

THIRUVALLUVAR UNIVERSITY

BACHELOR OF SCIENCE

B.Sc. BIOTECHNOLOGY DEGREE COURSE

CBCS PATTERN (w.e.f 2017–2018)

S. No.	Part	Study components		Hrs/ Wk	Credit	Title of the paper	Maximum marks		
		Course title					CIA	Univ. Exam	Total
Semester I									
1.	I	Language	Paper-1	6	4	Tamil/Other languages	25	75	100
2.	II	English	Paper-1	6	4	English	25	75	100
3.	III	Core theory	Paper-1	6	6	Cell Biology	25	75	100
4.	III	Core practical	Practical-1	3	0	Cell Biology	0	0	0
5.	III	Allied I	Paper-1	4	4	Bio systematic in Biology	25	75	100
6.	III	Allied practical	Practical-1	3	0	Bio systematic in Biology	0	0	0
7.	IV	Environmental Studies		2	2	Environmental Studies	25	75	100
				30	20		125	375	500
Semester II									
8.	I	Language	Paper-2	6	4	Tamil/Other languages	25	75	100
9.	II	English	Paper-2	4	4	English	25	75	100
10.	III	Core theory	Paper-2	6	5	Biochemistry	25	75	100
11.	III	Core practical	Practical-1	3	3	Cell Biology and Biochemistry	25	75	100
12.	III	Allied I	Paper-2	4	4	Principles of chemistry in Biology	25	75	100
13.	III	Allied practical	Practical-1	3	3	Biosystematics in Biology and Principles of chemistry in Biology	25	75	100
14.	IV	Value Education		2	2	Value Education	25	75	100
15.	IV	Soft Skill		2	1	Soft Skill	25	75	100
				30	26		200	600	800
Semester III									
16.	I	Language	Paper-3	6	4	Tamil/Other languages	25	75	100
17.	II	English	Paper-3	6	4	English	25	75	100
18.	III	Core theory	Paper-3	3	3	Microbiology	25	75	100
19.	III	Core practical	Practical-2	3	0	Microbiology	0	0	0

20.	III	Allied2	Paper-3	4	4	Principles of Genetics	25	75	100
21.	III	Allied practical	Practical-2	3	0	Principles of Genetics	0	0	0
22.	IV	Skill based subject	Paper-1	3	3	Medical Lab Technology I	25	75	100
23.	IV	Non-Major Elective	Paper-1	2	2	Basic Biotechnology	25	75	100
				30	20		150	450	600
Semester IV									
24.	I	Language	Paper-4	6	4	Tamil/Other languages	25	75	100
25.	II	English	Paper-4	6	4	English	25	75	100
26.	III	Core Theory	Paper-4	3	3	Immunology	25	75	100
27.	III	Core practical	Practical-2	3	3	Microbiology and Immunology	25	75	100
28.	III	Allied2	Paper-4	4	3	Biostatistics and Basic Computer Applications	25	75	100
29.	III	Alliedpractical2	Practical-2	3	2	Principles of Genetics and Biostatistics and Basic Computer Applications	25	75	100
30.	IV	Skill based subject	Paper-2	3	3	Medical Lab Technology II	25	75	100
31.	IV	Non-Major Elective	Paper-2	2	2	Applied Biotechnology	25	75	100
				30	24		200	600	800
Semester V									
32.	III	Core theory	Paper-5	5	5	Molecular Biology	25	75	100
33.	III	Core theory	Paper-6	6	5	Genetic Engineering	25	75	100
34.	III	Core theory	Paper-7	6	5	Industrial Biotechnology	25	75	100
35.	III	Core Practical	Practical-3	5	0	CorePractical-3 Molecular Biology, Genetic Engineering and Industrial Biotechnology	0	0	0
36.	III	Elective	Paper-1	4	3	A) Beekeeping B) Aquaculture C) Basics in stem cell biology	25	75	100
37.	IV	Skill based subject	Paper-3	4	3	Bioinstrumentation	25	75	100
				30	21		125	375	500
Semester VI									
38.	III	Core theory	Paper-8	5	5	Animal Cell Biotechnology	25	75	100
39.	III	Core theory	Paper-9	5	4	Plant Cell Biotechnology	25	75	100
40.	III	Core theory	Paper-10	5	4	Environmental Biotechnology	25	75	100
41.	III	Core Practical	Practical-3	0	3	Molecular Biology, Genetic Engineering and Industrial Biotechnology	25	75	100

42.	III	Core Practical	Practical-4	5	3	Animal Cell Biotechnology, Plant Cell Biotechnology and Environmental Biotechnology	25	75	100
43.	III	Elective	Paper-2	3	3	A) Sericulture B) Vermi and mushroom culture C) Medicinal plants	25	75	100
44.	III	Elective	Paper-3	3	3	A) Food quality management B) Public Health and Hygiene C) Enzyme technology	25	75	100
45.	IV	Skill based subject	Paper-4	4	3	Food processing technology	25	75	100
46.	V	*Extension activities		0	1		100	0	100
				30	29		300	600	900

NOTE:

(College can choose any one of the elective papers given A or B or C, as Elective for a particular Semester)

*Every student shall participate compulsorily for a period of not less than two years (4 semesters) in any of the following programmes. NSS/NCC/Sports/YRC/RRC/LEO/other extra-curricular activities.

(For further details, refer UGC regulations for UG Degree courses)

Part	Subject	Papers	Credit	Total credits	Marks	Total marks
Part I	Languages	4	4	16	100	400
Part II	English	4	4	16	100	400
Part III	Allied(odd sem)	2	4	8	100	200
Part III	Allied(Even sem)	2	4,3	7	100	200
	Allied – Pac (Even sem)	2	3,2	5	100	200
	Electives	3	3	9	100	300
	Core	10	(3-6)	45	100	1000
	Core practical	4	3	12	100	400
Part IV	Env. Science	1	2	2	100	100
	Soft Skill	1	1	1	100	100
	Value Education	1	2	2	100	100
	Language and others/NME	2	2	4	100	200
	Skilled based	4	3	12	100	400
Part V	Extension activities	1	1	1	100	100
Total		41		140		4100

CORE THEORY

PAPER-1

CELL BIOLOGY

Objective: To impart the basic knowledge of cell design and its components, tools and techniques.

UNIT I

Cell and membrane structure – Historical review, Discovery of cell, Cell theory. Ultra structure of Prokaryotic cell and Eukaryotic cell. Structure and functions of Plasma membrane. Structure and functions of Cytoskeleton. Bacterial cell wall and Eukaryotic cell wall

UNIT II

Power house of the cell – Mitochondria –structure, types, functions and cyto plasmic inheritance.

Food factory of the cell – Plastids – structure, functions and cyto plasmic inheritance – Photosynthetic pigments. **Protein factory of the cell** – Ribosomes – structure, types and classification.

UNIT III

Structure and functions of Intracellular Organelles– Nucleus, Nucleolus, Chromosome, Golgi complex, Lissome, Micro bodies, Centro some, Endoplasmic reticulum.

UNIT IV

Cell Division and Cell cycle – Eukaryotic cell cycle–Phases of cell cycle–Mitosis, Meiosis. Regulation of cell cycle. **Cell death and cell renewal** –apoptosis and PCD. Cell renewal.

UNIT V

Tools and techniques of Cell Biology – Microscopy –Principles of Light microscopy, Phase contrast microscopy, Electron microscopy (Scanning and transmission Electron Microscopy) and Fluorescence microscopy. Sub-cellular fractionation – differential and density gradient centrifugation.

SUGGESTED BOOKS

1. Cell–A Molecular Approach (5th Edition)–Geoffrey M Cooper, Robert E Hausmann
2. Cytology (8th Edition).P.S. Verma,V.K. Agarwal. S.Chand Publications
3. Cell Biology and Molecular Biology–N.Arumugam. Saras Publication
4. The World of the Cell (6th Edition)–Becker, Klein smith, Hardin
5. Lewin’s Cells (3rd Edition) – George Plopper, David sharp, Eric Sikorsi. Jones and Bartlett Learning Cell Biology –Thomas D Pollard, William C Earnshaw.
6. Cell Biology–Channarayappa, Universities Press, Hyderabad

ALLIED I

Paper 1

BIOSYSTEMATICS IN BIOLOGY

Objective: To impart the knowledge of animal and plants and their classification.

UNIT-I

Introduction to Biosystematics – Diversity of life in the world-Taxonomy, classification, nomenclature. Biological classification, taxonomic hierarchy, taxonomical aids- herbarium, botanical garden, museum, zoological park and taxonomic keys.

UNIT-II

Five kingdom classification- Characteristics of Monera - Archae bacteria and Eubacteria. Characteristics of Protista – Chrysophytes, Dinoflagellates, Euglenoids, Protozoan and Slime Moulds. Characteristics of Fungi–phycomycetes, ascomycetes, basidiomycetes, deuteromycetes. Characteristics of Plantae and Animalia. Viruses, viroids and lichens.

UNIT-III

Plant Kingdom- general characters and classification upto class with examples. Algae–classes. Bryophytes –liverworts and mosses. Pteridophytes – Gymnosperm, Angiosperm.

UNIT-IV

Animal Kingdom-general characters and classification upto class with examples. Porifera, Coelenterata (Cnidaria), Ctenophora, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Prochordates–cephalochordate, Hemichordate and Urochordata or Tunicata.

UNIT-V

Chordata – General characters and classification upto class with examples: Chordata – Pisces, Amphibian, Reptiles, Aves and Mammals.

SUGGESTED BOOKS:

1. Plant Diversity vol.1–Annie and V. Kumaresan 2012. Saras Pub.
2. Environmental Biodiversity–P.R. Dadav 1995.
3. Invertebrata–Phylum–R.L. Kotpal Series, Rastragi Pub. Meerut 2000.
4. Manual of Zoology–E. Ayyar. Madras Pub. 1995.
5. Comparative vertebrate Zoology. Waterman et. Al. MacMillan and Co. 1971.
6. Invertebrate Zoology–Ekambranatha Iyer
7. Vertebrate Zoology–Ekambranatha Iyer

SEMESTER II
CORE THEORY – 2
BIO CHEMISTRY

Objective: To understand the structure of various bio molecules, their interactions, synthesis and structural relationship

UNIT-I

Carbohydrates - Classification, occurrence, structure and functions of monosaccharide, disaccharides, oligosaccharides & polysaccharides. Carbohydrate metabolism - Introduction, digestion, absorption, glycolysis, gluconeogenesis, glycogenolysis, Glycogenesis, Citric acid cycle, Bioenergetics.

UNIT-II

Proteins - Classification, structure and biological function. Amino acids –Classification based on structure and polarity. Essential and non-essential amino acids. Amino acid metabolism- Introduction, digestion and absorption, amino acid degradation reactions, urea cycle, linking to TCA cycle.

UNIT-III

Lipids-Classification, structure and biological function–essential and non-essential fatty acids. Lipid metabolism-Introduction, digestion and absorption. β -oxidation. Cholesterol biosynthesis - pathway, importance and regulation.

UNIT-IV

Nucleic acids - Structure of purines and pyrimidines. Structure of DNA-Types of DNA.

Enzyme: Classification, Nomenclature, Mechanism of enzyme action.

UNIT-V

Vitamins & Hormones- Classification, physiological functions & deficiency disorders of vitamins- A,D,E,K,B complex and C.Hormones - thyroxin, insulin, growth hormones.

Separation technique – Chromatography – paper and thin layer. **Electrophoresis** - AGE, SDS-PAGE.

SUGGESTED BOOKS:

1. Lehninger, Cox and Nelson: Biochemistry
2. Voet & Voet: Biochemistry.
3. Stryer K. Biochemistry 1995. W.H. Freeman & Company, New York.
4. Mathews, H.R. Freedland R. Miesfeld, R.L. 1997. Biochemistry a short course. Wiley - Liss Inc.
5. Neal, A.C., Chemistry & Biochemistry: A Comprehensive Introduction. McGraw Hill Book Company.
6. Donald Voet, Judith G. Voet, Biochemistry, Second edition.
7. David L. Nelson, Michael M. Cox, Lehninger. Principles of Biochemistry, third edition.
8. Plummer, D.T. 1988. An Introduction to Practical Biochemistry, Tata McGraw Hill Co., New Delhi.

ALLIED I

Paper 2

PRINCIPLES OF CHEMISTRY IN BIOLOGY

Objective: To understand the basics of chemistry in biology
To familiarize in the preparation of standard solutions

Unit1: Atomic Structure

Structure of an atom, atomic number, atomic weight, stable and unstable atoms, molecules-Atomic Orbitals, quantum, numbers–Azimuthal, magnetic and spin Quantum numbers and their significance. Pauli's exclusion principle, Hund's rule, Aufbau Principle-Classification of s,p,d & f block elements.

Unit II: Periodic trends:

Periodic table-trends-Electron configuration, Atomic radii, Ionization energy, Electro negativity, Electron affinity, Metallic character-Alkali earth metals in the body: Na and K versus Li-The significance of atomic size in the selectivity of ion channel sin neurons

Unit III : Principles Chemical Analysis

Definition - Molarity, normality, Molarity and mole fraction-Types of titri metric reactions–acid - base, redox, precipitation and complex metric titrations, Indicators — Neutralization, redox, adsorption and metalion indicators.

Unit IV: Chemical Bonds:

Ionic bond or electrovalent bonds, covalent bonds, Vander Waals bond, Hydrogen bonds, a hydro bonds– pH, Effect of change in pH-Buffer system–mechanism of buffer action–bicarbonate buffer system-isomerism

Unit V: Water

Properties, ionization of water, tetra hedral structure of water – Free radicals in biology – ROS [super oxide (O₂⁻), hydrogen peroxide (H₂O₂), hydroxyl radical (HO[•]) and peroxy (ROO[•])and alkoxy (RO[•])]– Antioxidants–sources(animal and plant organ).

SUGGESTED BOOKS:

1. Puri B.R., Sharma L.R., Kalia K.K., Principles of Inorganic Chemistry, (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., (1993).
2. Tisdale S.L., Nelson W.L. and Beaton J.D. Soil fertility and fertilizers, Macmillon Pub Co New York 1990.
3. B.K. Sharma, Industrial Chemistry Goel Publishing my House 1995.
4. J.L. Jain, Sunjay Jain, Nitin Jain. Fundamentals of Biochemistry, S. Chand & Company.
5. Biochemistry and Biophysics, N. Arumugam, Saras Publications, 2nd Edn 2010.
6. Biochemistry, Powar and Chatwal, Himalaya Publishing House, 4th revised Edn 2000.
7. Practical Chemistry - A.O. Thomas – Scientific book center, Cannanore.
8. Practical Chemistry - 3 Volumes - S. Sundaram and others.
9. Vogel's text book of practical organic chemistry - Longman

CORE PRACTICAL I
CELL BIOLOGY AND BIO CHEMISTRY

CELLBIOLOGY

1. Mitosis in onion root tip
2. Meiosis in flower buds of *Alliumcepa* (onion) or grass hopper testis
3. Observation of buccal cells
4. Separation of cellular organelles by differential centrifuge
5. Separation of cell membrane components from leaves
6. Microscopy and calibration
7. Measurement size of various cells using micrometry

BIOCHEMISTRY

1. Qualitative test for carbohydrates (Glucose, Fructose, Galaxies & Starch)
2. Qualitative test for proteins
3. Qualitative test for lipids
4. Amino acid separation by paper chromatography
5. Amino acid separation by TLC
6. Effect of substrate concentration on salivary amylase.
7. Estimation of DNA by diphenylamine method
8. AGE and SDS–PAGE – demonstration only

Industrial visit: Submission of Report of Biochemical clinical lab visit

ALLIED PRACTICAL I
BIO SYSTEMATICS IN BIOLOGY AND PRINCIPLES OF CHEMISTRY IN
BIOLOGY

BIOSYSTEMATICS IN BIOLOGY

1. Study of the field collection, preservation and identification of plants
2. Study of the field collection, preservation and identification of animals
3. Identify biodiversity of pond ecosystem (using charts only)
4. Identify biodiversity of grassland ecosystem (using charts only)
5. Identify biodiversity of marine ecosystem (using charts only)
6. List out Plant diversity in the campus
7. List out Animal diversity in the campus
8. Preparation of Herbarium
9. Preparation of Insect Box
10. Field visit to any one Hotspot and submission of field report. Field based Viva–Voce.
(Out of 40% marks for internal assessment, 10% marks shall be dedicated to the field work assessments)

PRINCIPLES OF CHEMISTRY IN BIOLOGY

1. Preparation of standard, normal and molar solutions
2. Measurement of pH in different water samples (tap water, aquarium, sewage, seawater, pond water, effluents) by pH paper and pH meter.
3. Preparation of phosphate buffer solution
4. Preparation of TAE buffer
5. Estimation of HCl by NaOH using a standard oxalic acid solution
6. Estimation of oxalic acid by KMnO_4 .

Industrial visit: Submission of Report of visit to any one ecosystem nearby (pond, river, forest, grassland etc)

SEMESTER III
CORE THEORY
PAPER-3
MICROBIOLOGY

UNIT-I

Overview of history of Microbiology –Biogenesis and a biogenesis, Contributions of Spallanzani, Pasteur, Tyndal, Joseph Lister, Koch [Germ Theory], Edward Jenner and Flemming [Penicillin]. Scope of Microbiology. Classification of Microbes – Five kingdom concept, three kingdom concept.

UNIT-II

Bacteriology - Ultra structure of bacteria–gram positive and gram negative bacteria, morphology, culture characteristics, bio chemical reactions, pathogen city and diseases of *Staphylococcus aureus*, *Streptococcus pneumoniae*, *E.coli*, *Salmonella typhi*, *Vibrio cholerae* *Haemophilus influenzae*.

UNIT-III

Growth and multiplication of bacteria – bacterial growth curve, bacterial nutrition, factors affecting bacterial growth. Different types of bacterial culture-Batch, Synchronous, continuous, fed batch. Nutritional grouping of micro organisms – types of bacterial culture media.

UNIT-IV

Viruses - General classification and properties of viruses. Virus host inter actions – bacterio phages. Fungi - general characteristics of fungi–structure and functions of yeast. Algae -General classification and properties of algae, Economic importance of algae.

UNIT-V

Sterilization and staining techniques – Sterilization technique – Definition, Physical methods – heat, radiation, ultrasonic action, filtration. Chemical methods-disinfection, sanitization, anti sepsis sterilants and fumigation. Staining techniques–Definition of auxochrome, chromophores, dyes. Classification of stains-mechanism of gram staining, acid fast staining, negative staining, capsule staining, flagella staining, endospore staining.

SUGGESTED BOOKS:

1. Microbiology - concept and applications – Pelzer, M.J.J. Chang and N.R. Krieg 1993, McGraw Hill, NY.
2. Microbiology fundamentals and applications Renald, M. Atlas 1987. Prentice Hill.
3. Microbiology, Fundamentals and Applications, Ronald, M. Atlas, 1986.
4. General Microbiology, Stainer, 1986. Mc. Millan Pub. Co.
5. Microbiology. Davis, Dulbeco, R. Einstein, Gibbsbergs - Herpers and Row Publications, SG.
6. Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.
7. Pelczar, M., et al., Microbiology, 5th ed., 2000, Tata-McGraw Hill
8. Atlas, R.M., Principles of Microbiology, 2nd ed., 1997, McGraw-Hill

ALLIED 2

Paper 3

PRINCIPLES OF GENETICS

Objective: To imbibe the knowledge of basic genetic, human genetics and mutational aspects.

UNIT I

Mendelian Principles: Introduction – Birth of Genetics, Mendelian principles – Mendel's experimental organism. Mono hybrid cross–Principles of dominance and segregation. Di hybrid cross – Principles of Independent assortment.

UNIT II

Allelic variation and gene function–Completed dominance, incompletely dominance, Pleiotropy, Penetrance and expressivity. Sex-linkage, sex limited and sexinfluenced characters. Multiple alleles – Characteristics, ABO blood group, Rhesus allele, Pseudoallelism.

UNIT III

Methods of gene transfer – transformation, conjugation, transduction, sexduction. Fine structure of gene. Gene mapping –Two point cross, threepointcross. Tetra analysis haploid mapping – Tetra analysis in yeast, Neurospora, Looscare. Karyotype, Genetic disorder.

UNIT IV

Mutation –Historical background, Occurrence. Mutagens, molecular basis of classification –Point, Deletion, Insertion, Substitutionmutation, Spontaneous and Induced mutation. Radioactive mutation – Ionizing and Ultraviolet mutation.

UNIT V

Human genetics – Pedigree analysis, Twin studies–Mono zygotic, Di zygotic. Genetic testing–Prenatal genetic testing, Post natal genetic testing. Extra chromosomal inheritance –Concept, maternal effect in Snail, Flour moth. Cyto plasmic male sterility in plants, Plastid inheritance, Mitochondrial inheritance–Mono plasmy and hetero plasmy in mitochondria. Metabolic effect in yeast.

SUGGESTED BOOKS:

1. Text book of Genetics from Genes to Genomes–A joy Paul
2. Principles of Genetics (8th Edition)– Eldon John Gardner, Michael J Simmons, Peter Snustad.
3. Genetics–S.S.Purohit
4. Genetics–P.S. Verma,V.K. Agarwal
5. Genetics– A Conceptual Approach (2nd Edition)–Benjamin Apierce.W.H. Freeman Company
6. Genetics–Robert F Weaver, Philip W Hedrick.WMC Brown Publication
7. Genetics (6th Edition) – D.Peter Snustad, Michael J Simmons. JohnWiley and Sons. Inc. Publications.
8. Essential of human genetics (5th Edn)–Manu L Kothari, Opa A Metha and Sadhana S Roy chodhury, Universities Press, Hyderabad.

SKILL BASED SUBJECT- 1
MEDICAL LAB TECHNOLOGY I

Objective: To gain the knowledge of anatomy and physiology of organ systems of human beings.

UNIT - I

General Anatomy - Cell-structure & function. Tissue – Epithelium, Connective, Sclerous muscle. Nervous – neuron. Lymphatic System – lymph node.

Systemic anatomy - Basic features of Cardio vascular system, Respiratory system, Digestive system, Excretory system, Reproductive (Male & Female) system, Nervous system.

UNIT – II

General physiology – Blood –Blood cells, Hemoglobin, Blood grouping, Coagulation Factors, Anemia & Immuno globulins. Cardio vascular system-Heart rate, cardiac cycle, cardiac output, blood pressure, hypertension, radial pulse. Respiratory System–Ventilation, functions, Lungs- Volumes and capacities;

UNIT - III

Gastrointestinal System - Process of digestion. Endocrinology – Endocrine Glands-Description. Hormones-their secretion and functions. Excretory system, Structure of nephron, Urine formation.

UNIT - IV

Central Nervous System–Brain and spinal cord, Neuromuscular junction, Wallerian de generation. Motor nervous system-Upper and Lower motor neuron system. Sensory nervous system – Sympathetic nervous system, Parasympathetic nervous system.

UNIT - V

Skin –Structure & Function. Muscular System-Classification of muscles & their functions. Special Senses – Eye & ear.

SUGGESTED BOOKS:

1. Text book of Medical Physiology by G.K. Pal.
2. Mackie & McCarty Practical Medical Microbiology, Edited by J.G. Colledge et al vol.II, Churchill, Livingstone, London.
3. Medical Laboratory Technology by Lynch.
4. Medical Laboratory procedures Manual (T-M) by K.L.Mukherjee, Vol.I,II,III.
5. A manual of laboratory Diagnostic tests Fisch back c) Practical clinical Biochemistry, Harold Varley
6. Cellular pathology by Culling. 2.Theory and practical of histological techniques by Bancroft
7. Hematology: principles and procedures 6th Ed Lea & Febiger. 5. Bernadette F.Rodak, George A. Fritsma, Kathryn Doig (2007).
8. Hematology: Clinical Principles and Applications 3rd Ed, Elsevier Health Sciences.

NON - MAJOR ELECTIVE- 1

BASIC BIO TECHNOLOGY

Objective: To provide a holistic view of biotechnology, from basics to advanced applications

Unit I: History of biotechnology

Timeline of biotechnology -Green Revolution– Leaders in biotechnology -Leonard Hay flick Michael D. West-Craig Venter-David Baltimore-Robert Bownman

Unit II: Basic Biotechnology concepts

Brief overview of DNA structure, DNA replication, transcription, translation. Recombinant DNA and plasmid technology-

Unit III: Biotechnology in industry:

Fermentor and fermentation – downstream processing – List of biotechnology companies in India- Pharmaceutical company

Unit IV: Applications of biotechnology

Production of hormones, vitamins, antibiotics, interferon's, vaccines, alcohols, organic acids, enzymes. Transgenic animals, transgenic plants and GMOs.

Unit V: Issues in biotechnology

Introduction to some of the ethical, legal, social and scientific issues associated with the above technologies.

SUGGESTED BOOKS:

1. Basic Biotechnology, Colin Ratledge, Bjorn Kristiansen Cambridge University Press, 25-May-2006.
2. Basics and applied aspects of biotechnology, Varsha Gupta, Manjistha Sengupta, Jaya Prakash, Baishnab Charan Tripath, Springer publications
3. Basics of Biotechnology, Dr A J Nair, Universities Press,2004
4. A text book of biotechnology, R.C.Dubey, S. Chand Publisher,1993
5. Introduction to Biology and Biotechnology, Second Edition K.Vaidyanath, K.Pratap Reddy, K.Satya Prasad, CRC Press, 2009.

SEMESTER IV
CORE THEORY
Paper-4 IMMUNOLOGY

Objective: To understand the system and cells of the immune system.

UNIT I:

Immunology—Introduction, Historical perspective to the immune system. Innate immunity and acquired immunity. Primary and secondary lymphoid organs-structure and functions. Cells of the immune system, Antigens, Immune responses.

UNIT II

Immuno globulin –structure and functions, Immunoglobulin classes and biological activities. Epitopes – Properties of B-cell and T- cell epitopes. Monoclonal anti bodies – Production, Classical uses.

UNIT III

Immune cells -T- cells—Receptors, Maturation, Activation and differentiation. Cell mediated immune response, Cytokines and cytokine receptors. B- cells— Activation of B- cells by T-cell independent antigen and T-cell dependent antigens. Anti body mediate immune responses, Differentiation of B-cells.

UNIT IV

Major Histocompatibility complex—MHC, HLA complex, HLA typing. Immunological tolerance, auto immunity and autoimmune diseases.

UNIT V

Immuno hematology - ABO blood grouping, Rh Blood grouping, and medical applications of blood grouping, blood transfusion and hemolytic disease of the newborn. Hypersensitivity—Type I, II, III, IV and V.

SUGGESTED BOOKS:

1. Immunology by Kuby
2. Immunology–A short course–Eli Benjamin, Geoffrey Suashine, Sidney Leskowitz.
John wiley & sons. Inc. Publications.
3. Immunology–Dulsy Fatima and N.Arumugam –Saris Publication.
4. Fundamental Immunology (6th Edition)– William E Paul, Walters Kluwer Hedth,
Lippincott William Wilkins.
5. Immunology (7th Edition)–David Male, Jonathan Brost off, David Roth, Ivan Roitt,
Mosby . Elsevier

CORE PRACTICAL II
MICRO BIOLOGY AND IMMUNOLOGY

LAB IN MICROBIOLOGY

1. Sterilization techniques–Demo (Moist heat-autoclave, dry heat – hot air oven, radiation–Laminar air flow).
2. Preparation of Nutrient agar plates, broth, slants and butts
3. A septic Technique and the Transfer of Micro organisms
4. Observation of bacterial morphology -shape and arrangement of cells
5. Sampling and quantification of bacteria in air, soil and water
6. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
7. Identification of bacteria [simple staining, differential staining, acid fast staining, capsule staining, spore staining and motility]
8. Lactophenol cotton blue mounting of fungi
9. Methylene blue reduction test for milk
10. Microscopic observation of economically important bacteria and fungi with permanent slides.

LAB IN IMMUNOLOGY

1. ABO Blood Grouping and Rh Factor typing
2. TRBC and TWBC Count by Hemo cytometers.
3. Determination of Platelet Count.
4. Measurement of pulse and blood pressure.
5. Bleeding time & clotting time estimation.
6. Precipitation reactions (Radial immuno and Double immuno diffusion test)
7. Estimation of albumin in urine
8. Urine analysis –normal & abnormal constituents of urine.
9. Glucose tolerance test.
10. Pregnancy Test.

Industrial visit: Submission of Report of Clinical lab visit

ALLIED 2

Paper 4

BIO STATISTICS AND BASIC COMPUTER APPLICATIONS

Objective: To understand the data collection, statistical tools, computer anatomy and its application.

UNIT-I

Biostatistics – Introduction, definition, functions, scopes. Collection of data–primary, secondary. Sampling, Classification, Tabulation of data. Presentation of data-graphical and diagrammatic representation, Charting of data using MS-Excel.

UNIT-II

Measure of central tendency -individual, discrete and continuous series-mean, median, mode. Use of Excel in measures of central tendency, Measure of variation –range. Quartile deviation, Standard deviation, Standard error.

UNIT-III

Correlation analysis – types and methods. Calculation r-value, Correlation using MS-Excel. Regression analysis- regression line and regression equation, Linear regression using MS-Excel, student t-test; chi-square test.

UNIT-IV

Anatomy and computer peripherals – Anatomy of computer system, Parts of computer system- Hardware, Software, Input devices, Output devices, Memory, Binary numbers in computers, Unit of size, Computer language.

UNIT-V

MS-Excel-Introduction, Features-Opening of Spreadsheet, Components of an Excel work book, Entering data and saving a new work book, Mathematical calculations, Moving and copying data, Deleting and adding rows and columns, Aligning data, Changing the size of row and column, Creating a graph, Adding, renaming or deleting a sheet from the work book, Closing the work book, Quitting Microsoft Excel.

SUGGESTED BOOKS:

1. Biostatistics, Daniel, W.W. 1987. New York, John Wiley sons
2. An introduction to biostatistics, 3rd Edn, Sundar rao, P.S.S. and Richards, J Christian
Medical College, Vellore
3. Statistics for Biology, Boston, Bishop, O.N. Houshton, Mifflin.
4. Statistics for biologist, Campbell, T.C. 1998. Cambridge University press.
5. Elements of biostatistics, Prasad, S. Rastogi Pub
6. Digital computer fundamentals, Bartee, 6th Edn, Fundamental of computers,
algorithms, Horowitz, Sahhni, Taja sekaran
7. MS office, Sexena, 2001, Vikas pub, House Pvt Ltd, New Delhi
8. Computer programming and application, J. Fernandez and Venkatasamy, Suja Pubs.
9. Textbook of Computer applications and biostatistics, Remeth Dias and Kailas KMali,
Trinity Publishing House, Satara-415001. India. 2011.

ALLIED PRACTICAL II
PRINCIPLES OF GENETICS AND BIOSTATISTICS & BASIC COMPUTER
APPLICATIONS

LAB IN PRINCIPLE OF GENETICS

1. Observation of dominant and recessive traits in human – earlobes, tongue, taster & non-taster, thump and thump impression.
2. Genetics of blood typing
3. Pedigree analysis of some human inherited traits.
4. Verification of Mendelian ratio using beads
5. Observation of Mendelian traits in student population
6. Observation of giant chromosomes in chironomous larva
7. Study of Hardy-Weinberg Law using simulations (beads).
8. Study on poly genic inheritance

LAB IN BIOSTATISTICS AND BASIC COMPUTER APPLICATIONS

1. Collection of data and tabulation
2. Graphical representation of data – line graph, histogram
3. Diagrammatic representation of data – pie diagram, bar diagram
4. Calculation of Mean, median and mode (using Neem leaves or height and weight of the students)
5. Calculation of correlation co-efficient (r-value) for length and breadth of Neem leaves or height and weight of the students
6. Measurement of central tendencies for the given data using MS Excel
7. Calculation of r-value using MS Excel
8. Regression line using MS Excel
9. Drawing of graph with complete label for a given data

Industrial visit:

Submission of Report of statistical analysis of any two human traits of village population nearby (earlobes, tongue, taster & non-taster, thump and thump impression)

SKILL BASED SUBJECT– 2
MEDICAL LAB TECHNOLOGY II

Objective: To understand cell injury, histopathology, blood transfusion and cardiac profile.

UNIT-I

Cell Injury – Normal Cell, Cell Injury–types, morphology, cellular swelling. Cell death–types-autolysis, necrosis, apoptosis & gangrene. Inflammation: Acute & Chronic Inflammation.

UNIT-II

Haemo dynamic Disorders - Oedema, hyperemia, congestion, hemorrhage, circulatory disturbances, thrombosis. Hematological Disorders-Classification of Anemia-Iron Deficiency anemia, Megaloblastic anemia, Hemolytic Anemia.

UNIT-III

Histopathology – Introduction .Basic steps for tissue processing-Fixing, Embedding, Microtomy, Staining, Mounting, methods of decalcifications.

Staining Methods – Hematoxylin & Eosin stain, methods of preparation. Reticulin stain & PAP staining- components & methods.

UNIT-IV

Blood Transfusion-Principle & Practice of blood Transfusion, Guidelines for the use of Blood, Appropriate use of Blood, Standard operating procedures for usage, donation & storage. Screening of donor, compatibility testing, safety, procurement of supplies.

UNIT-V

Cardiac Profile–Description, Hypertension, Angina, Myocardial Infarction, Pattern of Cardiac Enzymes in heart diseases. Different methods of Glucose estimation – Principle, advantage and disadvantage of different methods. Different methods of Cholesterol estimation-Principle, advantage and disadvantage of different methods.

SUGGESTED BOOKS:

1. Ramanic Sood , Laboratory Technology (Methods and interpretation) 4th Ed. J.P. Bros, New Delhi.
2. Satish Gupta Short text book of Medical Laboratory for technician J.P.Bros, New Delhi.
3. Shirley Mitchell Lewis, Barbara J. Bain, Imelda Bates (2006) Dacia and Lewis Practical Haematology, 10th Ed, Churchill Livingstone /Elsevier.4.Barbara A. Brown (2008).
4. Medical Laboratory Manual for Tropical Countries, Volume II: Microbiology , by Monica Chees brough ELBS.
5. Hematology: principles and procedures 6th Ed Lea & Febiger. 5.Bernadette F. Rodak, George A. Fritsma, Kathryn Doig (2007).
6. Hematology : Clinical Principles and Applications 3rd Ed, Elsevier Health Sciences.

NON – MAJOR ELECTIVE- 2
APPLIED BIOTECHNOLOGY

Objective: To understand and familiarize with some of the techniques applied in agriculture, medicine, animal husbandry.

UNIT I

PCR Technology: Introduction, Principle, Components of standard PCR–PCR Buffers and enzymes. Variants of PCR–Multiplex, Nested, Quantitative, RT-PCR. Medical applications of PCR.

UNIT II

Vaccine Technology–Introduction, Generation of vaccine–First generation vaccines, Second generation vaccine (Cell Culture vaccine),Third generation vaccine (Recombinant and sub-unit and synthetic vaccines), fourth Generation vaccine (DNA vaccine). Medical Applications – Edible vaccines.

UNIT III

RNA Technology-Introduction–Biogenesis of micro RNA, miRNA, siRNA. Applications – Medical, Veterinary and Agriculture fields.

UNIT IV

Biosensor Technology– Introduction, Types, Immunosensors–Application, Medical. Blood Glucose monitoring for diabetes. Agricultural application–Pathogen detection, Food, Toxicology test. Industrial applications – Drug delivery – Military application–DID stick test.

UNIT V

DNA foot printing–Southern blotting, Western blotting. Hybridoma technology- Monoclonal anti body production, application, advantages and disadvantages–DNA finger printing.

SUGGESTED BOOKS:

1. Biotechnology and medicine and agriculture principles and practices – Anilkumar,
2. Ashwan's Preak, Sanjay Mohan Gupta. International Publishing House Pvt. Ltd. New Delhi.
3. Advances in Applied Biotechnology, Tong-Cun Zhang Motowo Nakajima, Springer Link
4. Applied Animal Biotechnology, V Kumaresan, Saras Publications, 2008
5. Applied Plant Biotechnology, V Kumaresan, Saras Publications, 2008

SEMESTER V
CORE THEORY - 5
MOLECULAR BIOLOGY

Objective: To impart fundamental knowledge of molecular biology in understanding the molecular mechanism of gene function and cell signaling.

UNIT I

DNA – Molecular structure, size, fragility, major and minor grooves. DNA de naturation and renaturation, Single stranded DNA. RNA- Structure and types.

UNIT II

Complexity of eukaryotic genome – Introns, Exons, repetitive DNA sequences. Mode and mechanism of DNA replication. DNA damage and Repair–types.

UNIT III

Transcription - Mechanism of transcription in prokaryotes and eukaryotes, Components of transcription factors. Basal transcription apparatus, Initiation, elongation and termination. Post transcriptional modifications.

UNIT IV

Genetic code – Definition, characteristics, deciphering the code. Translation- Mechanism of protein synthesis and post translation modification. Role of mRNA, tRNA and rRNA in protein synthesis. Antibiotics as inhibitors of protein synthesis.

UNIT V

Cell signaling– Cell signaling molecules and receptors, mode of cell to cell signaling. Hormones, Nuclear receptors, Neuro transmitters, Peptide hormones, Growth factors and cAMP & cGMP. Gene regulation – la coper on concept.

SUGGESTED BOOKS:

1. Molecular Biology(2nd Edition)David Frie felder
2. Molecular Biology of the Gene–Watson, Hopkins, Robertis, Steitz, Weiner
3. Molecular Cell Biology– Harvey Lodish, David Baltimore, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, James Darnell
4. Molecular Biology-Genes to Proteins (4th Edition)–Burton E Troop. Jones and Bartlett Learning.
5. Molecular Biotechnology: Principle and Practice, Channarayappa, Universities Press, Hyderabad.

CORE THEORY

Paper – 6

GENETIC ENGINEERING

Objective: To impart the basic knowledge of tools used in genetic engineering, cloning vectors, PCR and DNA finger printing.

UNIT-1

Tools of genetic engineering - DNA polymerase, poly nucleotidekinase, alkaline phosphates, DNA ligase, nick translation systems, deoxy nucleotidyl transeferase, reverse transcriptase, restriction endo nucleases.

UNIT-II

Cloning vectors - Plasmid vectors–pBR322, PUC, Ti plasmid. Phage vectors-lambda, M13, cosmids, phagemid. Yeast vector-expression vector, shuttle vector. Plant and animal vector–CaMV, SV40. Artificial chromosomes – BAC and YAC.

UNIT-III

Polymerase Chain Reaction–Introduction, principle, steps involved in PCR amplification. Types of PCR, applications of PCR. Primers.

UNIT-IV

Molecular markers – Nuclear markers -RFLP, RAPD, VNTR, SSRs, AFLP, Coxgene. Mitochondrial markers-CO1, Cox, ITS, 16SRNA, 18SRNA. DNA bar coding – introduction, components of DNA barcoding. DNA sequencing technology-Maxam and Gilbert method, Sanger chain termination method.

UNIT-V

DNA finger printing, Production of recombinant proteins–insulin and HGH. Gene libraries-Establishing a library, screening the gene library, c DNA library.

SUGGESTED BOOKS:

1. Genes to clones –Ernst L Winnacker, Panima Publishing House, New Delhi.(2003)
2. Gene cloning–TA brown, Blackwell Science (2001).
3. Molecular Biotechnology–Bernard R Glick and Jack J Pasternak, Panima Publishing House, New Delhi (2002).
4. A text book of Biotechnology, RC Dubey, S. Chand and Company Ltd (2006).
5. Biotechnology by satyanarayana (2010).
6. DNA bar coding: Methods and Protocols, H. Abdul Jaffa Ali, Vijay Nicolas Press, Chennai, 2016.

CORE THEORY

Paper – 7

INDUSTRIAL BIOTECHNOLOGY

Objective: To impart knowledge in microbial production of industrial products and their separation techniques.

UNIT-I

Fermentation technology - Screening of industrially important microbes, fermentation medium, components of media, fermentation types, fermentation kinetics. Bio reactor-types and design.

UNIT-II

Microbial Technology - isolation of industrially important microbes, criteria to select potent microbes, improvement of strains. Microbial production of primary and secondary metabolites-organic solvent – alcohol. Organic acids – citric acid. Antibiotics – penicillin. Amino acid-glutamic acid. Vitamin – vitamin B12.

UNIT-III

Downstream processing – Definition, stages. Release of intracellular products –cell disruption, solid liquid separation. Concentration, purification by chromatography-gel filtration, ion exchange, affinity, HPLC. Formulation of medium.

UNIT-IV

Enzyme Technology – Application of enzymes–commercial production of enzymes–amylase, cellulose, lactase, lipase. Immobilization of enzymes- methods of immobilization, effect of immobilization on enzyme properties, applications of immobilized enzymes.

UNIT-V

Fermented foods and Agricultural products-Production of Cheese, Yoghurt, Milk products, and Natural preservatives. Bio-fertilizers -SCP, Mush room cultivation & Cyano bacteria.

SUGGESTED BOOKS:

1. Microbiology Prescott Harley fifth edition McGraw Hill Higher Education – (2002)
2. Biotechnology-A handbook of Industrial; Microbiology W Crugerand A Cruger (2004)
3. Industrial Microbiology by L.E.Casida Willey Eastern Limited 1989
4. Environmental biotechnology and Cleaner Bioprocess Edited by Eugenia Olguyine (2001)
5. Principles of Fermentation Technology Stan bury Whitaker Second edition
6. Aditya Books Private Limited (1995)
7. Food Microbiology A.R. Adams, M.O. Moss, University of Surrey UK (2004).
8. Biotechnology by Satyanarayana I Edition (2005).
9. Industrial Microbiology A.H.Patel II Edition (2007)

CORE PRACTICAL III
MOLECULAR BIOLOGY, GENETIC ENGINEERING AND INDUSTRIAL
BIOTECHNOLOGY

LAB IN MOLECULAR BIOLOGY

1. Isolation of genomic DNA from plant
2. Isolation of genomic DNA from animal tissue
3. Isolation of genomic DNA from bacteria
4. Quantification of DNA by diphenylamine method
5. Quantification of DNA using 260/280 ratio method

LAB IN GENETIC ENGINEERING

1. Isolation of plasmid DNA
2. PCR amplification of marker gene
3. Separation of DNA by agarose gel electrophoresis
4. Restriction digestion of DNA
5. Southern Blotting

LAB IN INDUSTRIAL BIOTECHNOLOGY

1. Isolation of industrially important bacteria
2. Isolation of industrially important fungi (yeast)
3. Isolation of rhizobium from root nodules
4. Immobilization of yeast, microbes and enzyme
5. Microbial Production of ethanol.

Industrial Visit: Submission of report of visit to Biotechnological Industries

ELECTIVE PAPER – I

A. BEE KEEPING

Objective: To acquire knowledge of bee keeping and harvest its products.

UNIT I

Introduction - Classification of bees–Rock bee, Indian bee, little bee and Dammer bee. Distinctive features and identification of Queen, Drone and worker bees (Castes of Honey bees).

UNIT II

Bee Keeping - History in India, Scope and importance, Location and protection of piary, Newton's hive. Beekeeping equipment's and their uses.

UNIT III

Behaviors of bee - Bee dance, swarming, nuptial fight, robbing, absconding, super sedure.

UNIT IV

Bee Products- Honey–Nutritional value and medicinal properties, Bee wax, Bee venom, Royal jelly.

UNIT V

Diseases of Honey Bee – common bacterial, viral, protozoan and fungal diseases. Bee parasites.

SUGGESTED BOOKS:

1. Encyclopedia of Bee culture – A.I.Root Ed (1985) Published by International books and periodicals supply service, Desh Bandha Gupta Road, New Delhi–110005.
2. The complete Hand book of Bee Keeping –Herbert Mace Ed (1984) Published by Wardlock limited, London.
3. Applied Entomology– P.G.Fenemore, Alka Prakash Ed (1992) Published by Wiley Eastern Limited.
4. Bee keeping in India- Sharma, ICAR Publications.
5. A text book on a piculture - Tamilselvi and Abdul Jaffar Ali, Vijay Nicolas Press (2017).
6. Apiculture–Johnson. Jand Jeya Chandra. I (2001)

B. AQUA CULTURE

Objective: To impart the knowledge of fish culture and other aquatic organisms and their commercial significance.

UNIT - I

Aquaculture –Introduction, history and scope. Aqua culture in local, national and global scenario. Cultivable fresh water, marine and ornamental species. Culture systems- Traditional, Extensive, Semi-intensive and intensive systems

UNIT - II

Fresh water aquaculture –Introduction, monosex & poly culture, pokali culture, sewage fed fish culture, integrated fish farming, and brackish water aquaculture. Culture technique of carps

UNIT - III

Marine aqua culture – sea ranching, cage culture, raft culture, rope culture, pen culture. Culture technique of shrimps

UNIT - IV

Ornamental fish keeping - Common characters and sexual dimorphism of Fresh water aquarium fishes such as Guppy, Molly, Swordtail, Goldfish, Angelfish, Blue morph and Butterfly fish. Live feed organisms, General Aquarium maintenance.

UNIT-V

Economic importance of aqua culture – economically important fresh water and marine organisms -fishes, crabs, oyster, shrimp, lobster, mussels. Importance of Fishery products and by - products.

SUGGESTED BOOKS:

1. Anon, 1983. Advances in aquaculture and fisheries research: Report of a California Sea Grant Symposium, May18-201983. California Sea Grant.
2. Barnabè, G. (Ed.) 1990. Aquaculture. Ellis Horwood. 2Vols;
3. Jhingran V.G.1985,fish&FisheriesofIndia,Hindustanpublishingco.NewDelhi
4. Mill Dick, 1993: Aquarium Fish, DK Publ. Co. Inc. New York–USA.
5. Ramasamy Santhanam, N.Ramanathan, G.Jegatheesan.1990.Coastal Aquaculture in India, CBS Publishers & Distributors,-Aquaculture-
6. S. Ayyappan, J.K.Jena, A.Gopalakrishnan, Dr.A.K. Pandey, Hand book of fisheries and aquaculture, Indian Council of Agricultural Research. Directorate of Information and Publications on Agriculture
7. S.P.Malhotra,S.P.MalhotraV.R.P.Sinha.2007.Indian Fisheries and Aquaculture in a Globalizing Economy,Volume1Narendra Publishing House,-Technology & Engineering
8. Santhanam, James Lee Burke, Chatterjee Dipankar. 2012. A Manual of Fresh Water Aquaculture. Publisher: Oxford University Press.
9. Shammi, Q.J. and Bhatnagar, S., 2002. Applied Fisheries: Agro bios (India)
10. Shanmugam K.1992, Fishery Biology and Aquaculture - Leo Pathipagam – Chennai – India.
11. Yadav.1995:Fish and Fisheries, Daya Publ. Co., New Delhi–India

C. BASICS IN STEM CELL BIOLOGY

Objective: To understand the stem cell culture, maintenance and its applications.

UNIT-I

Stem Cell Biology—History, organization. Structure and organization of animal cell and functions.

UNIT-II

Cell Culture Techniques—A septic culture, preservation, preparation of culture media and reagents, sterilization, differentiation of stem cell.

UNIT-III

Equipment and materials for animal cell culture -Role of serum and supplements, serum and protein free media and application. Measurement of viability and cytotoxicity. Preservative methods of stem cells.

UNIT-IV

Stem cell culture-Embryonic stem cell, therapeutic uses of stem cell, disease recovery of stem cell, isolation and preservation of stem cell, clinical application of placenta off spring.

UNIT-V

Stem cell based treatment of diseases-stem cell used organogenesis in animals and human, clinical diagnosis of stem cell. Assisted reproductive technology -IUI, IVF, ICSI. Isolation of sperm and ova, role of sperm bank and ova bank, cryo preservation.

SUGGESTED BOOKS:

1. Essentials of Stem Cell Biology (Second Edition) Edited by: Robert Lanza, John Gearhart, Brigid Hogan, Douglas Melton, Roger Pedersen, E.Donnall Thomas, James Thomson and Sir Ian Wilmut
2. Essentials of Stem Cell Biology, Third Edition 3rd Edition by Robert Lanza (Editor), Anthony Atala (Editor)
3. Stem Cells: A Short Course 1st Edition by Rob Burgess (Author), John Wiley publisher, New Jersey.
4. Stem Cells: Basics And Applications, Kaushik D Deband Satish M Totey, Tata Mc Graw-Hill Education, 2009.
5. Stem Cells, Anna M. Wobus, Kenneth Boheler Springer Berlin Heidelberg, 02-Dec-2005

SKILL BASED SUBJECT III

BIO INSTRUMENTATION

Objective: Objective of the course is to focus on basic principles of different instruments & their application in Biotechnology.

UNIT-I

Electrophoresis–Principle and instrumentation of zone electrophoresis, Agarose gel electrophoresis, SDS-PAGE, immuno electrophoresis, iso electric focusing, capillary electrophoresis. **Centrifugation**–Principle, instrumentation and applications of differential, zonal, density gradient and ultra centrifugation.

UNIT-II

Chromatography - classification and types –Principle, instrumentation and applications of adsorption, partition, exclusion, ion exchange, affinity, column chromatography – TLC, HPTLC, HPLC and GLC.

UNIT-III

Blotting techniques-Southern blotting, Western blotting and Northern blotting. DNA microarrays, Isolation and purification of DNA, RNA and Plasmids. PCR, DNA fingerprinting, DNA sequencing techniques.

UNIT-IV

Spectroscopy - Principle, radiation energy & atomic structure, Basic law of absorption, Colorimeter. UV- Vis Spectroscopy-Theory, instrumentation–single beam and double beam spectro photo meter, application in biology. FT-IR.

UNIT-V

Bio instruments - Introduction, scope of bioinstrumentation in industrial organization. Working principle of basic bio instruments – pH meter, Balance, Hotplate & Magnetic stirrer, Incubator, Water bath, Photo meters, Nephelo meters, Manometer, Autoclave.

SUGGESTED BOOKS:

1. Biochemistry, Vote, D.& Vote, J.G.(1995), Seconded n. John wiely & sons
2. Bio instrumentation, John Webster, (2004).John weily & Sons.
3. Bio instrumentation, Veerakumari (2006). Firstedn. MJP Publisher
4. Molecular Biology of the Gene, James, D. Watson Hopkins N.H.Robert, J.W & Steitz, J.A.
5. Biochemistry, Zubay, G.L. edition 4.,WmC, Brown Pulshers
6. Analytical Biochemistry and separation techniques, Palanivelu, P (2008). Tulsi Books center Madurai.
7. Principles of Biochemistry, Lehninger, Nelson, D. & Cox, M. (2000). Edition 4 W.H. Freeman and Company, New York.
8. Biophysics, Arora. (2004).Edition1, Himalaya publishers, New Delhi.
9. Practical Biochemistry, Wilson, K. & Walker, J. 2003. Edition 5, Cambridge University

SEMESTER VI
CORE THEORY – 8
ANIMAL CELL BIO TECHNOLOGY

Objective: To impart the knowledge of the most recent techniques used in animal biotechnology and their application to animal husbandry and bio medical field.

UNIT-I

Introduction to animal cell culture lab: Design and equipments -Sterile area, Laminar flow hood, CO₂ incubator, Cryo storage - liquid - Nitrogen flask, Refrigerated centrifuges, Freezers (-80⁰C), Inverted microscope, Hemo cyto meter, pHmeter, magnetic stirrer, micro pipettes and pipette aid.

UNIT-II

Animal cell culture: Fundamentals, facilities and applications. Media for Animal cells. Types of cell culture-Primary, secondary. Cell transformation, cell lines, Insect cell lines, stem cell cultures, cell viability and cyto toxicity. Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis organ culture. Cryopreservation.

UNIT - III

Primary culture – development and maintenance of cell line. Disaggregation-enzymatic and mechanical. Manipulation of cells-electro oration, liposome mediated transformation, microinjection. Scaling-up of cell lines-Cell growth ,characterization, cell viability and death. Cyto toxicity of cultured cells.

UNIT – IV

Genetic engineering in animals – methods of DNA transfer into animal cells-calcium phosphate co precipitation, micro-injection, electro oration, liposome capsulation. Biological vectors. Hybridoma technology, Vaccine production.

UNIT – V

Gene therapy –Mapping of human genome. RFLP and applications. DNA fingerprinting and Forensic science. Molecular diagnosis of Genetic disorders.

Transgenic: Transgenic animals - Merits and demerits-Ethical issues in animal biotechnology. Production and recovery of products from animal tissue.

SUGGESTED BOOKS:

1. Culture of Animal cells: A Manual of Basic Techniques (2004) R.Ian Freshney.
2. Animal cell culture methods Jennie P. Mattarand David Barnes.
3. Freshney, I.R. Culture of Animal cells: a manual of basic technique. John-Wiley & Sons, New Jersey.2006.
4. Bosch, T.C.G. Stem cells-From Hydrato Man. Springer India.2008.
5. Nigel Jenkins. Animal Cell Biotechnology –Methods and protocols. Humana Press Inc, New Jersey.2005.
6. M.M.Ranga, 2000. Animal Biotechnology, Agrobios (India)

CORE THEORY
Paper-9
PLANT CELL BIO TECHNOLOGY

Objective: To provide the knowledge of various aspects of plant biotechnology including micro propagation and genetic improvement of plants through hybridization, somatic hybridization and genetic transformation.

UNIT-I

Genomic interaction–Protoplasmic fusion, cyto plasmid male sterility. Genetic engineering in plants-Pest resistance, Herbicide resistance. Resistance to fungi and bacteria. Delay of fruit ripening. Somaclonal variation, valuable germ plasm.

UNIT-II

Plant tissue culture -tot potency, cyto differentiation, callus culture, anther culture, cell suspension culture, micro propagation, organogenesis, somatic embryo genesis, protoplast culture.

UNIT-III

Bio chemistry and molecular biology -Nitrogen fixation in legumes by Rhizobium. Molecular biology of plant stress response (a biotic).Genetic modification-transgenic plants and its application, ecological impact of transgenic plants. Genetic Engineering in Food industry–back ground, history, controversies over risks, applications.

UNIT-IV

Hybridization-Isolation, purification and culture of protoplast. Identification and characterization of somatic hybrids, hybrids- applications. Haploid Plants from Anther Culture-In Vitro propagation for commercial production of ornamentals.

UNIT-V

Plant transformation – Vectors- Agro bacterium mediated transformation, particle bombardment, electro oration. Conformation of transgene expression by molecular techniques-PCR, Northern, Southern and Western blot analysis. Gene silencing by anti sense and RNAI technology in plants.

SUGGESTED BOOKS:

1. Grierson, D., and S.N. Covey.1988. Plant Molecular Biology. Blackie & Sons. Ltd. Glasgow.
2. Lycett, G.W. and D. Grierson (Eds) .1990. Genetic Engineering of Crop Plants. Heinemann, London.
3. Chrispeeds, M.J. and D.F.Sadava.1994. Plants, Genes and Agriculture... Jones and Bartlett, Boston.
4. Mantel. S.H, Mathews. J.A, Mickee. R.A.1985. an Introduction to Genetic Engineering in Plants. Blackwell Scientific Publishers, London.
5. Marks. J.L. (Ed.).1989. A Revolution on Biotechnology. Cambridge Univ. Press, Cambridge.
6. Dodds J.H.1985. Plant Genetic Engineering. Cambridge Univ. Press, Cambridge.
7. Bernard R Glick. and J.J.Pasternak. 2002. Molecular biotechnology, Principle and Applications of Recombinant DNA. ASM Press, Washington, D.C.
8. Monica A.Hughes.1996.Plant Molecular Genetics .Addison Wesley Longman,
9. Harlow, England Kalyan Kumar De,1992,Plant Tissue Culture, New Central Book Agency, Calcutta
10. Robert N.Trigiano, Dennis J.Gray, 1996, Plant Tissue Culture Concept and Laboratory Exercises, CRC Press, London.
11. P.S.Srivasta, 1998, Plant Tissue Culture and Molecular Biology, Narosa Publishing House, New Delhi.

CORE THEORY

Paper-10

ENVIRONMENTAL BIO TECHNOLOGY

Objective: To provide the knowledge of biotechnological applications in waste treatment and bio degradation of various xenobiotics using microorganisms.

UNIT-I

Ecosystem - structure, functions. Energy flow and mineral cycle-C, N, P. Environmental problems –Ozone depletion, Green House Effect, Water, Air, Soil pollution, Land degradation.

UNIT-II

Waste water–Physical, Chemical and biological characteristics. Introduction to water microbiology, Water borne diseases. Waste water treatment - Physical, Chemical and biological. Membrane filtration and Reverse Osmosis. Waste water treatment efficiency assessment.

UNIT-III

Xenobiotics – Xeno biotic compounds, Biodegradation of xenobiotics, Biological detoxification, Hazardous waste management. Mining and metal biotechnology–Copper and Iron, Microbial transformation, accumulation and concentration of metals, Metal leaching -extraction.

UNIT-IV

Bio fuels – Introduction, Production of non-conventional fuels–Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons. Use of micro organisms in augmentation of petroleum recovery.

UNIT-V

Environmental Genetics- Degradation plasmids (TOL), Release of genetically engineered microbes (GEM) in the environment, Impact of GEM in environment, Role of GEM in degradation of industrial pollutants. Bio sensors and microprobes.

SUGGESTED BOOKS:

1. Waste water Engineering– Treatment, Disposal and Re use, Metcalf and Eddy. Inc. Tata McGraw Hill, New Delhi.1991
2. Bio remediation engineering, design and application 1995 John's. Cookson, Jr. Mc Graw Hill, Inc.
3. Environmental Biotechnology by A.K. Chatterjee, 2004 Prentice - Hall of India Pvt. Limited.
4. Environmental Biotechnology by1995, S.N. Jogd and Himalaya Publishing.
5. Alan Scragg, Environmental Biotechnology, Longman, 1999.
6. Milton Wain Wright, An Introduction to Environmental Biotechnology, Kluwer Academic Press, 1999.
7. Environmental Biotechnology by S.K.Agarwal, APH Publishing Corporation, 2001.
8. Bio degradation & Bio remediation (1999), Martin Alexander, Academic press.

CORE PRACTICAL III
MOLECULAR BIOLOGY, GENETIC ENGINEERING AND INDUSTRIAL
BIOTECHNOLOGY

LAB IN MOLECULAR BIOLOGY

1. Isolation of genomic DNA from plant
2. Isolation of genomic DNA from animal tissue
3. Isolation of genomic DNA from bacteria
4. Quantification of DNA by diphenylamine method
5. Quantification of DNA using 260/280 ratio method

LAB IN GENETIC ENGINEERING

1. Isolation of plasmid DNA
2. PCR amplification of marker gene
3. Separation of DNA by agarose gel electrophoresis
4. Restriction digestion of DNA
5. Southern Blotting

LAB IN INDUSTRIAL BIOTECHNOLOGY

1. Isolation of industrially important bacteria
2. Isolation of industrially important fungi (yeast)
3. Isolation of rhizobium from root nodules
4. Immobilization of yeast, microbes and enzyme
5. Microbial Production of ethanol.

CORE PRACTICAL IV

ANIMAL CELL BIO TECHNOLOGY, PLANT CELL BIOTECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

ANIMAL CELL BIOTECHNOLOGY

1. Preparation of animal cell culture media and sterilization
2. Preparation of single cell suspension from spleen
3. Cell counting and viability
4. In vitro fertilization (IVF)

PLANT CELL BIOTECHNOLOGY

1. Plant culture media preparation and sterilization.
2. Explant selection, sterilization and inoculation.
3. Callus culture
4. Endosperm culture.
5. Another culture.
6. Synthetic seed preparation
7. Protoplast isolation and culturing

ENVIRONMENTAL BIOTECHNOLOGY

1. Estimation of total solids in industrial wastes
2. Analysis of TDS in industrial wastes
3. Estimation of suspended solids in effluent water
4. Determination of COD and BOD in sewage water
5. Analysis of Microbial contamination in air by open plate method

Industrial Visit: Submission of report of visit to Animal or Plant Tissue culture Unit

ELECTIVE PAPER – II

A. SERICULTURE

Objective: To understand the technical knowledge of rearing silkworm and related benefit to human kind.

UNIT-I

Sericulture- Introduction, Scope. Species of silk worm - *Bombyxmori*, *Antheraeaapaphia*, *Attacusriciniand* *Antheraeaassama*. lifecycle–Egg, Larva, Pupa and Adult. Types of silk.

UNIT-II

Mori culture–uses of mulberry, Propagation–stem cutting, root grafting, simple layering. Harvesting methods–Leaf picking method. Preservation of leaves.

UNIT III

Model rearing house–Rearing appliances, Rearing stand, Ant wells, Rearing tray, Paraffin paper, Foam rubber strips, Chopsticks, Feathers, leaf chambers. Requirements for chopping–board, knife and mat, pruning knife, cleaning net, Chandrikes, Hygrometer, Thermometer and Disinfection pad. Silk worm rearing–Disinfection, hatching of Egg card, Brushing, Feeding, Mounting, Bed cleaning, Mounting, Harvesting and Reeling.

UNIT-IV

Silk Reeling –Methods of reeling operation –a brief account on Reeling end formation, twisting, drying, reeling, re-reeling and finishing. By products of sericulture.

UNIT-V

Diseases of silk worm – Protozoan disease – Pebrine. Bacterial disease –Flacherie. Viral disease –Grasserie. Fungal disease– Muscardine. Pest of Silkworm– Uzi fly.

SUGGESTED BOOKS:

1. Ganga, G. and J.Sulochana Chetty, 2006. An Introduction to sericulture. Oxford and IBH Publishing Co. Pvt .Ltd.
2. An Introduction to Sericulture -G. Ganga and Sulochana Chetty.J, (1997) Oxford and IBH Publishing Co. Pvt. Ltd.
3. A Text Book of invertebrates - Arumugam N, (2010) Saras Publication

B. VERMI AND MUSHROOM CULTURE

Objective: To understand the basic knowledge of vermi composting and mushroom culture.

UNIT-I

Earth worm—Taxonomic position and diversity. Morphological and ecological grouping, Types—Epigeic, Anecic and Endogeic species. Ecological role and economic importance of earth worm.

UNIT-II

Vermi culture – definition, scope and importance. Local and exotic species for culture, Environmental requirements. Culture methods – wormery. Breeding techniques - indoor and outdoor cultures –monoculture and poly culture.

UNIT-III

Applications of vermi culture –Vermi composting, use of vermi castings inorganic farming, earthworms for management of municipal organic solid wastes. Nutrient value of worm cast / vermi compost, Effect of vermi compost on plants.

UNIT-IV

Edible and poisonous mushroom – Introduction, history, scope – Types of edible mushroom available In India – Medicinal and other uses. Poisonous mushroom. *Calocybeindica*, *Volvariellavolvacea*, *Pleurotus citrinopileatus* *Agaricus biosporus*.

UNIT-V

Mushroom cultivation-paddy straw mushroom (*Volvariellavolvacea*) and oyster mushroom (*Pleurotus*spp.) with details of bed and spawn preparation, cultivation and harvest. Low cost mushroom farm design of production.

SUGGESTED BOOKS:

1. Hand Book Of Bio fertilizers & Vermi culture, Eiri Board Engineers India Research Institute (2009)
2. The Worm Book For Beginners: 2nd Edition (Revised), Mr Frank Randall (Author), Create Space Independent Publishing Platform; 2nd edition (February 22, 2013).
3. Compost, Vermi compost, and Compost Tea: Feeding the Soil on the Organic Farm, Grace Gershuny, Chelsea Green Publishing; Revised and updated edition (April 15, 2011).
4. Earthworm Ecology 2nd Edition, Clive A. Edwards, C R C Press; 2nd edition (March 26, 2004).
5. Vermi technology- A.Mary Violet Christy, 2008.M.J.P.Publications, Chennai.
6. Hand book on Mushrooms (Ed-IV), Bahl, N, (2006), Oxford and IBH Publishing Co Pvt Ltd, New Delhi.

C. MEDICINAL PLANTS

Objectives: Elementary treatment of various morphological uses in the identification and utilization of medicinal plants in general.

Unit I: Introduction: Herbal Medicine–History of Traditional Medicine – History of Islamic Medicine, Siddha, Ayurveda, Homeopathy, Allopathy and Unani medicine.

Unit II: Ethano botany: *Withaniasomnifera* (Amukkara) *Glycyrrhizaglabra* (Athimathuram), *Myristicafragrans* (Jathikkai), *Gymnemasylvestre* (Cakkaraikkolli), *Pongamiapinnata* (Punkam)-PropertiesandMedicinaluses.

Unit III: Common medicinal plants: Family, Local Name, Common name, Medicinal uses–*Ocimumsanctum*, *Solanumtrilobatum*, *Cardiospermumhalicacabum*, *Adhatodavaisica*, *Catharanthusroses*, *Ecliptaalba*.

Unit IV: Parts of Medicinal plants: Fruit –Amla, Bulb – Garlic, Rhizome – Ginger, Seed –Castor, Bark – Cinchona, Leaves –Neem and Flower – Clove.

Unit V: Cultivation methods– crop protection – Harvesting– Storage and Protection– Marketing utilization–Export of medicinally important plant (General aspects).

SUGGESTEDBOOKS:

1. Gokhale, S.S,C.K.Kokate and A.P.Purohit (1994). Pharmacognosy. Niraliprakashan, Pune.
2. Faroogi, A.A. and B.S.Sreeramu (2004), Cultivation of Medicinal and Aromatic crops. University Press (India) P. Ltd., Hyderabad.
3. Pal. D.C and S.K. Jain (1998), Tribal medicine, Naya Prakash, 206, Bidhan Sarani, Calcutta.
4. Thirugnanam, Akbarsha and Krishnamurthy (2010), Indian Medicinal plants and Home Remedies, Selvi Pathipagam, Trichy.

ELECTIVE PAPER – III

A. FOOD QUALITY MANAGEMENT

Objective: To know the standardization of food quality management and environment quality management system.

UNIT-I

Introduction to quality management -Definition, Scope, Significance and Objectives of Quality management. Dimensions of quality in foods, Food quality evaluation techniques, Quality control Vs Quality assurance.

UNIT-II

Adulteration and Quality Control in Process -Adulteration –Types of adulterants, Adulterant identification techniques, Quality assurance for raw materials, working process and finished goods, Safe handling of food product, equipments and machineries, personal hygiene maximum permissible level (MPL) for adulterants.

Unit-III

National Standards - PFA, FPO, MMPO, MPO, AGMARK, BIS, Legal Metrology, Environment and Pollution Control Board, Factory License.

International food standards–Trends in Food Standardization, An Overview and structure of 9001:2000/2008, ISO 9001:2000, 22000:2005, 22000:2005

UNIT-IV

HACCP in Animal Food Processing: Meat processing hygiene-cleaning and sanitation in meat identification of Hazards in animal food-Hazard Analysis and Critical Control Point (HACCP) for meat, poultry and sea food retailers and industries - clause in Food Safety and Standards Authority of India (FSSAI) related to animal food products-Export Inspection Council (EIC) and Export Inspection Agencies (EIA) role.

UNIT-V

Environmental Quality Management System-(ISO14000), Effluent treatment plant location and maintenance, Eco friendly food processing system, green plant, Eco friendly packaging methods, Challenges in quality management and green processing system implementation.

SUGGESTED BOOKS:

1. Food Safety Management Programs: Applications, Best Practices, and Compliance, Debby Newslow, CRC press.2013.
2. Food Quality Assurance: Principles and Practices
3. Imtiaz Ali, CRC press. 2003.
4. Food Quality, Safety and Technology
5. Editors: Lima, Giuseppina P.P., Vianello, Fabio (Eds.), Springer - Verlag Wien, 2014.

B. PUBLIC HEALTH AND HYGIENE

Objective : To understand the communicable and infectious diseases and other aspects of health care.

UNIT-I

Introduction to Public Health—Introduction, Definition, Significance. Evolution of Public & community health. Determinants of Health – Biological, Behavioral, Socio-economic, Cultural, Environmental, Geographical etc.

UNIT-II

Concept of Primary Health Care – Public Health delivery system in India-Introduction to National Health Policy – 1983&2002, National Population Policy –2005, National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM), National Public Health Programs.

UNIT-III

Medical Terminology - Introduction to bacteriology /virology/ Mycology/ Parasitology/ Genetic diseases /Genetics /Pediatric diseases/ Problems/ Neoplasia/ Inflammation & healing.

UNIT-IV

Communicable & Infectious Diseases –General overview of communicable diseases, impact of communicable diseases on developing. Non - Communicable Diseases- Overview and introduction to NCDs-risk factors, prevention and management. General strategies, new approaches and policies of NCDs. NCDs programs of WHO, PAHO and Government of India.

UNIT-V

Occupational, Industrial and Urban Health-Occupational Safety & Health-Chemical and physical exposures, control of occupational exposures, injury control occupational health disorders and diseases. Occupational health of working population of organized and unorganized sectors -Farmers, Industrial workers, health workers, etc

SUGGESTED BOOKS:

1. World Health Organization : Report on infectious diseases and Report on Multi drug resistance, World Health Organization, Geneva
2. Principles and Practice of Medicine: Davidson, Edward, Bouchieret. Al., Pearson Professional Ltd. London, 1995
3. Biology of Disease: Jonathan Phillips, Paul Murray, Black well Science Ltd. Australia, 1995
4. Practical Medical Microbiology: Mackie and M.C.Cartney, Longman Group, U.K.1995
5. Global Hand book On Non-Communicable Diseases and Health Promotion By David V.Mcqueen, Springer Publication.
6. Education Of Communicable And Non-Communicable Diseases S.L.Goel Published By Deep & Deep Publications Pvt.Ltd.,2009
7. Occupational Health: Management and Practice for Health Practitioners By S.P.Hattingh, 3rd edition.
8. Urban Health: Global Perspectives edited by David Vlahov, JoIvey Boufford, Clarence E.Pearson, Laurie Norris, published by Jossey bass
9. Industrial Health Jack E.Peterson American Conference of Governmental Industrial Hygienists,1991

C. ENZYME TECHNOLOGY

Objective: To understand concept of enzymes, mechanisms, enzyme kinetics and applications

Unit I

Introduction: Historic back ground-General Terminology, Nomenclature and Classification of Enzymes.

Enzyme activity- chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes.

Unit II

Enzyme Mechanism: Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis-Acid-base catalysis, covalent catalysis, Classification of coenzymes, Coenzymes and Cofactors- Prosthetic group. Reversible Inhibition- Competitive, Non Competitive, Un competitive.

Unit III -

Metabolic regulation: Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Organization of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes

Unit IV

Factors affecting the enzyme activity: Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis - Menten Equation, Km, Vmax, L.B Plot, Turn over number,

Unit V

Clinical enzymes: Enzymes as thrombolytic agents, Anti-inflammatory agents, streptokinase, asparaginase, Iso enzymes like CK and LDH, Transaminases (AST,ALT), Amylases, Cholinesterases, Phosphatases. Immobilization of enzymes, ELISA. Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes

SUGGESTEDBOOKS:

1. Fundamentals of Enzymology: Nicholas Price & Lewis Stevens
2. Enzymes : Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry textbooks by Stryer,Voet and Lehninger (Relevant Chapters)
4. Proteins by Gary Walsh
5. Internet / Journal Resources

SKILL BASED SUBJECT IV
FOOD PROCESSING TECHNOLOGY

Objective: To impart the knowledge of food processing, labeling and quality control.

UNIT-I

Food Processing – Scope and importance. Properties of food – Physical, thermal and mechanical. Quality enhancers, contaminants. Microbes in food industry.

UNIT-II

Raw material preparation – Cleaning, Sorting, Grading and Peeling. Processing Methods–Heating, Bleaching and Pasteurization. Freezing, Dehydration, Canning, Additives, Fermentation, Extrusion Cooling, Hydrostatic pressure cooking, Direct heating, Microwave processing and Infra Radiation processing – Concepts and equipment used.

UNIT-III

Fruit and vegetable processing – Mango pulp processes , Tomato processing, Mushroom processing. Onion processing. Pickles and Sauerkraut technology. Vegetable juices and concentrated products. Sensor evaluation methods for fruits and vegetable products.

UNIT-IV

Food labeling - Nutrition labeling and Specification. Food Packaging –Packaging requirement of food, different packaging materials and their properties and advantages and disadvantages. Theory of can corrosion, can lacquer, can defects.

UNIT-V

Quality control – definition. Aspects, tools, chart. Quality factors in food–Introduction to ISO 9000 & IS14000 series, PFA, MPO, BIS, Codex Alimentaries & FPO rules, HACCP.

SUGGESTED BOOKS:

1. Introduction to food engineering, **R. Paul Singh**, *Academic Press. B-2000*
2. Molecular approaches to improving Food quality and safety, **Bhatnagar. D and Cleveland. T**, *Van Nostand Reinhold, NewYork-1992*
3. Fruit and vegetable preservation – Principles and Practices, **Sri Vastava Rand Sanjeev Kumar** *International Book Distributing Co-1998*
4. Fruit and vegetable processing, **Sumaa Bhatti, Umavarma**, *CBS Publishers*
6. Outlines of Dairy Technology, **De Sukumar**, *Oxford University Press, New Delhi-1999*