

**DEPARTMENT OF ZOOLOGY
UNIVERSITY OF MADRAS**

M. Phil., ZOOLOGY CURRICULUM (2017 – 2018 ONWARDS)

Course Code	Title of the Course	Faculty	Core / Elective	Credits
Semester I				
LIF C521	Research Methodology	All Faculty Members	Core 1	5
LIF C522	Recent Advances in Zoology	All Faculty Members	Core 2	5
LIF E521	Invertebrate Immunology	Prof. M. Arumugam Prof. P. Mullainadhan Dr. R. Manikandan	Elective	5
LIF E523	Live feed in Aquaculture	Prof. N. Munuswamy Dr. C. Arulvasu Dr. R. Shanthi	Elective	5
LIF E524	General Entomology	Prof. S. Janarthanan Dr. M. Jayakumar	Elective	5
LIF E525	Animal Tissue Culture	Dr. C. Arulvasu	Elective	5
Semester II				
LIF C523	Dissertation <i>viva voce</i>	Supervisor	Core 3	21

Syllabus

LIF C521	Research Methodology	5 Credits
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Units

- I. Colorimetry and Spectrophotometry
- II. pH, Electrodes and pH meter
- III. Histology, Histochemistry, Bioinformatics & Electron Microscopy
- IV. Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence Microscopy, Wide field and Confocal Microscopy
- V. Centrifuges, Chromatography, Electrophoresis, ELISA and Blotting
- VI. Principles and Applications of Tracer Techniques in Biology, Animal Cell Culture Technique
- VII. Good Laboratory Practice

References:

1. Jain JL, Sunjay Jain, Nitin Jain. Fundamentals of Biochemistry
2. Pantin (1948) Microscopical techniques, Cambridge University Press, London
3. Pearse AG (1968) Histochemistry: Theoretical and applied, Vol I, 3rd edition, J&A Churchill Ltd, pp 758.
4. Lillie RD (1954) Histopathologic Technique and Practice Histochemistry, 2nd edition, Blackiston, New York.
5. Hoppert M (2003) Microscopic Techniques in biotechnology, Wile-VCH GmbH & Co., Weinheim, Germany, pp330.
6. Chandler DE & Roberson RW (2009) Bioimaging: Current concepts in light and electron microscopy, Jones & Bartlet Publishers, Sndburry, MA, USA, pp440
7. Broda E. Radioactive Isotopes in Biochemistry
8. Wolf G. Isotopes in Biology
9. Srivastava. Fundamentals of Nuclear Physics

Units**I. Environmental Biology**

Global climate change factors – Human impact on earth and biodiversity; Invasive species, exotic species – Threat to animal biodiversity; Ecology of transgenic crops and animal interaction. GIS and satellite imaging in biodiversity assessment

II. Developmental Biology, Stem Cell Biology and Immunology

Differentiation, Stem cell niche in planaria, *C. elegans* and *Drosophila*; Pluripotency of Stem cells: Embryonic and adult stem cells, organization, characteristics; Molecular mechanisms of self-renewal, pluri/multipotency and lineage; scientific approaches and challenges in stem cell therapy; Immune response to bacterial, viral and parasitic diseases and malignancy; Concept of vaccination and immunotherapy; Transplantation immunology-Basic concepts and recent advances

III. Biochemistry

Structural and functional organization of interphase nucleus - Genome organization; Co- and post translational modifications of proteins; DNA-Protein Interactions; Protein-protein interactive cloning and Yeast two hybrid system; Molecular mechanism of hormone action

IV. Molecular Biology & Biotechnology

Human genome project-landmarks on chromosomes generated by various mapping methods; Goals of human genome project and its implications on research and society; Model organisms and other genome projects; High throughput analysis of gene functions - DNA microarray; Protein array; Mass spectrometry

V. Bioinformatics, Biosafety and IPR

Sequence Databases - Kinds of Databases; Pairwise and Multiple sequence alignments, BLAST; Phylogenetic analysis: Evolutionary change in gene and genome sequences - Branches, nodes, internal nodes, rooted and unrooted trees; Introduction - Historical background - Primary containment for biohazards; Biosafety levels - Biosafety levels of specific microorganisms, infectious agents and infected animals. Biosafety (Government of India) guidelines related to genetically modified organisms (GMOs) & living modified organisms (LMOs). Institutional bio-safety committee. Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D; IPs of relevance to Biotechnology and few case studies

References:

1. Velma Grover (ed.), Climate Change Perspectives Five Years after Kyoto Science Publishers (USA), 2004
2. Velma I. Grover (ed.), Global Warming and Climate Change, Science Publishers (USA), 2008 (2 vols.)
3. Naidu, R., V.V.S.R. Gupta, Steve Rogers, Rai S. Kookana, Bioavailability, Toxicity and Risk Relationships in Ecosystems, Science Publishers (USA), 2003
4. Gilbert, S. P. Developmental Biology, 8th Edition, Sinauer Associates Inc., 2006.
5. Wolpert, Principles of Development, 2nd Edition, Oxford Universitypress, 2002.
6. Brown TA, Genomes, 3rd ed. Garland Science 2006
7. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne. Immunology, 6th Edition, Freeman, 2002.
8. Abbas et al., Cellular and Molecular Immunology, 5th Edition Saunders, 2007.
9. Benjamin et al., Immunology – A Short Course, 5th Edition, Wiley- Liss, 2003.
10. Kiessling, A. A., Human Embryonic Stem Cells, Jones and Barlett Publishers, Second Edition, 2006.
11. Lanza, R. Essentials of Stem Cell Biology, Academic Press, 2005.
12. Turksen, K., Adult Stem Cells, Humana Press, 2004.
13. Thomson, J. and others, Hand Book of Stem Cells: Embryonic, Adult and Fetal Stem Cells, Vol ! & 2, Academic Press, 2004.
14. Sandy B. Primrose, Genomics Application in Human Biology, First Edition, Blackwell Publications, 2004.
15. Memon, M.G.K., P.N. Tandon, Human Genome Research, Allied Press, 1999.
16. Jin Xiong, Essential Bioinformatics, 1st Edition, Cambridge University Press, 2006.
17. David Mount, Bioinformatics: Sequence and Genome Analysis 2nd Edition, Cold Spring Harbor Laboratory Press, 2004.
18. Baxeavanis and Oullette, Bioinformatics: A practical guide to the analysis of genes and proteins, 3rd Edition, John Wiley & Sons, 2004.
19. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
20. Brown TA, Genomes, 3rd Edition. Garland Science 2006 SA Moody, Principles of Developmental Genetics, Academic Press. 2007.
21. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.
22. Watson, J.D., N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner; Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc, 2007.
23. Alberts et al, Molecular Biology of The Cell, 2nd Edition, Garland 2007.
24. Lewin, Genes IX, 9th Edition, Jones & Bartlett, 2007.
25. Gilbert, Developmental Biology, Eighth Edition, Sinauer, 2006
26. Cooper, The Cell: A Molecular Approach, 4th Edition, Washington, D.C: ASM Press, 2007.
27. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
28. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007

Units**I. The cells and tissues of the invertebrate immune system:**

Structure and classification of blood cells-origin and formation of blood cells-fixed cells-phagocytic organs

II. Cellular defense system:

Hemolymph coagulation and blood cell clotting-phagocytosis-nodule formation-encapsulation-cytotoxicity-hemocyteactivation

III. Humoral defense system:

Lysins, agglutinins, lymphokine-like substances, antimicrobial factors, prophenoloxidase system

IV. Relative roles of cellular and humoral immunity *in vivo*:

Process of clearance-relative roles of cellular and humoral mechanisms-ultimate fate of sequestered foreign substances

V. Avoidance and Resistance to host defense reactions:

Active avoidance/resistance

VI. Mechanisms of non-self-recognition:

The discriminative ability of invertebrates-detection of recognition molecules-Nature of recognition molecules and receptors-Transplantation and cytotoxic reactions as tests for specificity and memory of invertebrate immunity

VII. Phylogeny of the immune system-comparison between invertebrate and vertebrate immune system**VIII. *In vitro* and *in vivo* techniques in invertebrate immunobiology:**

Cell separation, cell counts, phagocytosis assays, hemagglutination and hemolysis assays, immunoprecipitation, immuno diffusion, immuno electrophoresis, western blotting, immuno-fluorescence labeling and clearance of foreign materials.

References:

1. Soderhal and Kenneth (2010). Invertebrate immunology. 1-104.
2. Rinkevich, B., W. E. G. Muller. (1979). Invertebrate immunology.1-245.
3. Karl Maramorosch (1975). Invertebrate immunology.
4. Ratcliffe, N. A & Gagen, S. J. (1976). Cellular defense reactions of insect hemocytes *in vivo*: nodule formation and development in *Galleria mellonella* and *Pieris brassicae* larvae. Journal of Invertebrate Pathology 28-372.
5. Ratcliff, N. A., A. F. Rowley, S. W. Fitzgerald, C. P. Rhodes. (1985). Invertebrate immunology: Basic concepts and recent advances

Units**I. Ecological factors and Ecosystem**

Environmental biology – scope – major areas – elements of environment – ecological factors (light and temperature) – structure and function of an ecosystem

II. Aquatic Ecosystem

Biological aspects and chemical aspects of various aquatic ecosystems, Physicochemical parameters – pH, temperature, nutrients (phosphates, nitrates contents), light, BOD, COD

III. Plankton - fresh water ecosystem

Occurrence and distribution of planktons, Phytoplankton – cyanobacteria, algae, Zooplankton. Toxic and non – toxic algae (Cyanobacteria / blue green algae) - types of cyanobacteria, nature and diversity, isolation and identification

IV. Toxins of Cyanobacteria

Types of toxins – classification, toxicity – neurotoxic, hepatotoxic, cytotoxic. Its role – impact on aquatic biota, techniques of extraction, Ecological significance, future scope

V. Environmental pollution

Sources – effect on animals – control methods, water pollution – eutrophication and algal blooms (HABs), surface scums, effects on animals and control methods

References:

1. Odum, E.P., 1983. Basic Ecology, Holt- Saunders International Edition, Japan.
2. Agarwal, K.C. 1989. Environmental biology, Agro Botanical Pub, India
3. Trivedi, P.R and Gurdeepraj. 1992. Environmental Biology, Akashdeep Publishing House, New Delhi
4. Pandey, G.N and G.C. Carney, 1989. Environmental Engineering, Tata McGraw Hill Publishing Co. Ltd
5. Sharma P.D., 1995. Environmental Biology and Toxicology, Rastogi and Co., India.
6. Sharma P.D., 1995. Ecology and environmental, Rastogi and Co., Meerut, India.
7. Ingrid Chorus and Jamie Bartram, 1999. Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management, E & FN Spon, an imprint of Routledge, 11 New Fetter Lane, London.

Units**I. Phytoplankton**

Biology – importance of phytoplankton culture – Medium preparation – Types of culture media –Inoculum preparation by isolation – Mass culture – Mixed culture - Phases of growth – Types of phytoplankton – Methods for measuring phytoplankton

II. Zooplankton

Artemia – Cyclops – Rotifers – Mass culture of rotifer – reproductive biology of lower crustaceans – Importance of Zooplankton –Biology and life cycle of Zooplankton – Ecology and distribution – resting egg production

III. Larval Nutrition

Nutritional profile of feed - formulated - conventional- artificial, feed cost. Feeding methods - list of tested ingredients that can cost-effectively be used for diet/feed formulation - Major Nutrients, Nutrient requirements of finfish/shellfish

IV. Feed technology

Artificial feed formulation, preparation, evaluation, Feeding strategies Nutritional fish pathology- Culture of live feed

V. Bio-encapsulation

Enhancement products/ inert diets - - profitability of the selected aquaculture technologies using supplementary feeds - compositional variation of fish feeds across different fish farming practices - demand for, and availability of, local feed ingredients for feed-based aquaculture – bioencapsulation - methods of bioencapsulation – advantages – disadvantages

References:

1. Hagiwara, A., T.W. Snell, Lubzens and C.S. Tamaru. 1997. Live food in Aquaculture, Hydrobiologia.358, Kulwer Academic publishers. London, 328pp.
2. Hoff, H. and T.W. Snell. 1989 In: *Plankton culture Manual* 2nd Edition. Florida Aquafirm, Florida, 126pp.
3. Peters, R.H., and R.de Bernardi. 1987 “Daphnia” Mem. Ist. Itak. Idrobiol., 45: 411pp.
4. Sorgeloos, P., Lavens, P.H., Tackart,W. and D.Versichele, 1986. Manual for the culture and use of brine shrimp *Artemia* in aquaculture. ARC, State University of Ghent, Belgium, 319pp.
5. Fulks. W., and K.L.Main. 1991, Rotifer and Microalgae Culture systems. Proceeding of U.S.-Asia Workshop, Oceanic Institute, Hawaii, USA, 220pp.

Units

1. Systemic position of insects in Arthropoda – Inter and intra relationship with other arthropods
2. History and development of Systematic Entomology
3. Origin and evolution of insects – insects dominance
4. Principles of insect classification – Taxonomic characters and classification of various insect orders.
5. Recent advances in taxonomy – molecular approaches – biotype and ecotype characterization
6. Repositories of insect collection
7. Characters of insects, structure and function of body wall
8. Cuticular outgrowth – cuticular processes and appendages
9. Special intergumentary structures – internal cuticular appendages – Apodemes – apophysis – epidermal glands
10. Cuticle formation – Ecdysis – Apolysis – modification of cuticle – cuticular sensory organs
11. Insect colourations – Hemochromes – their importance
12. Body regions and their segmentation – sclerites
13. Structure of insect head – sutures – types of head in various insects – head appendages
14. Structures of eyes and antenna – types and modifications of antennae
15. Mandibulate mouth parts – Functional importance
16. Haustellate mouth parts – Functional importance
17. Structures of thorax – Segmentation, sclerites and modification
18. Origin and development of wings – venation – types and modifications – mechanism of flight – wing coupling
19. Structure of leg – articulation – modification with reference to mobility
20. Structure of abdomen – genital and perigenital abdominal appendages
21. Genitalia – modifications and sexual dimorphism
22. Embryogenesis – Blastokinesis and cleavage in insects
23. Ontogenesis – Development of organ systems
24. Structure of alimentary canal in a typical insect
25. Modification of alimentary system in different groups of insects
26. Salivary and other digestive secretions – Physiology of digestion
27. Significance of endosymbionts in nutrition – types of microorganisms – location, transmission
28. Circulatory system – Structure and functions
29. Mechanism of blood circulation – variations in circulatory system in aquatic, parasitic and blood sucking insects
30. Respiratory system – organization and functional importance
31. Physiology of respiration – Respiration in endoparasitic and aquatic insects
32. Excretory system and structures associated with excretion - functions
33. Physiology of excretion – variations in terrestrial, aquatic and high altitude insects
34. Nervous system and its organization
35. Muscular system – structure and arrangement – Functions of muscular system in terrestrial, aerial and aquatic insects
36. Structure and function of reproductive organs in male and female
37. Spermatogenesis and oogenesis – Kinds of reproduction in insects
38. Physiology of insect senses – mechano and photo receptors
39. Chemoreceptor – their implications
40. Physiology of moulting in insects – formation of new cuticle
41. Structure and location of endocrine glands – significance on growth and metamorphosis
42. Neurosecretions on growth and metamorphosis

Reference Books:

1. Blum, M.S. 1985. Fundamentals of Insect Physiology, Wiley, New York, 598p.
2. Chapman, R.F. 1998. The Insects Structure and Function. ELBS Edition, London. 770p.
3. Kerukut, G.A. and L.I. Gilbert. 1985. Advances in Insects Physiology. Comprehensive Insect Physiology, Biochemistry and Pharmacology. Vol I-XIII, Pergamon Press, Oxford.
4. Richards, O.N. and R.G. Davies. 1977. Imm's General Textbook of Entomology. X Edition, Cahpman and Hall, London.
5. Richards, O.W. and R.G. Davies. 1984. Imm's General Textbook of Entomology, Structure, Physiology and Development, X Edition, Chaman and Hall, London.
6. Rockstein, M.1974. The Physiology of Insect (Vol I to V), Academic Press New York. 640p.
7. Snodgrass, R.E. 1946. Principles of Insect Morphology. McGraw Hill, New York. 667p.
8. Wigglesworth, V.B. 1972. The Principles of Insect Physiology. Seventh Edition, Chapman andHall, London. 872p.

Units**I. Introduction of Tissue Culture**

Control of environment; characterization and homogeneity of sample, in vivo modeling, origin of cells and instability, types of tissue culture, cell adhesion, cell proliferation, differentiation, energy metabolism, initiation of cell culture

II. Aseptic technique and safety

Elements of aseptic environment, sterile handling, standard procedure, risk assessment, general safety, radiation biohazards, ethics

III. Culture vessels and media preparation

The substrate material, choice of culture vessel, feeder layers preparation, development of media, physicochemical properties, complete media, selection of media and serum, advantage and disadvantage of serum & serum free media, preparation of aseptic tissue culture media.

IV. Primary culture, passage and cell lines

Types of primary culture, isolation of tissue, primary culture, subculture and propagation, immortalization of cell lines, cell line designations, selection of cell line.

V. Characterization, differentiation, contamination and cryopreservation

Morphology, chromosome analysis, DNA content, RNA, protein & enzyme activity, differentiation, sources of contamination, types of microbial contamination, monitoring for contamination, eradication of contamination, cross contamination. Cryopreservation, cell banks, applications

References:

1. Animal biotechnology and animal tissue culture. Freshney R. I (2002)
2. Animal biotechnology and tissue culture by Ramdoss.
3. Invertebrate tissue culture methods. J. Mitsuhashi 2002.
4. Animal tissue culture techniques. Sudha gankal.

LIF C523	Dissertation and <i>viva voce</i>	21 Credits
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