Wm. C. Brown Publishers. Jeremy M. Berg. John L. Tymoczko and Lubert stryer (2002). Biochemistry.(5th edition).W.H.Freeman and company, New York. Lubert Stryer.(1995). Biochemistry.(4th edition). W.H. Freeman and company, New York.

Reginald, H., Garret and Charles M. Grishm. (1998). Biochemistry (Second Edition) Saundars College Publishing. Thomas M. Devlin. (2002). Textbook of Biochemistry with clinical correlations.(5th edition).A John Wiley and sons,Inc.,publication, New York. Trudy McKee and James R. McKee. (1999). Biochemistry-An Introduction. (2nd edition).WCB McGraw-Hill, U.S.A

Practical: Microbiology, Virology & Biochemistry

Wilson, K. and Walker, J. (2000). Practical Biochemistry, 5th Edition, Cambridge University Press.

Cappuccino and James, G (1996) Microbiology a laboratory manual, Addison Wesley Publishing Company Inc. 4th edition, England, California.

David R. Brooke. Bergey's Manual of Systematic Bacteriology (Vol. I), Eastern Halz, Springer Publication.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994) Methods of General and Molecular Bacteriology, Ed. American Society for Microbiology, Washington D.C.

James T. Stanley, Marvin P. Bryant. Bergey's Manual of Systematic Bacteriology (Vol. II), Nobert Pfeming Springer Publishers. Wilson K. Walker (1995). Practical Biochemistry, Principles and Techniques, Cambridge University Press.

Gerhardt, P., Murray, R.G., Crood, W.A. and Kreig, N.R. (1994) Methods for general and molecular bacteriology, ASM, Washington D.C.

Jeanne Dejkstra, Ces.P.de Jager (1998) Practical plant virology, Springer Verlag, Lab Manual, Berlin, Heidel Berg, New York.

Miller, J.H. (1992) A short course in bacterial genetics, Cold Spring Harbor.

MICROBIAL PHYSIOLOGY

Caldwell, D.R. (1995). Microbial Physiology and metabolism, Wm. C. Brown Publishers, U.S.A. Lansing M. Prescott, John P. Harley and Donald A. Klein. (2003). Microbiology.(5th edition).McGraw-Hill company, New York. Larry McKane and Judy Kandel.(1996). Microbiology-Essentials and applications.(2nd edition).McGraw Hill, Inc., New York.

Moat, A.G. and Foster, J.W. (1988). Microbial Physiology (Second Edition). John Wiley & Sons, New York.

Pelczar Jr, M.J. Chan, E.C.S. and Kreig, N.R. (1993). Microbiology, Mc. Graw Hill. Inc, New York. Salle, A. J. (1996). Fundamental principles of Bacteriology (7th edition).Tata McGraw-Hill publishing company limited, New Delhi.

White, D. (1995). The physiology and biochemistry of Prokaryotes, Oxford University Press, Oxford, New York.

ENVIRONMENTAL AND AGRICULTURAL MICROBIOLOGY

Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.

Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.

Ec Eldowney S, Hardman D.J., Waite D.J., Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.

Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.

Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.

Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C. Patricia Cuning (1995). Official Methods of Analysis, Vol. I and II, 16th Edition, Arlington, Virginia, U.S.A., AOAL.

Richard G. Burus and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Scientific Publishers.

Tuffery (1996). Laboratory Animal, an Introduction, II Edition, John Wiley and Sons, New York.

Practical - Environmental, agricultural Microbiology

Atlas Ronald, M., Bartha, and Richard (1987). Microbial Ecology 2nd Edition. Benjamin/Cummings Publishing Company, California.

Dirk, J. Elsas, V., Trevors, J.T., Wellington, E.M.H. (1997). Modern Soil Microbiology, Marcel Dekker INC, New York, Hong Kong.

Ec Eldowney S, Hardman D.J., Waite D.J., Waite S. (1993). Pollution: Ecology and Biotreatment – Longman Scientific Technical.

Grant W.D. and Long, P.L. (1981). Environmental Microbiology. Blackie Glasgow and London.

Mitchel, R. (1992). Environmental Microbiology. Wiley – John Wiley and Sons. Inc. Publications, New York.

Clescri, L.S., Greenberg, A.E. and Eaton, A.D. (1998). Standard Methods for Examination of Water and Waste Water, 20th Edition, American Public Health Association.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Publications, Washington D.C.

Patricia Cuning (1995). Official Methods of Analysis, Vol. I and II, 16th Edition, Arlington, Virginia, U.S.A., AOAL.

Richard G. Burus and Howard Slater (1982). Experimental Microbial Ecology, Blackwell Scientific Publishers.

Tuffery (1996). Laboratory Animal, an Introduction, II Edition, John Wiley and Sons, New York.

MICROBIAL BIOTECHNOLOGY

Balasubramanian, D., Bryce, C., Dharmalingam, K., Green, J. and Jayaraman, K. (1999). Concepts in Biotechnology, University Press, India.

Colin Ratledge and Bjorn Kristiansen (2001). Basic Biotechnology, Cambridge University Press, U.K.

Joshi, V.K. and Ashok Pandey. (1999). Biotechnology, Food fermentation (Microbiology, Biochemistry and Technology) Vol. I & II Basic, Educational Publishers and Distributors, Ernakulam.

Whitaker Stanbury (1998). The principles of fermentation technology, Butterworth Heineman, U.K.

Vedpal's S. Malik, Padma Sridhar, Sharma, M.C. and Polasa, H. (1992). Industrial Biotechnology, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

IMMUNOLOGY AND MEDICAL MICROBIOLOGY

Chapel, H. and Halbey, (1986). Essentials of Clinical Immunology. ELBS.

Donald M. Weir, John Steward. (1993). Immunology VII edition. ELBS, London.

Hue Davis (1997). Introductory Immunology (First Edition). Chapman & Hall Publisher, London.

Ivan M. Roit. (1994) Essential Immunology – Blackwell Scientific Publications, Oxford.

Paul (1998). Fundamental Immunology, II Edition, Raver Press, New York. Peter J. Delves, Ivan M. Roit (eds) (1998) Academic Press – Encyclopedia of Immunology – 2nd edition.

Ridklad, M. Aydl (1995). Immunology, II Edition, Baltimore, Hong Kong, NMS Publication. Roit, J.M. Brostaff, J.J. and Male, D.K. (1996). Immunology (4th Edition) C.V. Mosby Publisher, St. Louis.

Collee, J.G., Duguid, J.P., Fraser, A.G. and Marimoin, B.P. (1989). Mackie and McCartney Practical Medical Microbiology, 13th edition. Churchill Livingstone. David Greenwood, Richard CD., Slack, John Forrest Peutherer. (1992). Medical Microbiology.

16th edition. ELBS with Churchill Livingstone. Joan Stokes, E., Ridgway GL and Wren MWD (1993). Clinical Microbiology, 7th edition, Edward Arnold. A division of Holder and Stoughton.

Tom Parker, M., Leslie H. Collier (1990). Topley & Wilson's Principles of Bacteriology, Virology and Immunity (VIII Edition). Balasubramanian, A. and Senthil kumar, P.K, Medical Microbiology. Darshan Publication, Rasipuram.

MOLECULAR GENETICS

Freidberg, E.C., Walker, G.C., Siede, W. (1995). DNA repair and Mutagenesis, ASM Press, Washington D.C.

Lewin, B, (2000). Genes VII. Oxford University Press.

Maloy, S.R., Cronan Jr. Je. Freifelder D (1998). Microbial genetics. Jones and Barlett Publishers.

Malacinski, M. and Freifelder, D. (1998). Essential of Molecular Biology. III Edition. Jone and Barlett Publishers, Boston.

Maloy, S.R., Cronan, J.R. Freifelder, D. (1994). Microbial Genetics, Jones and Bartlett Publishers.

Siger, M., Berg, P. (1991). Genes and Genomes, University Science Book.

Snustad, D., Simmons, J. and Jenkins, B. (1997). Principles of Genetics. First edition. John Wiley and Sons.

Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1998). Molecular biology of the gene, 4th edition, Benjamin/Cummings publishing company.

MOLECULAR BIOLOGY AND GENETIC ENGINEERING

Brown, T.A. (199). Gene Cloning. 3rd edition. Chapman and Hall Publications, U.S.A.

Burrel, M.M. (1993). Enzymes of Molecular Biology, Humana Press.

Chirikjian, J.G. (1995). Biotechnology – Theory and Techniques, Vol. II, Jones and Burtlett Publishers.

Gerhardt, P. Murray, R.G., Wood, W.A., and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Press, Washington D.C.

Glezk, B.R. and Pasternak, J.J. (1998) Molecular Biotechnology – Principles and Applications of Recombinant DNA, ASM Press, Washington D.C.

J. Mc. Cafferty. Hoogenboom, H.R. and Chiswell, D.J. (1996). Antibody engineering – A practical approach, Oxford University Press.

Lewin, B. (2000). Genes VII. Oxford University Press, Oxford.

Murray Moo (1992) Plant Biotechnology. Young, Pergamon Press.

Radledge, C. and Kristiansen, B. (2001). Basic Biotechnology, II Edition, Cambridge University Press.

Techniques for Engineering Genes (BIOTOC – Biotechnology), (1993), Published on behalf of Open Universitat and University of Greenwich, Butterworth Heinman Ltd, Oxford.

Walsh, G. and Headon D. (1994). Protein Biotechnology, John Wiley and Sons, New York.

Winnacker, E.L. (1987). From genes to Clones: Introduction to Gene technology. VCH Publications, Federal Republic of Germany.

Antony, J.F., Griffiths, Gilbert, W.M., Lewontin, R.C. and Miller, J.H. (2002). Modern genetic analysis, Integrating Genes and Genomes, 2nd edition, WH Freeman and Company, New York.

Blackburn, G.M. and Gait, M.J. (1996). Nucleic acids in chemistry and biology. Oxford University Press.

Bruce Alberts, Dennis Brag, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson. (1994). Molecular Biology of cell. Garland Publishing Inc.

George M. Malacinski, David Freifelder. (1998). Essentials of Molecular Biology. Jones and Bartlett Publishers.

Maloy, S.R., Cronan, J.R. Freifelder, D. (1994). Microbial Genetics, Jones and Bartlett Publishers. Macinski, G.M. and Freifelder, D. (1998). Essentials of Molecular Biology, 3rd Edition, John and Bartlett Publishers.

Sir John Kendrew (1994). The encyclopedia of Molecular Biology. Blackwell Science Ltd.

Practical - Molecular Biology Genetic Engineering, Immunology and Medical Microbiology

Ausubel, F.M., Brent, R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith, J.A. and Struhl, K. (1994). Current Protocols in Molecular Biology.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kreig, N.R. (1994). Methods for General and Molecular Bacteriology.

Hames, B.D. and Rickwood, D. (1990). Gel Electrophoresis – A Practical Approach, Oxford University Press, New York. Sambrook, J and Russell, D.W. (2001). Molecular Cloning – A Laboratory Manual, 3rd Edition, Vol I, II, III, Cold Spring Harbour Laboratory Press, New York. Victor Lorian (1991). Antibiotics in Laboratory Medicine , 3rd Edition, Williams and Wilkins.

Westermeier, R. (1993). Electrophoresis in Practice, VCH, Federal Republic of Germany.

Wilson, K. and Walker (1995). Practical Biochemistry, Principle and Techniques, IV Edition, Cambridge University Press.

Ronald M. Atlas, Lawrence C. Paxis (1993) Hand book of Microbiological Media. Ed. LC. CRC Press, London.

Balows, A., Hauser Jr K.L., Isenberg, H.D., Shalomy, H.J. (1991). Manual of Clinical Microbiology, ASM, Washington D.C.

Gerhardt, P., Murray, R.G., Wood, W.A. and Kruzsh, N.R. (1994). Methods for General and Molecular Bacteriology, ASM Washington D.C. Lorian, V. (1991) Antibiotics in laboratory medicine, 3rd edition, Williams and Wilkins, Baltimore.

BIO PROCESS TECHNOLOGY

Demain, A.L. and Davies, J.E. (1999). Manual of Industrial Microbiology and Biotechnology. ASM Press.

Glick, B.R. and Pasternak, J.J. (1994). Molecular Biotechnology, ASM Press.

Stanbury, P.F., Whitaker, A. and Hall, S.J. Principles of Fermentation Technology, Pergamon Press.

Glick, B.R. and Pasternak, J.J. (1998). *Molecular Biotechnology*, II Edition, ASM Press, New York.

Mittal, D.P. (1999). *Indian Patents Law*, Taxmann, Allied Services (p) Ltd.

Tortora, G.J., Fernke, B.R. and Case, C.L. (2001), *Microbiology – An Introduction*, Benjamin Cummings.

Venkataraman, L.V. (1983). *A monograph on Spirulina platensis*, CFTRI, Mysore.

BIostatISTICS AND BIOinformatics

Arora, P.N. and Malhon P.K., (1996) *Biostatistics*. Imalaya Publishing House, Mumbai.

Baxevanis, A.D. and Ouellette, B.F.F. (2001). *Bioinformatics: A practical guide to the analysis of genes and proteins – Wiley Interscience – New York*

Cynthia Gibas and Per Jambeck (2001) *Developing Bioinformatics Computer Skills: - Shroff Publishers & Distributors Pvt. Ltd (O'Reilly), Mumbai*

Des Higgins and Willie Taylor (2000) *Bioinformatics: Sequence, structure and databanks*. Oxford University Press

Rashidi, H.H. and L.K. Buehler (2002) *Bioinformatics Basics: Applications in Biological Science and Medicine*, CRC Press, London

Sokal and Rohif, (1973) *Introduction to Biostatistics - Toppan Co. Japan*.

Stanton, A and Clantz, *Primer of Biostatistics - The McGraw Hill Inc., New York*.

Sokal and Rohif, (1973) *Introduction to Biostatistics - Toppan Co. Japan*.

Stanton, A and Clantz, *Primer of Biostatistics - The McGraw Hill Inc., New York*.
