

JAMAL MOHAMED COLLEGE (AUTONOMOUS), TIRUCHIRAPPALLI – 20
M. Sc., DEGREE COURSE STRUCTURE FROM 2011 - 2012
DEPARTMENT OF ZOOLOGY

SEM	SUBJECT CODE	COURSE	SUBJECT TITLE	HRS/ WEE K	CRE DIT	Int. Mark	Ext. Mark	Mark
I	11 PZO 1401	CORE COURSE I	BIOL. OF INVERT., CHORDATES & PALEONTOLOGY	6	4	25	75	100
	11 PZO 1402	CORE COURSE II	GENETICS	6	4	25	75	100
	11 PZO 1403	CORE COURSE III	CELL & MOLECULAR BIOLOGY	6	4	25	75	100
	11 PZO 1404	CORE COURSE IV	BIOTECHNOLOGY	6	4	25	75	100
	11 PZO1405 P	CORE COURSE V	PRACTICAL for (CC I – IV	6	4	40	60	100
			TOTAL	30	20	140	360	500
II	11 PZO 2406	CORE COURSE VI	MICROBIOLOGY	6	5	25	75	100
	11 PZO 2407	CORE COURSE VII	ANIMAL PHYSIOLOGY	6	5	25	75	100
	11 PZO 2408	CORE COURSE VIII	ENVIRONMETAL BIOLOGY AND RESOURCE MGMT.	6	5	25	75	100
	11 PZO 2409	CORE COURSE IX	NANOTECHNOLOGY	6	5	25	75	100
	11 PZO 2410P	CORE COURSE X	PRACTICAL for CC VI – IX	6	4	40	60	100
			TOTAL	30	24	140	360	500
III	11 PZO 3411	CORE COURSE XI	DEVELOPMENTAL BIOLOGY. & EVOLUTION	6	5	25	75	100
	11 PZO 3412	CORE COURSE XII	BIOCHEMISTRY	6	5	25	75	100
	11 PZO 3413P	CORE COURSE XIII	PRACTICAL for CC XI & XII	6	5	40	60	100
	11 PZO 3501	CORE BASED ELE I	IMMUNOLOGY	6	4	25	75	100
	11 PZO 3502	CORE BASED ELE II	BIOSTAT & BIOINFORMATICS	6	4	25	75	100
			TOTAL	30	23	140	360	500
IV	11 PZO 4414	CORE COURSE XIV	GENERAL & APPLIED ENTOMOLOGY	6	5	25	75	100
	11 PZO 4415P	CORE COURSE XV	PRACTICAL for XIV	6	5	40	60	100
	11 PZO 4503	CORE BASED ELE – III	BIOPHYSICS & RADIATION BIOLOGY	6	4	25	75	100
	11 PZO 4504	CORE BASED ELE - IV	CLINICAL LAB TECHNIQUES	6	4	25	75	100
	11 PZO 48	PROJECT WORK		6	5	25	75	100
			TOTAL	30	23	140	360	500
			GRAND TOTAL	120	90	500	1500	2000

Semester I
Core course I
Code: 11 PZO 1401

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

BIOLOGY OF INVERTEBRATES, CHORDATES AND PALAEOLOGY

UNIT: I Biology of Invertebrates

Symmetry in animal organization – Significance of Coelom - Significance of Metamerism – Evolution of Metamerism – Locomotion in Annelids, Nutrition in Polychaetes, Molluscs and Echinoderms.

UNIT: II

Respiration and in Arthropods and Molluscs
Different types of excretory organs in Invertebrates and their structure and function – Nervous system in Arthropods and Echinoderms.

UNIT: III Biology of Chordates

Integumentary system – Skin of Mammals - Glands – Hairs – Scales – Horns – Skin pigments.

Comparative study of Digestive system and Circulatory system of Chordates.

Dentition in Mammals, Stomach in Mammals, Evolution of Aortic arches.

UNIT: IV

Respiration in Fishes – Pulmonary respiration in Tetrapods.

Excretory system – types and Evolution of Kidneys

Reproductive system – Accessory reproductive glands

Appendicular skeleton – Pectoral and Pelvic girdles of different classes.

UNIT: V

Minor Phyla: Rotifers, Phoronids and Chaetognatha

Invertebrate fossils - Evolutionary trends and Phylogenetic importance of Trilobites, Ammonoids, Belemnoids, Nautiloids and Echinoid fossils.

Vertebrate fossils: Dinosaurs and Archaeopteryx

References:

1. Ayyar, E.K., and Ananthakrishnan. T.N. (1992). A Manual of Zoology, Vol. II (Chordata), Visvanathan Publishers.
2. Barnes, R.D. (1982) Invertebrate Zoology, IV Ed., Holt Saunders – International Edition.
3. Barrington, E.J.W (1979) – Invertebrate Structure and Function, II Ed., ELBS and Nelson.
4. Hyman, G.H., The Invertebrates, Vols. I to VII, Mc Graw Hill Book Co. Inc. New York.
5. Kent. G.C., (1976), Comparative Anatomy of the Vertebrates, McGraw Hill Book Co., Inc., New York.
6. Kotpal, R.L., (2002), Minor Phyla., Rastogi Publication, Meerut.
7. Vasantika Kashyap (1997), Life of Invertebrates, Vikas Publishing House Pvt. Ltd., New Delhi.
8. Waterman, A.J. (1971), Chordate Structure and Function, The Macmillan Company.

GENETICS

UNIT: I

Gene interaction and types: Epistasis, Additivity, Modifiers, Lethality – Linkage – linkage in human beings – somatic cell hybridization – Mechanism of crossing over – Gene mapping in chromosome by crossing over method. Structure of gene – cistron, muton, recon, introns, and exons – overlapping genes.

UNIT: II

Gene families – RNA Splicing – Cis-trans splicing – tRNA processing – DNA recombination at the molecular level – Role of RecA and Rec B C D enzymes. Gene regulation: The Operon Concept *lac* operon *trp* operon and *ara* operon system in bacteria – Lytic cascade and lysogeny regulation in Lambda phage – Gene regulation in eukaryotes: Short term regulation and Long term regulation.

UNIT: III

Bacteria: Genetic material – Parasexual processes in bacteria: transformation, conjugation, sexduction, and transduction – Mapping of bacterial chromosomes – Biology of plasmids – Transposon – types and mechanism of transposition. Phages : Genetic material – recombination in phages – Fine structure of rII locus in T4 phage.

UNIT:IV

Chromosomal aberrations – DNA Damage and repair mechanisms – Molecular basis of mutations. Carcinogens – Genetic basis of cancer: Oncogenes and cancer, Oncoproteins and their roles – Genes in populations - Hardy–Weinberg principle and gene frequency – Factors affecting Hardy–Weinberg equilibrium.

UNIT: V

Inborn errors of metabolism: Phenylketonuria, alkaptonuria, albinism, Lesch-Nyhan syndrome, ADA deficiency, galactosemia, G6PD deficiency, Tay Sach's disease, and Gaucher's disease. Human karyotype: preparation and analysis - chromosomal syndromes in man. Detecting genetic diseases – genetic counseling, prenatal diagnosis, genetic diseases - Treating genetic diseases - Altering genetic traits. Human Genome Project – Features, methods and future prospects.

Reference Books:

1. Benjamin Levin (2005) Genes VIII, Oxford University Press, New York.
2. Daniel L. Hartl (1996) Genetics, III Ed., Jones Bartlett Publishers. Boston.
3. David Friefelder (1998) Microbial Genetics, Narosa Publishing House, New Delhi.
4. Elaine Johansen Mange and Arthur P. Mange (1994) Basic Human Genetics, Sinour Associates, Inc., Sunderland, Massachusetts.
5. Jenkins, J. B. (1983) Human Genetics, The Benjamin Cummings Publishing Co.,
6. John D. Hawkins (1996) Gene Structure and Expression, III Ed., Cambridge University Press.
7. Robert H. Tamarin (1996) Principles of Genetics, WCB Publishers.
8. Strickberger Monroe, W. (1996) Genetics, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Ursula Goodenough (1984) Genetics, Saunders College Publishing Co., London.
10. Watson J D *et. al.* (1987) Molecular Biology of Gene, IV Ed., The Benjamin Publishing Company Inc., UK.

Semester I
Core course III
Code: 11 PZO 1403

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

CELL AND MOLECULAR BIOLOGY

UNIT I: METHODS OF CELL STUDY

Cell study: Micrometry - Cell culture methods - Cell fractionation techniques –Cytophotometry - Immunocytochemistry – Autoradiography; Cytochemical staining and detection methods of Carbohydrates, Protein, Lipids, DNA and RNA.

UNIT II: CELL STRUCTURE AND FUNCTION

The nuclear envelope and traffic between the nucleus and cytoplasm:- Structure of nuclear envelope- Nuclear pore complex-selective transport of proteins to and from the nucleus- Nuclear protein- Nucleolus. Mitochondria- Energy Transduction.

Protein sorting and transport: The endoplasmic reticulum- Golgi apparatus and lysosomes.

UNIT III: DNA, RNA AND PROTEIN SYNTHESIS

DNA replication- Unidirectional and Bidirectional DNA replication - Role of RNA primers in DNA replication- Satellite DNA - DNA damage and repair. Types of RNA- Mechanism of prokaryotic transcription and eukaryotic transcription. Role of ribosome's and RNAs in protein synthesis.

UNIT IV: CANCER BIOLOGY

Characteristics of cancer cells- Types of tumors-Apoptosis and its relevance in cancer- Cellular oncogenes- Tumor viruses-Environmental carcinogens- Tumor suppressor genes: RB genes and P53 - Application of molecular biology to cancer prevention and treatment.

UNIT V: GENE EXPRESSION AND REGULATION

Regulation of gene expression in prokaryotes and eukaryotes - Attenuation and antitermination - DNA methylation - Heterochromatization, Transposition - Regulatory sequences and transacting factors - Environmental regulation of gene expression.

TEXT BOOKS:

- 1) Powar C.B. 1997. Essentials of cytology, Himalayan Publishing House, New Delhi.
- 2) Verma P.S and Agarwal V.K. 1998. Concept of Molecular Biology, Chand & Co.Ltd. Delhi
- 3) Gupta, P.K. 1999. A Text Book of Cell and Molecular Biology, Raptogi publication, Meerut
- 4) De Robertis, E.D. P. and De Robertis, E.M.F. 1987. Cell and Molecular Biology, VIII Ed. Lea and Febiger, Philadelphia.

REFERENCE BOOKS:

- 1) Bruce Alberts and Dennis Brey 1994. Molecular biology of the cell . 3rd Edition. Garland Publishing , Inc. New york and London.
- 2) Becker and Deamer, 1991. The world of the Cell . 2nd Edition. The Benjamin and Cumming publishing Company, Inc California.
- 3) Geofferey M. cooper and Robert E. Hausman, 2004. The Cell –A Molecular approach. 3rd Edition. Asm Press, Washington D.C. USA.
- 4) Alberts et al., 2002. Molecular biology of the Cell . 4TH Edition , Garland Science, a member of the Taylor and Francis group, New york, USA.

Semester I
Core Course IV
Code: 11 PZO 1404

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

BIOTECHNOLOGY

UNIT: I

rDNA technology in animal based systems: Scope – methods of introduction of genes – Isolation of genes – gene fragments and amplification – cloning vectors – enzyme systems – expression vectors – genome analysis – Human Genome Project – transgenic animals and applications.

UNIT: II

Animal cell culture technology – methods involved – applications – cell lines - Gene transfer techniques used in animal cells and eggs – stem cell culture and preservation – cell culture based processes and products - hormones, enzymes, regulatory molecules and therapeutics.

UNIT: III

Industrial Biotechnology: Fermentation – types of fermentation – Fermenter designs – Upstream and downstream processing – product recovery and purification – Production of alcohol, enzymes, vitamins, and single cell proteins – Improvement of inoculum source for better production.

UNIT: IV

Biotechnology in medicine: Production of monoclonal antibodies, Hybridoma technology: Production of insulin, growth hormone, interferon, recombinant vaccines, subunit vaccines and live vaccines – Diagnosis of genetic disorders by RFLP, PCR, OLR assay and Western blotting – Treatment of cancer – Bone marrow transplantation – GVH diseases - Gene therapy : *Ex vivo* and *In vivo* gene therapy, Embryonic stem cell methods.

UNIT: V

Biotechnology in Sericulture – production of hybrid silk varieties – production of transgenic silk worm - genes of silk production – application of silk worm as bioreactor for culturing cells.

REFERENCE BOOKS

1. Babiuk, L.A., John, P. Phillips and Murray (1989) Animal Biotechnology, Pergamon Press, Oxford.
2. Brown, C.M., Campbell, I. and Priest, F.G. (1988) Introduction to Biotechnology. Blackwell Scientific Publications, U.K.
3. Gor Dard and Lucassen, E. (1993). *In vitro* culture of Animal Cells, Butterworth – Heinemann Publications.
4. Higgins, I.J., Best, D.J. and Jones, J. (1988) Biotechnology – Principles and Applications. Blackwell Scientific Publications, Oxford, London, Edinburgh.
5. Keshav Trehan (1996), Biotechnology, New Age International Pvt. Ltd. Publishers, New Delhi.
6. Marx, J.L. (1989) A Revolution in Biotechnology, Cambridge University Press.

7. Mc Neil and Harvey L.M. (1990) Fermentation, Blackwell Scientific Publications.
8. Old, R. W and Primrose, S B. (1989) Principles of Gene Manipulation, Blackwell Scientific Publications.
9. Primrose, S. B (1989) Modern Biotechnology. Blackwell Scientific Publications, Oxford, London.
10. Prentis , S. (1985) Biotechnology New Industrial Revolution, Orbis, London.
11. Smith John, E. (1988) Biotechnology. Edward Arnold, London.
12. Watson, J.D. *et al.*, Recombinant DNA . Scientific American Books, W. H Freeman and Company, New York.
13. Mathavan, S., 1998. Production of foreign protein in Silk worm larvae. Madurai Kamaraj University, Madurai, pp 1- 95
14. Ganga, G. and J. Sulochana Chetty, 1999. An Introduction to Sericulture, Oxford & IBH Publishing Co., Pvt. Ltd.

M. Sc., (Zoology) Practical - I

Semester I
Core course V
Code: 11 PZO 1405P

Hrs. 6
Credits 4
Marks 100

**BIOLOGY OF INVERTEBRATES, CHORDATES, GENETICS,
CELL AND MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

1. INVERTEBRATES & CHORDATES

- a. TAXONOMY : 50 representative species :
25 Invertebrates - 8 Invertebrate Phylum upto class level (identifying features)
20 Vertebrates - 5 classes upto order level (identifying features)
- b. MOUNTING : Teleost – Scales
Honey bee – Sting
- c. SPOTTERS: Invertebrate larval forms
Invertebrate fossils – Ammonoids, Belemnoids, Nautiloids and Echinoid.
Minor Phyla – Rotifera, Phoronida, Chaetognatha
- d. DISSECTIONS: Frog – V Cranial and Spinal nerves using virtual laboratory

2. GENETICS

Drosophila culture – Identification of mutants and sexes
ABO Blood groups & Rh - Genetic significance
Human Karyotyping and Pedigree analysis
Hardy-Weinberg Law and Calculation of gene frequency - Co-dominance and multiple alleles.

3. CELL BIOLOGY

Micrometry
Human buccal smear
Blood smear – Cockroach, Man
Blood cells as osmometers

4. MOLECULAR BIOLOGY

Isolation of DNA from animal tissue
Isolation of plasmid DNA from Bacteria (Demo)

5. BIOTECHNOLOGY

Demonstration of agarose gel electrophoresis
Spotter : Models of PCR, Southern blotting, Vectors

Semester II
Core course VI
Code: 11 PZO 2406

M. Sc., (Zoology)

Hrs. 6
Credits 5
Marks 100

MICROBIOLOGY

UNIT: I INTRODUCTION

General features and Classification of Bacteria, Virus, Yeast, Actinomycetes and Fungi. Structure and life cycle of Bacteria and Virus; DNA (T₄ Phage) Virus and RNA (HIV) Virus.

UNIT: II MICROBIAL CULTURE

Bacterial growth and nutritional requirements - Microbial culture - Environmental parameters - Methods of maintenance of culture - Culture of microorganisms - Types of culture media - Preparation of culture media. Culture characteristics of Bacteria; Gram's staining techniques.

UNIT: III MICROBIOLOGY IN EVERYDAY LIFE

Microbiology of air, water and soil . Food microbiology - Microbes of milk and food - methods of detection, pasteurization and food poisoning; food preservation. Environmental Microbiology - role of microbes in Environment protection and Management.

UNIT: IV INDUSTRIAL AND AGRICULTURE MICROBIOLOGY

Fermentation process - Microbial role in fermentation production of Alcohol, Vinegar, Pharmaceuticals, Organic acids, Amino acids, Enzymes and Fuels.
Agriculture: Biological nitrogen fixation; *Nif* genes, Nitrogen fixers- Biofertilizers- Bio pesticides (Bt, NPV).

UNIT: V MEDICAL MICROBIOLOGY

Pathogenicity, Infection, Virulence - Causative agents - Modes of transmission - Control measures of diseases - Diphtheria, Tetanus, TB, Typhoid, Gonorrhoea, Syphilis, Polio, AIDS, Viral Hepatitis A & B.

Microbial control: Physical and Chemical methods. Antimicrobial agents (Antibiotics).

TEXT BOOK:

Pelczar, Chan and Krieg, (1993). Microbiology, Tata Mc Graw Hill Pub. Co. Ltd. New Delhi.

REFERENCES:

1. Sulia, S.B & Santhanam, S. (2001) General Microbiology , Oxford and IBH.
2. Thomas, C.G.A. (1988) Medical Microbiology, ELBS Publications.
3. Ananthanarayanan, R and Jayaram Panicker, C.K. (2000). Text Book of Microbiology, Orient Longman, Chennai and Hyderabad.
4. Pelczar, M.J. & Reid, R.D. (1965). Microbiology Mc Graw Hill Company. New York.
5. Powar, C.B. and Diginawala. H. F. (1987) General Microbiology - Vol. I & II. Himalaya Publishing House, Bombay.
6. Sharma, P.D. (1993) Microbiology - Rastogi Publications, Meerut.

Semester II
Core course VII
Code: 11 PZO 2407

M. Sc., (Zoology)

Hours 6
Credit 5
Marks100

ANIMAL PHYSIOLOGY

UNIT: I

Homeostatic mechanisms: Thermoregulation: Temperature compensation in poikilotherms- Temperature regulations in homeotherms- Tolerance to high temperature- tolerance to cold and freezing- physiology of hibernation and aestivation.

Osmotic and ionic regulation: Response to hyperosmotic and hypoosmotic media with reference to crustaceans and fish, Adaptation to Pressure, High altitude-buoyancy.

UNIT: II

Excretion: Ammonia toxicity – detoxification pathways – excretion to different habitat.

Nervous co-ordination: Ionic basis of excitability – resting membrane potential – electrogenesis, propagation of action potential – interneuron transmission – electrical synapses – chemical synapses – neurotransmitters.

Animal electricity: Electric organs – production of electric discharge – functional significance.

UNIT: III

Receptor mechanism: Mechano reception, Muscle receptors, Pressure receptors – Gravity receptor - phonoreception. Tango receptor

Photoreception: Retinal pigments – photochemistry of vision.

UNIT IV

Bioluminescence: Occurrence – physical aspects – chemistry of light production – functional significance. Animal behavior: Biological clock – endogenous rhythm – circadian rhythm – circannual and lunar periodicity – Zeitgeber – entrainment – physiological basis of learning and memory

UNIT V

Endocrine system: Pituitary – Thyroid – Pancreas – Adrenal.

Mammalian reproductive physiology

TEXT BOOKS:

1. Hoar, W.S., 1987. General and comparative Physiology, Prentice Hall
2. Turner, C.D. and Bagnara, J.T. 1976. General Endocrinology, 6th Edn. WB Saunders Co.,

REFERENCE BOOKS:

1. Beck, 1971. Human Design, Harcourt Brace Jorrorich Inc.
2. Dawson, H. 1964. General Physiology, Little Brown Co. Boston.
3. Echert, R. and Randall, D. 1987. Animal Physiology, CBS Publishers and Distributors
4. F.N. 1971. Animal function, Principles and Adaptation, Macmillan Co., London.

ENVIRONMENTAL BIOLOGY AND RESOURCE MANAGEMENT

UNIT I

Scope of Ecology, its relevance to mankind – Ecological Interfacing – Abiotic factors – Water, Light, Temperature and Soil. Biotic factors – Animal relationships – positive / negative interactions – intra specific and inter specific competition.

UNIT II

Ecosystem : Concepts and ecosystem management - Fresh water ecosystem (Pond & River) and Marine ecosystem – Food chain – Food web – Tropic levels – Energy flow –. Habitat Ecology : Marine habitat, Freshwater habitat. Mangrove

UNIT III

Population – Density, Growth, population fluctuation and regulation, dispersal, Age. Community ecology – types of Communities – characteristics and structure of community – Ecological succession- structure and types.

UNIT IV

Pollution – types, their biological effects and control. Air pollution, Water Pollution, Land pollution, Noise Pollution, Thermal Pollution, Sewage and Solid Waste disposal and management – Green house effect – Ozone layer and its significance, Global warming, Acid rain,– Eutrophication, Toxicity- Biomagnifications and LC 50 value. .

UNIT V

Natural Resources - renewable and non-renewable - resources management. Biodiversity – types – Mega diversity with reference to India – Conservation of Biodiversity. Environmental Impact Assessment (EIA), Biological indicators and their role in environmental monitoring – Bioremediation – Biodegradation of heavy metal and oil pollution. Remote sensing techniques in resource management (Land, water and minerals), Disaster management (Earth Quake, Cyclone, Landslide and Tsunami)

Reference:

1. Clarke, G.L., 1954. Elements of Ecology. John Wiley & Sons, N:y.
2. Kendeigh, S.C. 1961. Animal Ecology. Prentice Hall
3. Odum, E.P. 1971. Fundamentals of Ecology, W.B. Saunder's Co. Philadelphia
4. Odum, E.P. and Barrett, G.W. 2005. Fundamental of Ecology. Thomson Brooks/ Cole (EWP) 5th Ed.
5. Rastogi, V.B. and M.S. Jayaraj 1989, Animal Ecology and distribution of animals, Kedarnath Ramnath.
6. Sharma, P.D. 1990. Ecology and Environment. Rastogi Publications. Meerut.
7. Southwick, C.H. 1976. Ecology and the quality of Environment. D. Vas Nostrand Co.
8. Verma, P.S. and V.K. Agarwal, 1996 Principles of Ecology. S.Chand & Co. New Delhi.

Semester II
Core course IX
Code: 11 PZO 2409

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

NANOTECHNOLOGY

UNIT – I: FUNDAMENTALS AND OVERVIEW OF NANOSCIENCE

Definitions and scaling. Properties at nanoscale (optical, electronic and magnetic). Metal and Semiconductor Nanomaterials, Quantum Dots, Wells and Wires, Bucky balls and Carbon Nanotubes.

UNIT – II: NANO BIOMATERIALS

Introduction-Biocompatibility – anti bacterial activity – principles involved – Biomaterial nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing

UNIT – III: BIOMEDICAL APPLICATIONS

Nanoparticles in Drug delivery - Nanotechnology in Diagnostics applications: Biochips-analytical devices, Biosensors- Natural nanocomposite systems as spider silk, bones, shells; nanomaterials in cancer treatment.

UNIT – VI : NANOTECHNOLOGY AND ENVIRONMENT

Application of nanotechnology in Green energy, sustaining Natural resources, Global climate changes. Nanotechnology and energy production: Fuel Cells — applications in power and transportation

UNIT – V : NANO TOXICOLOGY

Nanomaterials in Environment - Toxicology of Airborne and Manufactured nanomaterials in the environment - Nanoparticles and Living Organisms: Portals of entry and target tissues- Mechanisms and Health Effects - Risk assessment – Ethical – Legal and Social Implications

References

TEXT BOOKS

1. Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education.
2. Nanomaterials by A.K. Bandyopadhyay; New Age International Publishers
3. Hari Singh Nalwa, “*Nanostructured Materials and Nanotechnology*”, Academic Press, 2002
4. Yuliang Zhao and Hari Singh Nalwa, ‘Nanotoxicology: Interactions of Nanomaterials with Biological Systems, American Scientific Publishers, 2007
5. "Nanotoxicology - Interactions of Nanomaterials with Biological Systems", Ed Yuliang Zhao and Hari Singh Nalwa, June 2006
6. Springer handbook of nanotechnology by Bharat Bhushan
7. MEMS and nanotechnology – Based sensors and devices communication, Medical and Aerospace applications - A.R.Jha.

**MICROBIOLOGY, ANIMAL PHYSIOLOGY, ENVIRONMENTAL
BIOLOGY AND MANAGEMENT PRACTICES, NANOTECHNOLOGY
AND MICROTECHNIQUE**

MICROBIOLOGY

- Culture techniques
- Culture of bacteria
 - Bacterial growth curve
 - Antibiotic sensitivity – Gram Staining +ve and -ve
Differential staining
 - Preparation of culture media
Agar medium
 - Serial dilution technique & pour plate
 - Culturing of bacterial broth, slants, plating, streaking

Equipments in Microbiology

- Inoculation loop
- Autoclave
- Laminar flow hood
- Spotters related to theory

ANIMAL PHYSIOLOGY

- Quantitative estimation of amylase activity
- Quantitative estimation of ammonia and urea
- Rate of salt loss and salt gain in fish using different experimental media
- Estimation of blood chloride.

ENVIRONMENTAL BIOLOGY

- Report on ecological collection representing different habitats – sandy, muddy, rocky shores.
- Hydrological studies of water samples with reference to pollution:
Chlorides, Silicates, Calcium, Total Hardness, Phosphates, Nitrates, pH, DO & BOD - water quality index
- Qualitative & Quantitative estimation of plankton (marine sample)

NANOTECHNOLOGY

- Spotters: Nano biochips, carbon nano tube; nanoparticles; Fuel cells

MICROTECHNIQUE

- Preparation of permanent serial sections of tissues (10 slides) and embryos (10 slides) of Frog and Chick respectively. Preparation of tissue sections for histochemical tests.

EDUCATIONAL TOUR

- Visit to R & D labs and different natural habitats related to the above subjects and submission of report is compulsory.

A record of laboratory work shall be submitted at the time of practical examination

Reference :

Cappuccino, J. G and Sherman. 1999. Microbiology – A Laboratory Manual, Addison Wesley Pub.,

Semester III
Core course XI
Code: 11 PZO 3411

M. Sc., (Zoology)

Hrs. 6
Credits 5
Mark 100

DEVELOPMENTAL BIOLOGY AND EVOLUTION

UNIT: I

Structure of gametes – sperm – Spermatogenesis– The motile apparatus of sperm – cross section of sperm tail – structure of mammalian egg - super ovulation, ICSI, GIFT- Artificial insemination - In vitro fertilization

The sperm – binding protein of the mouse zona pellucida. Induction of the mammalian acrosome reaction by ZP3

UNIT: II

Early development of the Nematoda *Caenorhabditis elegans* – cleavage & axis formation – gastrulation in *C.elegans*

Genetic regulations of early embryonic development in *Drosophila*. Homeotic selector genes.

Origins of anterior – posterior polarity of the egg of *Drosophila* – protein gradients in the early embryo

Embryonic induction – organizers – Spemann and Mangold experiments – molecular biology of the Nieuwkoop center –functions of the organizer – Induction.

UNIT :III

Influence of hormones on growth and metamorphosis of insects and amphibians – Formation of the limb bud in amphibian – specification of the limb fields – induction of the early limb bud – cell death and the formation of digits and joints. Regenerative ability of various invertebrates and vertebrates – mechanism of regeneration in amphibians – blastema formation – factors affecting regenerations.

UNIT :IV

Evolutionary developmental biology – (“evdevo”) – Unity of Type and conditions of existence – Hox genes and atavisms – Homologous pathway of development – modularity as a principle of evolution – Heterochromy in evolution – Generating Evolutionary Novelty – A new evolutionary synthesis explaining biodiversity

UNIT : V

Evolution of population – from races to species, adaptation pattern, behavioural adaptations and strategies, natural selection, isolating mechanisms, mode of speciation – Evolution of man and future evolution of man.

REFERENCE BOOKS:

1. Balinsky, B.L. 1981. An introduction to Embryology V Ed. Saunders Co. Philadelphia.
2. Berrill, N.J. 1986 Developmental Biology, Tata McGraw Hill, New Delhi.
3. Browder, L.N., 1980. Developmental Biology, Saunders co., Philadelphia.
4. Gilbert, S.F., 1995. Developmental Biology, II Edn. Sinauer Associates Inc. Publishers Sunderland, Massachusetts, USA.
5. Saunders, A.W. 1982. Developmental Biology, Patterns, principles, problems. Macmillan publishing Co., New York.
6. Stevan, B and Oppenheimer 1980. Introduction to Embryonic development, Alley and Bern.
7. Odum, E.P. (1996) Fundamentals of Ecology (III Edn.) Natraj Pub. Dehradun.
8. Sharma, B.K. and Kaur, H. (1997). Environmental chemistry Goel Pub. House, Meerut
9. Tacconi, L. (2000). Biodiversity and Ecological Economics Participation, values and resource management. Earthscan Pub. Ltd. London.
10. Castri, F.D. and Younes, T. (1996). Biodiversity: Science and development. CAB Int, Wallingford, U.K.
11. Strickberger, M.W. (1996). Evolution. Jones and Barlett Pub. Inc., London.
12. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. (1975). Evolution. Surjeet Pub. and Co., New York.

Semester III
Core Course XII
Code: 11 PZO 3412

M. Sc., (Zoology)

Hrs. 6
Credits 5
Marks 100

BIOCHEMISTRY

UNIT – I :

Carbohydrate : Monosaccharides – general structure and properties; oligosaccharides; Polysaccharides; Protein: Amino acids – Peptides – Protein configuration – classification – properties; Lipids : general structure, classification – properties of fats and fatty acids.

UNIT – II :

Nucleic Acids : Chemistry –nucleosides- nucleotides- variance of DNA - DNA and RNA types – Bio synthesis of Purines – Pyrimidines; Enzymes; nomenclature – classification – three dimensional structure –mechanism of action.

UNIT – III :

Glycolysis- alcoholic fermentation – pyruvate oxidation – citric acid cycle – HMP path way – glyoxylate cycle – electron transport – oxidative phosphorylation; oxidation of even chain fatty acids (oxidation), unsaturated fatty acids and odd chain fatty acids; amino acid metabolism – amino group metabolism – nitrogen excretion .

UNIT – VI :

Fat soluble vitamins – occurrence – structure – properties- deficiency; coenzyme Q – stigmasterol; water soluble vitamins – occurrence – structure – properties – deficiency.

UNIT – V :

Hormone: General function – outline classification – steroidal hormones – peptide hormone – amino acid derivatives – para hormones – vasoactive peptides – pheromones – mechanism of hormone action.

References

TEXT BOOKS

1. Lehninger,L., 1993. Principles of Biochemistry CBS publishers and distributors, New Delhi.
2. Stryer, Lubert, 1975. Biochemistry W.H. Freeman & Company, San Francisco

REFERENCE BOOKS:

1. Frunton J.S. & S. Simmonds, G.General and R.H.Dol. 1987. Outlines of Biochemistry John Wiley & Sons.
2. Baldwin, E. 1964. An introduction to comparative Biochemistry, CUP, London.
3. Beck, 1971. Human Design, Harcourt Brace Joranorich Inc.
4. Giese, A.C. 1979. Cell Physiology and Biochemistry, Prentice Hall
5. Gordon, M.S., Bartholomew, G.A. Grilnell, A.D., Jorgensen, C.B.,and White,
6. Jain, J.L. 2003. Fundamentals of Biochemistry, S. Chand & Compnay Ltd. New Delhi.

M. Sc., (Zoology) Practical - III

Semester III
Core course XIII
Code: 11 PZO 3413P

Hrs. 6
Credits 5
Marks 100

DEVELOPMENTAL BIOLOGY, EVOLUTION AND BIOCHEMISTRY

DEVELOPMENTAL BIOLOGY

Preparation of sperm suspension in frog/bull and observation of the spermatozoa
Observation of live spermatozoa & study of rate of motility of sperm in frog / bull semen
Effect of thyroxin or iodine on metamorphosis of frog. Induced ovulation in Fish,
Artificial fertilization using eggs & sperm of fish and frog.

Spotters : Different stages of oestrous cycle of rats.

EVOLUTION

Fossils – Nautiloid, Ammonoid, Belemnoids; Colouration and Mimicry

BIOCHEMISTRY

Quantitative estimation of aminoacid, protein, carbohydrate and lipids in tissue samples

Preparation of solutions – Molarity, Normality percentage

Buffer preparation – determination of pH using pH meter

EDUCATIONAL TOUR

Visit to R & D labs and different natural habitats related to the above subjects and submission of report is compulsory.

Semester III
Core Based Elective - I
Code: 11 PZO 3501

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

IMMUNOLOGY

UNIT I IMMUNITY AND IMMUNE SYSTEM

Immunity: Innate, acquired, passive and active. Immune system: lymphoid organs – primary and secondary; structure and functions; Cells of the immune system: b-lymphocytes, T-lymphocytes – subsets, third population of lymphocytes – polymorphonuclear cells and macrophages; lymphokines.

UNIT II ANTIGEN, ANTIBODY AND COMPLEMENT

Antigen: Antigenic determinants, types; Antibody: Immunoglobulins – structure and functions. Antigen and antibody interaction. Complement : Nomenclature, activation, function.

UNIT III IMMUNE ACTIONS AND PROPHYLAXIS

Immune response: Primary and secondary – mechanism of humoral and cell mediated immune response; immunity to infections – bacterial and viral; immunoprophylaxis: toxoids and vaccines, immunization schedule.

UNIT IV IMMUNOLOGICAL DISORDERS

Hypersensitivity: Types I, II, III and IV; autoimmune disorder; immunodeficiency diseases; tumour immunity - Major histocompatibility complex; transplantation immunity.

UNIT V IMMUNOLOGICAL TECHNIQUES

Agglutination test, Precipitation test, Immunodiffusion, Immunoelectrophoresis – qualitative & quantitative- Immunofluorescence, Widal test, VDRL test, test for AIDS; Hybridoma technology, radioimmuno assay, enzyme linked immunosorbant assay (ELISA), Immunoblotting –Western blotting

Text Book:

Chakravarthy, A.K., (1993) Immunology, Tata McGraw Hill Publishing Company, New Delhi.

Reference Books:

1. Roitt, (3rd Edition) Immunology, Crover Medical Publishing Company, London
2. Barret, J. T. (1983) Text Book of Immunology (5th Edition), The C.V. Mosly Company.
3. Richard, H.M. (1992), Immunology(2nd Edition), Williams and Wilkins, Baltimore Maryland.
4. Hidemann, W.H. (1980) Essentials of Immunology, Elsevier Science Publishing Co. Inc.
5. Weinn. D.M. and Steward, L. (1993), Immunology, Singapore Publishers Private Limited.

Semester III
Core Based Elective II
Code: 11 PZO 3502

M. Sc., (Zoology)

Hrs. 6
Credits 4
Mark 100

BIOSTATISTICS & BIOINFORMATICS

UNIT: I

Definition of biostatistics – samples and population – variables, derived variables; Sources, classification, tabulation & presentation of data diagrammatic representative of data - Mean, Median, Mode, Standard Deviation, variance, coefficient of variation, Standard Error

UNIT: II

Methods of sampling and sampling distribution - Probability – Events – Addition and Multiplication laws- Binomial and Normal distribution - Correlation - (scatter diagram) dot diagram – Karl Pearson's – Correlation coefficient.

UNIT: III

Regression analysis – X on Y and Y on X. - Student t' test, (mean difference and paired sample) Significance of Chi-square test, F – test : ANOVA – One way analysis of variance.

UNIT: IV

Bioinformatics : Definition, Scope. Biomolecular Structure (Primary, secondary, tertiary and quaternary) - Proteins and Nucleic acids. Secondary or derived data base – Molecular modeling data base (MMDB)

UNIT: V

DNA data base, Comparison of sequences – FASTA and BLAST – Methods to access and download genome sequences of several organisms from GENE BANK, EMBL and other sources - Sequence Alignments (CLUAW)- Structure prediction – Phylogenetic tree – RASMOL.

REFERENCE BOOKS:

1. Sokal, R.J. and Rohlf, S.J. 1981, Introduction to Biostatistics, W.H. Freeman, London.
2. Arora, P.N. 1998, Biostatistics . Himalaya Publishing House.
3. Ramakrishnan, P. 1996, Biostatistics, Saras Publications, Nagercoil.
4. Irfan Ali Khan and Atiya Khanum. (2003) Fundamentals of Bioinformatics. Ukaaz Publications Hyderabad, AP, India.
5. Murthy, C.S.V. (2003) Bioinformatics. Himalaya Publishing House. Mumbai, Delhi, Nagpur, Bangalore, Hyderabad, India
6. Subramanian, C. 2004. A Text book of Bioinformatics, Dominant Publishers and Distributors. New Delhi, India.

7. Mittal, C. 2003. Fundamentals of Information Technology, Praghati Prakasam, Meerut.
8. ZAR, J. H. 2004. Biostatistical Analysis. Pearson Education Pvt. Ltd. Singapore.

Semester IV
Core course XIV
Code: 11 PZO 4414

M. Sc., (Zoology)

Hrs. 6
Credits 5
Marks 100

GENERAL AND APPLIED ENTOMOLOGY

UNIT: I

Taxonomy: Basics of insect classification. Classification upto super families – Key characteristics with common South Indian examples.

Morphology: Head : segmentation and sutures. Wings : venation – Appendages in Apterygotes – Genitalia.

UNIT: II

Physiology:

Integumentary system – structure and chemistry – physiology of moulting .

Digestive system: Structure and physiology of digestive system

Respiration: Aerial respiration – aquatic respiration – respiration in endoparasites.

Circulatory system: Structure of heart, mechanism of haemolymph circulation – Haemolymph and its composition – A study of haemocytes and their functions.

UNIT: III

Excretory system: Malpighian tubules and their functions – role of rectum in water and ion regulation.

Nervous system: Structure – Neurotransmitters – structure and function of compound eye – stridulatory organ.

Reproductive system: Male and female reproductive systems – types of ovaries – vitellogenesis – mating - oviposition – viviparity – accessory reproductive glands – their secretions and functions.

Endocrine system: Endocrine control of moulting and metamorphosis – role of hormones in male and female reproduction. Neuroendocrine system of insects.

UNIT: IV

Economic importance of insects – Biology of honeybee, silk moth and lac insect. Culture methods – appliances used and problems related to these cultures.

Biology , damage caused and control methods of any 5 chief insect pests of agricultural importance – pests of paddy, sugarcane, cotton, ground nut, coconut, - bhendi and brinjal – pests of stored products.

Medical and veterinary entomology: Arthropods as vector of human diseases – Biology of house fly, mosquito, flea, louse and sandfly – control methods.

UNIT: V

Principles of Insect control – prophylactic measures – cultural, mechanical, physical methods

Biological control: Parasites, predators and microbial agents.

Chemical methods: Pesticides - classification –Types of formulations – mode of action – toxicity - insecticide resistance to environmental safety.

Non-conventional methods: Use of insect growth regulators (IGR), repellents, antifeedants, Pheromones and chemosterilants. Integrated Pest Management (IPM) definition – need for IPM and uses.

Reference Books:

1. Mani,M.S., (1982) General Entomology, Oxford and IBH publishing Co., New Delhi.
2. Snodgrass, R.E., (1985) Principles of Insect Morphology, McGraw Hill and Co., New York.
3. Wigglesworth,V.B., (1992) physiology of Insects, IX Ed., Chapman and Hall, London.
4. Borror,D.H., and De Long, (1964) An introduction to the study if insects, Holt Reinhart & Winston Inc., New York.
5. Chapman, R.F. (1992) The insects: Structure and Function, Hodder and Broughton Ltd., Kent, U.S.A.
6. Nayar, K.K., Ananthkrishnan,T.N., and David.,M. (1995). General and applied Entomology, Tata McGraw Hill Pub. Co., Ltd., New York.
7. Richards., O.W., and R.G. Davies (1983) IMM's' General Text Book of Entomology, X Ed., Vols. I and II, Chapman and Hall, New York.
8. Vasantharaj David,B (2001) Elements of Economic Entomology, Popular Book Depot., Chennai – 15
9. Nayar, K.K. et al., (1983) Economic Entomology and Applied Entomology, Oxford and IBH Publishing co., New Delhi.
10. Nayar,K.K., T.N.Ananthkrishnanj and David B.V. (1986) General and Applied Entomology, Tata McGraw Hill Publications, New Delhi.
11. Rathinaswamy,T.K.(1986) Medical Entomology, S. Viswanathan and Co., Madras.

M. Sc., (Zoology) Practical - IV

Semester IV
Core course XV
Code: 11 PZO 4415 P

Hrs. 6
Credits 5
Marks 100

GENERAL AND APPLIED ENTOMOLOGY

I. Collection and Identification of Insects, their parts and stages

1. Collection and preservation of insects.
2. Identification of insects belonging to important orders and super families using dichotomous key.
3. Identification of beneficial insects, predators and parasites (relevant to biological control).
4. Identification of harmful insects (two examples for each of the plants mentioned in theory).
5. Identification of household pests, mosquitoes and fleas
6. Study of types of larvae and pupae.
7. Study of types of antennae, legs, wing, mouth parts and external genitalia.

II. Mounting and Dissections

1. Mounting of mouth parts of bedbug, mosquito, honey bee and house fly
2. Dissections of digestive system, nervous system and reproductive systems of Grasshopper, Chrysocoris, Mylabris, House fly, Silk worm moth and Honey bee.
3. Dissection of Neuroendocrine system of cockroach.
4. Dissection of silk gland of silk worm.

III. Experiments

1. Estimation of Insects respiratory rate using respirometer.
2. Experiment on the role of cuticular lipids in preventing transpiration.
3. Experiment on the functioning of Malpighian tubules (in vitro study)
4. Insect haemolymph – total and differential counts of haemocytes.

IV. Field visits

Visits to Sericulture units, Crop research stations, Farms and IPM Centers to have a first hand knowledge on culture techniques and problems.

A record of laboratory work and collection of insects (including insects of economic importance) shall be submitted for the practical examination.

Semester IV
Core Based Elective - III
Code: 11 PZO 4503

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

BIOPHYSICS AND RADIATION BIOLOGY

UNIT I

Thermodynamic principles in biology – Concept of free energy – Energy rich bonds – Biological energy transducers – Oxidation and reduction and redox potential.
Chromatography: Thinlayer, affinity, gas, HPLC and Principles applications – Electrophoresis – Ultracentrifugation (Velocity and buoyant).

UNIT II

Principles and applications of light, Phase contrast, Fluorescence, Scanning and Transmission electron microscopy
Principles of X-ray diffraction- fluorescence –UV- NMR and ESR spectroscopy.

UNIT III

Scope of Radiation Biology –Sources of natural radiation: Terrestrial and cosmic sources. Man made radiation: Medical (occupational, diagnostic) - Nuclear activities (Nuclear fuel cycle, Nuclear test, Nuclear accidents, Mining) – Types of radiation (Alpha, Beta & Gamma) - Properties of Radiation (external emitters and internal emitters) – Radiation Units (Becquerel, RAD, Gray & Curie).

UNIT IV

Biological effects of radiation - Cellular level – Organ system level – Genetic effects (aberration) – Radiation sickness – syndrome – Cancer induction - Dosimetric study.

UNIT V

Application of Radio isotopes

Application in Biology: Tracer Technology – Metabolic and Biochemical Pathways.
Application in Agriculture and Industry: Genetic improvement of crop plant – Insect, Pest and Disease Management - Food Preservation .
Application in Health Care: Diagnostic Techniques – Radio Pharmaceuticals – Radiation Oncology.
Radioactive waste: Sources and Management - Nuclear energy programme in India.

REFERENCE BOOKS:

1. Shan, V.C. (1985) Elements of Radiation Biology, Today's & Tomorrow's Printers & Publishers, New Delhi.
2. Merrill Eisenbud (1997) Environmental Radioactivity, Academic Press, California.
3. Sharma, B.K., (1990) Environmental Chemistry, Goel Publishing House, Meerut.
4. Grosh, D.S. (1965) Biological Effects of Radiation, Blaisdell Publishing Co.,
5. Bascq, Z.M. and Alexander, P. (1961). Fundamentals of Radiobiology.

6. Sood, D.D. Reddy, A.V.R. and Ramamoorthy, N. (2000) Fundamentals of Radiochemistry, Indian Association of Nuclear Chemists and Allied Scientists, Radiochemistry Division, Mumbai.
7. Wolf, G. (1964) Isotopes in Biology, Academic Press, New York.
8. Use of Radioisotopes in Biology (1989) BRNS, BRIT-DAE, Mumbai.
9. Rao, P.S. (1999) Guest Editor, Nuclear Agriculture and Biotechnology, IANCAS Bulletin 15 (1).
10. Sharma, A.K. (1998) Guest Editor Preservation of Food by Ionising Radiation, IANCAS Bulletin, 14(1).
11. Sood, D.D. Reddy, A.V.R. Iyer, S.R.K. Gangadharan, S and Gursharan Singh, (1998) Applications of Radioisotopes and Radiation in Industrial Development, NAARRIM, Mumbai.
12. Lele, R.D. (1984) Principles and Practice of Nuclear Medicine, Arnold-Heinemann, New Delhi.
13. Pillai, M.R.A. Bhandarkar, S.D. (1998) Radioimmunoassay: Principles and Practice, 3rd Edition, BARC, Mumbai.
14. Kowalsky, R.J and Perry, J.R. (1987) Radiopharmaceuticals in Nuclear Medicine Practice, Appletons Lange.
15. Ramamoorthy. N, Shivarudrappa. V, Bhelose, A.A.(2000) Radiopharmaceuticals and Hospital Radiopharmacy Practices, Eds. BRNS, BRIT-DAE, Mumbai.
16. Shahul Hameed. P, Shahul Hameed, M.M. Ravikumar. S, and Masilamani, V. (2001) Proceedings of the National Seminar on Atomic Energy, Ecology and Environment, Jamal Mohamed College, Tiruchirappalli.

Semester IV
Core Based Elective – IV
Code: 11 PZO 4504

M. Sc., (Zoology)

Hrs. 6
Credits 4
Marks 100

CLINICAL LAB TECHNIQUES

UNIT: I ESSENTIAL PRE-REQUISITES OF A CLINICAL LABORATORY

Introduction – scope of the subject CLT – collection of specimens and preservation – records and report preparation and maintenance – cleaning, maintenance and care of glassware – sterilizations - physical and chemical methods – Disposal of specimen and infected materials – safety precautions in the laboratory – First aid treatments.

UNIT: II LABORATORY INSTRUMENTS

Light microscope: parts and working – Centrifuge – Weighing balance – Colorimeter – Spectrometer, Incubator -. Haemocytometer – Albuminometer – Urinometer – Sahlis haemoglobinometer.

UNIT: III MICROBIOLOGY

Bacteria – structure and types – staining procedures – culture media and antibiotic sensitivity test.

Sexually transmitted diseases: Syphilis, Gonorrhoea, chancroid or soft sore, Donovanosis, Genital candidiasis, Non-gonococcal urethritis, *Corynebacterium vaginale* and herpes genitalis, Lymphogranuloma venereum, Trichomoniasis.

UNIT: IV CLINICAL ANALYSES

BLOOD: Collection of blood (Venous and Capillary) – Plasma and serum for analysis – Total RBC count – Total leucocytes count - differential count – Haemoglobin estimation (Sahlis methods) ESR (Wintrobe and Westgren methods) – Bleeding and clotting time – Estimation of packed cell volume – Blood grouping and cross matching (Slide and Tube methods) - Anti – D (Rho) test (slide, rapid tube and Du test).

URINE : Collection, preservation, routine examinations – protein – glucose – acetone – bile salts – bile pigments – urobilin – urobilinogen – microscopical examination of urine

FAECES: Microscopical examination – intestinal parasites – helminthes, nematodes, cestodes, trematodes, protozoa

UNIT V

SPUTUM: Collection – microscopical and naked eye inspection – clinical examination.

CEREBROSPINAL FLUID: Composition – CSF cells total and differential count - estimation of protein – sugar chloride.

SPERM: collection of semen – microscopic examination – smear and count.

PREGNANCY TESTS- Male frog test – Gravindex test

HISTOPATHOLOGY – Microtechnique – tissue preparation – fixation – dehydration – embedding , sectioning, staining and mounting.

REFERENCE BOOK:

Samuel, K.M. (1992) Notes on Clinical Lab Techniques (IV Edition). Publishers: M.K.G. Iyyer & Sons, Madras.