BHARATHIAR UNIVERSITY: COIMBATORE - 641 046
Department of Zoology
M.Sc. Animal Biotechnology (CBCS Pattern)

07ZOOBC01 Core: I - Biochemistry and Biophysics

The objective of the course is to provide a concise and unifying approach to physical chemistry, biochemistry and biophysics. It also provides the structure, function and interactions of bio molecules, how biological processes occur at the molecular level and to understand these processes with strong backgrounds in chemistry, biology, and physics.

Unit – I

Structure of atom, molecules, ionic bonds, covalent bonds, hydrogen bond, Vander Vaal's forces, Intermolecular forces, electrolytes, pH and buffer capacity in the cell environment.

Unit – II

Amino acids: Structure, classification, properties, isoelectric point and zwitter ions. **Proteins**: Classification based on chemical structure, function and solubility; properties, primary, secondary and tertiary, Helix, principles of isolation and purification, Synthesis of polypeptides.
Enzymes: Classification, Kinetics, Co-factors, Enzyme inhibition, Enzyme substrate compounds.

Unit – III

Nucleic acids: DNA structure and properties, DNA as a genetic material, DNA synthesis – mechanism of replication (semi conservative and reverse transcription), nucleotides. **Different types of RNA**: mRNA and rRNA.
Lipids: Classification, properties – saturated and unsaturated fatty acids – plant waxes, steroids, cholesterol and lecithin.
Carbohydrates: Classification, structure and properties of functional groups.

Unit – IV

Bioenergetics: Laws of thermodynamics, concept of free energy, oxidation reduction (redox) reactions. Energy coupling reactions, energy rich compounds, ATP cycle, standard free energy, membrane potentials, and negative entropy changes in living systems, enzyme catalysis.

Unit – V

Analytical techniques: Principle and application of Chromatography (Paper, thin-layer, column and GLC), Centrifugation (RPM and G, Ultra centrifugation), Spectroscopic techniques (UV, visible spectroscopy, X-ray crystallography, NMR, IR, fluorescence & atomic absorption), Isotopes and their importance (GM counters & Scintillation counting).

Practical:

1.pH: Operation of pH meter to measure the pH of Haemolymph and body fluids.

2. Preparation of buffers: Phosphate buffer and citrate buffer.
3. Chromatographic techniques:
   a. Paper chromatographic techniques to separate amino acids.
   b. Thin layer chromatographic technique to separate lipids.
   c. Column chromatographic techniques to separate urinary pigments.
   d. HPLC – Demonstration.
4. Colorimetric/Spectrophotometric estimation of the following biomolecules.
   a. Total free amino acids (Ninhydrin reagent method)
   b. Protein (Biuret and Lowry *et al*., 1951 method)
   c. Total soluble carbohydrates (Anthrone reagent method)
   d. Total serum triglycerides
5. Protein extraction from animal tissues and separation
6. Electrophoresis (PAGE) – Demonstration.

Reference Books:

1. Biochemistry, by D.Voet and J.G. Voet, 2004. *John Wiley & Sons*, USA

2. Biochemistry, by R.H. Garrett and C.M. Grisham, (3rd Edition) 2007. *Saunders College Publishers.*

3. Principles of Biochemistry by A.L. Lehninger. 1984. *CBS Publishers and Distributors*, New Delhi.

4. Physical Biochemistry by D. Friefelder, (2nd edition) 1982. *W.H. Freeman & Company*.

5. The Physical Basis of Biochemistry, by Peter R. Bergethon, *Springer-Verlag*, 1998.

6. Biophysics-An Introduction, by C. Sybesma, 1989, *Kluwer Academic Publisher.*

7. Cellular Biophysics I and II, by Thomas F. Weiss, 1995, *MIT Press.*

8. Basic Biophysics for Biology, by E. K. Yeargers, 1992, *CRC press.*

9. Principles of Biochemistry by Albert L. Lehninger (4th edition) 2004. *CBS Publishers & Distributors,* New Delhi.

10. Biochemistry by Lubert stryer (4th edition) 2000. *Freeman International Edition.*

11. Biochemistry by Keshav Trehan, 1990. *Wiley Eastern Publications.*

12. Fundamentals of Biochemistry by J.L.Jain *et. al.* (4th edition) 1994. *S.Chand and Company.*

13. Textbook of Organic Chemistry (A Modern Approach) Ist edition) 2002. *McGraw Hill.*

14. The Biochemistry of Nucleic acid – Tenth Edition-Roger L.P.Adams, John T. Knowler and David P.Leader, 1992. *Chapman and Hall Publications.*

15. Essentials of Biophysics by Narayanan, P (2000), New Age Int. Pub. New Delhi.

16. A Text Book of Biophysics by Roy R.N. (1999), *New Central Book Agency.*

17. Biochemistry. S. C. Rastogi, 2nd edition. 2003. *Tata McGraw Hill Publishing Company Ltd.,* N. Delhi.

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07ZOOBC02 Core: II – Molecular Cell Biology

Unit – I

Cell organization, Sub-cellular structures of prokaryotic and eukaryotic cells. Synthesis and sorting of plasma membrane. Chromatin structure and nucleosome concept, Organization and function of genetic material, Gene paradox, Repetitive DNA, Satellite DNA, Overlapping genes, Split genes, Pseudogenes. Chromatin, nuclear and mitochondrial genome organization, Structures of DNA and RNA, Stereochemistry of bases and secondary structures. Genetic structure analyses of eukaryotic genomes.

Unit-II

Evidence of basic targets, Enzymes, Mechanisms of DNA replication in eukaryotes. t-RNA, m-RNA, r-RNA and hn-RNA structures and folding, Mechanisms in eukaryotes RNA splicing. Ribosomes, Genetic code, General control of DNA, RNA and protein synthesis, Post-translational modifications, Protein targeting.

Unit-III

Gene regulation in eukaryotes, Gene clustering**,** Mechanism of positive and negative control of gene expression. Translational and transcriptional control of regulatory mechanism of gene expression, Environmental effects on gene regulation.

Unit-IV

Signaling at the cell surface, Types of signaling pathways that control gene activity, Integration of signals and gene controls. Moving proteins into membranes and organelles, Vascular traffic, secretion and endocytosis, Metabolism and movement of lipids.

Unit-V

Regulation of the Eukaryotic cell cycle, Cell birth, Lineage and cell death. Cancer/ oncogenes, Cell markers, Cellular morphology, Primary and established cell lines, Kinetics of cell growth, Genetics of cultured cells. Stem cell culture, embryonic stem cells and their applications. Cell culture based vaccines. Somatic cell genetics.

Practical:

1. Principles of microscopy and optics*.
2. Cell size determination
3. Microtomy and photography*.
4. Mounting of polytene chromosomes.
5. Preparation of mitosis in Onion root tip.
6. Cell division in Grasshopper testis*.
7. Preparation of animal tissue culture medium using membrane filtration*.
8. Preparation of single cell suspension from spleen/ thymus of mice*.
9. Cell counting and cell viability using trypan blue dye exclusion assay
10. SDS - PAGE of protein from animals*.

* Practical by demonstration only.

List of Suggested Reference Books:

1. Cell and Molecular Biology, (8th edn)., De Robertis, E.D.P. and De Robertis, E. M.F. 1995, *B.I.Waverly Pvt. Ltd.*, New Delhi.

2. Essential Cell Biology, B. Albert et al., 1998. *Garland Publishing*, Inc. New York.

3. Principles of Cell and Molecular Biology. (2nd edn.)., Kleinsmith, L. J. & Kish, V.M. 1995.

4. Molecular Biology of the Cell. (3rd edn.)., Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. (eds.) 1994. *Garland Publishing*, Inc., New York.

5. Molecular Cell Biology (5^{th} Edn.), H. Lodish et al., 2004. *W.H. Freeman and Company*, New York.

6. Molecular Biology of the gene, J.D. Watson. 1977. (3^{rd} Edn.) *W.A. Benjamin Inc.* London.

7. An Introduction to Genetic Analysis (7^{th} Edn.)., A.J.F. Griffths et al., 2000. *W.H. Freeman & Co.*

8. Principles of Biochemistry, A.L. Lehninger. 1984. *CBS Publishers*, New Delhi.

9. Principles of Genetics (6th Edn.)., R.H. Tamarin, 1996. *McGraw-Hill*, New Delhi.

10. Genes VIII, Lewin, B., 1987. ***Oxford University Press***, Oxford, New York, Tokyo.

11. Molecular Cell Biology, Darvell, J. *et. al.*, 1998 – *Garland Publishing iwc*, New York.

12. Culture of Animal Cells, (4th Edition), R. Lan Freshney, 2000, *Wiley-Liss*.

07ZOOBC03 Core: III - Microbiology

Unit – I

Introduction to Microbiology – Scope of microbiology – History of microbiology – Classification of bacteria, fungi, yeast and virus. Structure and functions of bacteria and virus. Reproduction in bacteria – Transformation, conjugation, transduction. Mapping in bacterial genomes.

Unit – II

Cultivation and control of microorganism – Methods of collection of sample – methods of estimation of microorganism in soil, water and air – Isolation and identification of bacteria. Methods of sterilization and disinfection – Microbial control – Physical and chemical – techniques of pure culture – Method of cultivation of bacteria – Phases of growth – Influence of environment on bacteria – Nutritional requirements of heterotrophic bacteria.

Unit – III

Microbial Ecology: Distribution of microorganism in soil, water and air – Environmental factors influencing the distribution of microorganism – Role of microorganisms in the cycling of nutrients – Carbon, nitrogen, phosphorous and sulphur cycle – Bacterial photosynthesis – Microbial interactions – synergism, symbiosis, commensalism and parasitism.

Unit – IV

Food Microbiology: Sources, types incidence of microorganism in vegetables, meats, poultry, seafood, milk and diary products – spoilage of food, fruits, vegetables, cereals, meat, poultry egg, seafood, caned products – Factors influencing spoilage – Methods of detection of spoilage, physical, chemical, bioassay – principles of food preservation and prevention of food spoilage – Food poisoning organism.

Unit – V

Microbial Technology: Genetic engineering of food and additives – Single Cell Protein (SCP) production – Production of organic acids (acetic acid), ethanol – Antibiotics – Microbial toxins – bacterial – Vitamins – methanogenesis – hydrogen oxidizing bacteria – Fermentation products – Degradation of protein, cellulose, pectin and chitin – Oil degrading bacteria.

Practical:

1. Preparation and requirements of microbiology laboratory.
2. Microscopy the operational uses of light microscope, preparation, use and care.
3. Preparation of Non-selective selective culture media.
4. Estimation of bacterial from soil and water using plate count or serial dilution.
5. Isolation of bacteria.
6. Observation of morphological characters of bacterial and protozoan temporary wet mount technique.
7. Staining methods: Preparation of smears for staining, simple staining, negative staining, gram staining.
8. Control of microorganism – physical methods (moist and dry heat) – mechanical removal methods (sterilization and filtration).

References:

1. Burden, K.L. and R.P. Williams (6th Ed.) 1968. Microbiology. The *Macmillan Co*., London P. 818.
2. Dawes, E.A. (Ed.) 1986. Energy conservation in bacterial photosynthesis. *In:* Microbial energetics. *Blackie & Son Ltd*., Glasgon, 133-144pp.
3. Doelle, H.W. (Ed.) 1969. Fermentation acetic acid bacteria and lactic acid bacteria. In: Bacterial metabolism. *Academic Press*. New York, London. 256 – 351 pp.
4. Hay, J.M. (Ed.) 1986. Modern Food Microbiology. *CBS publishers*, Delhi. 622 pp.
5. Reed, G. (4th Ed.) 1983. Prescott & Dunn's Industrial Microbiology. AVI Publishing Co., Inc. Connecticut, 883. pp.
6. Roberts, T.A. and F.A. Skinner (Eds.) 1983. Food Microbiology: Advances and Prospects, *Academic Press*, Inc. London, 393 pp.
7. Selle, A.J. (Ed.) 1967. Fundamental Principles of Bacteriology. *Tata McGra – Hill Publishing Company Ltd*., New Delhi, 822 pp.
8. Shelegel, K.G. (6th Ed.) 1986. General Microbiology. *Cambridge University Press*, Cambridge, 587 P.
9. Steinkraus, K.H. (Ed.) 1983. Hand Book of Indigenous Fermented Food. Marcel Dekker Inc. New York, 671 P.
10. Wistreich, G.A. and M.D. Lechtman, 1976. Microbiology, 3rd edition. *Macmillan Publishing Co*., London, 786 P.

07ZOOGE11 Elective: I - An Introduction to Human Cytogenetics

Unit-I

History of Human Chromosome Research - Denver Conference (1940) - Chicago Conference (1966) - Paris Conference (1971) - Nomenclature of Human Chromosome.

Unit-II

Identification of Human diploid chromosome - peripheral blood cultures - banding techniques - G-band; Q-band; C-band; R-band - Identification of 23 pairs of Human chromosomes by band position.

Unit-III

Chromosomal syndromes: Autosomal syndromes - Sex chromosomal syndromes - Structural chromosomal syndromes.

Unit-IV

a) **Prenatal diagnosis:** Chorionic villi sampling - Foetoscopy, Ultrascopy - Amniocentesis**.** b) **Postnatal diagnosis:** Peripheral blood leucocyte culture - Sister Chromatid Exchange - Fragile site - Mitotic index. c) **Genetic Counseling.**

Unit-V

Hereditary forms of Cancer - Oncogenes and Cancer - Chromosomes and Cancer - Cancer and the environment.

Reference Books:

1. Study guide for Cumming's human heredity principles and issues by Shontz, Nancy N. ; Cummings, Michael R. (3rd Edition), 2000. *Pacific Grove, CA : Brooks/Cole Thomson Learning*

2. Genetics Medicine (1994) - by Karl. H. Muench. *Elsevier pb*. London

3. Human Genetics by Elof Axel Carlson, 1984. *Tata McGraw-Hill pb*. New Delhi.

07ZOOGS14 Supportive: I - Entomo-biotechnology

Unit – I

Critical examination and discussion of advances in the areas of insect biotechnology, including genetic engineering and genomics.

Unit – II

An in-depth analysis and role of insect as vectors of pathogens, or as parasites causing disease in humans (principally) and animals – mosquito transmitted diseases - The interaction of host and parasite and the dynamic nature of the epidemiological system

Unit – III

Biology of insect, viruses, bacteria, fungi and entomopathogenic nematodes and their use in insect pest/vector control.

Unit – IV

Genetic improvement of natural enemies, Insect cell line, Botanical insecticides and Neuro-endocrinology - bioactive peptides.

Unit – V

Transgenic plants- role in insect control, Genetic control - Sterile (transgenic) Insect Technology (SIT).

References:

1. Yoshinori N & Kaya H, (1993). Insect Pathology (*Academic Press*) Pp. 1 - 666
2. Ananthakrishnan, T.N (2007). Dimensions of Molecular Entomology (*University Press*). Pp. 1- 162
3. Blissard, G.W. and Rohrmann, G.F.1990. Baculovirus Diversity and Molecular Biology. *Ann. Rev. Entomol.* 35: 127-155.
4. Burges, H.D. 1981. Microbial Control of Pests and Plant Diseases. Pp.949. *Academic press.* New York.
5. Carter, J.B.1984. Viruses as pest control agents. *Biotechnol. and Genetic Engineering Reviews*, 1: 375 – 419.
6. Cho, T., Shular, M.L. and Granados, R.R. 1989. Current Developments in New Media and cell Culture System for the Large Scale Production of Insect Cells. *Advances in Cell Culture*. 7: 261-277.
7. Cockburn, A.F., Howels, A.J. and Whitten, M.J. 1984. Recombinant DNA Technology and Genetic Control of Pest Insects. *Biotechnology and Genetic Engineering Reviews*, 2: 69-99.
8. Day, P.R. 1986. Biotechnology and Crop Improvement and Protection. *BCRC Monograph No. 34*, Pp. 24.
9. Hedin, P.A., Men, P.A. and Hollingsworth, R.M. (eds.) 1988. Biotechnology for Crop Protection, 471 Pp. *American Chemical Society*, Washington, DC.
10. Herzog, D.C. and Hoy, M.A. 1985. Biological Control in Agrl. IPM system, Pp. 5889. *Academic Press, New York.*
11. Hoy, M.A. 1985. Recent Advances in Genetics and Genetic Improvement of Phytoseiidae. *Ann. Rev. Entomol.*, 30: 343-370.
12. Kirschbaum, J.B. 1985. Potential Implication of Genetic Engineering and other Biotechnologies to Insect Control. *Ann. Rev. Entomol*. 30: 51-70.
13. Maeda, S. 1989. Expression of Foreign Genes in Insects using Baculovirus Vectors. *Ann. Rev. Entomol.* 34.
14. Meeusen. L. and Warren, G. 1989. Insect Control with Genetically Engineered Crops. *Ann. Rev. Entomol.* 34: 373-381.
15. Miller, L.K. Lingg, A.J. and Bulla, L.A. Jr. 1983. Bacterial, Viral and Fungal Insecticides. *Sciences*, 219: 715-721.

07ZOOBC04 Core: IV - Animal Physiology

This study helps in understanding how the body functions adapts with respect to its external and internal environment, related to nervous integration, sensation, metabolism and reproduction.

Unit –I

Locomotion and Nutrition: Types of muscles – Ultra-structure – Mechanism of contraction of skeletal muscles – Nervous control of muscles. Nutritive requirements – General. Organization of alimentary canal – Role of salivary glands, liver, pancreas and intestinal glands in digestion.

Unit – II

Digestion and Excretion: Absorption of digested food-hormonal control of digestion - Introduction to intermediate metabolism –Structure of mammalian kidney – Urine formation – acid base regulatory mechanisms; endocrine regulation of water and mineral balance.

Unit – III

Circulation and Respiration: Composition of blood, blood groups in man, coagulation – Structure of mammalian heart, open and closed system of circulation, blood pressure and its regulation.

Unit – IV

Nervous integration and sense Organs: Organization of Nervous system – nerve conduction – synapse – neurotransmitters – nervous co-ordination – coding information to sensory organs – Chemoreceptor – Mechanoreceptor – Thermoreceptor – Photoreceptor.

Unit – V

Reproduction: Functional morphology of reproductive organs, gametogenesis, parthenogenesis, reproductive cycles – Pheromones.

PRACTICAL:

1. Influence of pH on salivary amylase activity.
2. Biochemical analysis (Qualitative) – carbohydrate, proteins and fats.
3. Measurement of Blood Pressure (Indirect method).

4. Estimation of serum bilirubin (direct and indirect method).
5. Oral Glucose Tolerance test.
6. **Models:** Stomach, Eye, Ear, Liver, Brain, Heart and Kidney.

REFERENCE

1. Ganong, H, Review of Medial Physiology, 1989. 14th edition, *Appleton &Lange publisher*, New York
2. Physiology: A regulatory system approach, Fleur, and Strand, (1978). *Macmillan Publishing Company*, *New York; Collier Macmillan Publishers*, London.
3. Shier, D., Butler, J. and Lewis, R., Hole's Human Anatomy and Physiology, (10th edition) 2003. *WCB/McGraw Hill*, Boston. 2003.
4. Animal Physiology, EcKert, R (5th edition), 2002. W.H.Freeman.
5. Williams S. Hoar (1991) General and Comparative Physiology 3rd edition. *Prentice Hall of India*- New Delhi.
6. Neilson, K.S. Animal Physiology, 1997. *Cambridge University Press*, Pergamon Press, Oxford.
7. Prosser, C.L. and Brown-Jr. F.A.: Comparative Animal Physiology, 1961. *W.B. Saunders*, Philadelphia.
8. Barrington, E.J.W. (1975): An Introduction to General & Comparative Endocrinology 2nd ed. *Clarendon press*, Oxford.
9. Medical Physiology (4th Edition) Guyton Arthur C., Hall John E., *W. B. Saunders.*

07ZOOBC05 Core: V - Endocrinology

The study of hormones and their influence on body metabolisms plays important role in every of medicine. Metabolic processes are involved in formation, maturation and function of body tissues and in pathology of many diseases.

Unit - I

Nature, function and classification of hormones – Feedback control of hormone secretion – Organisation and functions of neuroendocrine systems- Hypothalamo– hypophyseal interactions- Bioactive peptides.

Unit - II

Thyroid gland – Structure, function and biosynthesis of thyroid hormone - Parathyroid – Structure and PTH – Calcitonin – Role of hormones in calcium and phosphate metabolism.

Unit - III

Gastrointestinal hormones - their secretion, control and function – Insulin and glucagons – Adrenal hormones and Stress management – Catecholamines as emergency hormones- their role in the regulation of carbohydrate, protein and lipid metabolisms.

Unit - IV

Adrenal gland – Structure and role played its hormones in glucose metabolism – Aldosterone and the rennin- angiotensin system – Pineal gland- structure and its influence on reproduction and pigmentation – Thymus gland – Structure and thymic hormones – their functions in brief.

Unit - V

Steroid hormone biosynthesis in the ovary and testis – Hormonal regulation of ovarian cycles in mammals – Folliculogenesis, ovulation, corpus luteum formation and regression – Hormones in pregnancy and lactation. Gonadal steroid action on spermatogenesis and spermiogenesis – Role of hormones in sex accessory gland growth and functions.

Practical:

1. **Spotters**: Transverse section of Pituitary, Thyroid, Pancreas, Adrenal, Thymus, Prostrate gland, Vas deferens, Seminal vesicles, Ovary and Testis.

2. Estimation of urea and uric acid.

3. **Hormone assays**: Urinary 17 Ketosteroids. Blood glucose – Oral Glucose Tolerance Test.

References:

1. Williams, R H. 1981. Text book of Endocrinology, Ed. 6th W. B. Saunders Company, Philadelphia, London.

2. De Groot. 1979. Endocrinology, Vol. 1-3, Grune and Stratton, New York.

3. Astwood, E. B. 1968. Clinical Endocrinology, Grune and Stratton, New York.

4. Bondy P.K. and Rosenberg L.E. 1974. Duncan's disease of Metabolism – Genetics, Metabolism and Endocrinology. W. B. Saunders Co., Philadelphia, London.

07ZOOBC06 Core: VI - Experimental Embryology

Experimental embryology is an experimental science, which provides understanding of the processes of early embryonic development, to analyze the mechanisms of development by experimental manipulation of developing embryos and to review current methodologies for conducting research in the field of embryology. It also emphasizes on current experimental approaches utilized in research of normal and abnormal development of the mammalian embryo.

Unit –I

Introduction and scope – Gametogenesis: **Spermatogenesis**: Origin of Primordial germ cells – Differentiation of spermatozoa – structure and motility of sperm – egg activation – acrosomal reaction. **Oogenesis**: Development of Oocytes – types of eggs – Biochemical changes during Oogenesis.

Unit – II

Fertilization process: Activation of sperm and egg– interaction of sperm and egg – Sequence of events in sperm entry – Egg surface changes. **Post–fertilization changes:** changes in the organisation of the egg cytoplasm caused by fertilization.

Unit – III

Cleavage: Cell division and chemical changes during cleavage – pattern of cleavage – Distribution of cytoplasmic substances in the egg – role of egg cortex - morphogenetic gradient in the egg cytoplasm. **Gastrulation**: Principles and patterns of gastrulation – Fate map.

Unit – IV

Organizer: Spemann's primary organizer – analysis of nature and mechanism of induction; **Organogenesis**: Cellular interaction – differentiation and organogeny. **Embryonic adaptation**: Extra embryonic membrane structure in Reptiles and Birds. **Placenta**: Classification, structure and physiology.

Unit – V

Post embryonic developmental events: Metamorphosis (Insects and amphibians); Regeneration in various animals. Asexual reproduction: Occurrence and forms of asexual reproduction. Cryo-preservation of gametes and embryos – in-vitro fertilization and embryo transfer – sperm banking – Fertility control and regulation.

Practical:

1. **Spotters** : a) Oogenesis, Spermatogenesis

   ***b*)** Frog: Four cell stage
   Late cleavage
   Blastula
   Gastrula
   Gastrula yolk plug stage
   Neural fold
   Neural plate
   Neural tube
   Tadpole – 4mm stage
   7mm stage
   11mm stage

   c) Chick**:** 13 Hours stage
   16 Hours stage
   24 Hours stage
   33 Hours stage
   36 Hours stage
   48 Hours stage
   56 Hours stage
   72 Hours stage
   96 Hours stage

2. Sperm analysis for sperm morphology and motility and density.
3. Mounting of the blastoderm of chick
4. Induced metamorphosis of tadpoles and insects – using thyroxin.
5. Serial sections of chick embryo.

Recommended Readings:

1. Berril, N.T. : Developmental Biology, 1971. *McGraw Hill* Co., New York.

2. Berril, N.T., Karp, G. : Development, 1988. *Tata McGraw Hill* Co., New York

3. Patten's Foundation of Embryology, Bruce M Carlson. *Tata McGraw Hill* Co., New York

4. Waddington, G.H. : Fundamentals of Embryology, 1949. *George Allen and Unwin.*

5. Huxley De Beer: The Elements of Experimental Embryology, 1934. *Cambridge Univ. Press, Cambridge, Hafher Publishing Co.*

6. Rover, C.P. : An Outline of Developmental Physiology (1968). *Pergamon Press.*

7. Austin, C.R. : Fertilization (1966). *Prentice Hall.*

8. Austin, C.R. : Ultrastructure of Fertilization (1967). *Holt Reinhart and Winston.*

9. Hay, E.D. : Regeneration (1970). *Holt Reinhart and Winston.*

10. Nelson, G.F. : The Comparative Embryology of Vertebrates (1979). *Blackinston and Co.*

11. Balinsky, B.I. : An Introduction to Embryology (1960). *W. B. Saunders Co., Philadelphia*

12. Bodemer, C. : Modern Embryology (1968). *Hold, Rinehart and Winstorn, Inc, New York.*

13. Trampush, HAL and Kiotsis, V. : Regeneration and Related Problems (1972). *North Holland Publishing Co.,*

14. Vorontsova, M.A. and Liosner, L.D. : Asexual Propagation and Regeneration (1960). *Pergaman Press.*

15. Monray, A. Chemistry and Physiology of Fertilization (1978). *Halt Reinhart and Winston.*

BHARATHIAR UNIVERSITY: COIMBATORE - 641 046
Department of Zoology
M.Sc. Animal Biotechnology (CBCS Pattern)

07ZOOGE12 Elective: II - Applied Entomology

Unit- I

History and Scope of Entomology - Classification of Insects up to orders - Productive insects – Honeybee, Lac insect, and Silkworm (*Bombyx mori*) Biology and Economic Importance.

Unit – II

Chemical control of insect pests: Classification of insecticides- mode of action – Major Crop pests.

Unit – III

Biotechnology of Pest control: Mass rearing predators and parasites – Genetic manipulation in insect pest control – Biopesticides, Bacterial pesticides - Bacillus thuringiensis, viral pesticide – NPV. Nematodes as Biopesticides.

Unit – IV

Integrated pest management: Principles of IPM programme, Ecological basis of pesticide application.

Unit – V

Insect of Public Health and Household pests. Mosquito vectors of Malaria, Filaria, Dengue and Japanese Encephalitis, Housefly, Head louse and Bed bug, Cockroach – Stored product pests – Ticks and Mites on animals.

References:

1) **Chapman, R. F., (1982)** The Insects Structure and Function, *English Language Book Society / Hodder & Stoughton*, Hong Kong , P 919

2) **Vasantharaj David, B., (2001**) Elements of Economic Entomology, *Popular Book Depot*, Chennai, P. 590.

3) **Wigglesworth, V.B., (1972)** The Principles of Insect Physiology, *University Press*, Cambridge, P.827.

4) **Peter W. Price (1984**) Insect Ecology. *Ed. by John Wiley & Sons, Inc*. United States of America P.607.

07ZOOGS15 Supportive: II - Crustacean Aquaculture and Technology

Learning objectives:

- To develop skills and acquire knowledge to be able to understand different aquaculture systems consisting of common and high demanded crustacean species and their culturing techniques, the relationship between successful aquaculture and environmental stewardship.
- To provide an opportunity for underpinning of sustainability (the environment, culture ability and economic viability of culture operations).
- Specifically, this paper will help to learn how aquaculture supports production of representative species on socio-economic perspectives, conservation, and for various other purposes.
- To learn about the interrelationship between culture operations and the natural environment, specifics on culture of selected species.

Unit-I

Importance of fisheries and aquaculture - Current issues regarding sustainability of aquaculture - Ecological and social aspects of aquaculture development - Nutritional value of crustaceans as food.

Unit-II

Taxonomy of crustaceans – Live feeds (Algae and algal culture, Micro-invertebrate culture (Rotifers, *Artemia*, Copepod etc.) - Artificial feeds - Aquaculture and Techniques (semi-intensive, intensive, hyper-intensive).

Unit-III

Brooding (selective breeding, "specific pathogen free") - The hatchery technology and prawn seed production.

Unit-IV

Culture and Grow-out technology for commercially important crustaceans: freshwater prawns, marine shrimps, freshwater crayfish, lobsters, and crabs.

Unit-V

Nutritional requirement and feeding strategies - Water quality management and maintenance of sanitation - Pathology and quarantine - Post-harvest handling and marketing.

List of Suggested Reference Books:

1. Palaemonid Prawns, K.V. Jayachanadran, 2001, *Science Publishers, Inc*., USA, UK.

2. A Text Book of Fish, Fisheries and Technology, K.P. Biswas. M.Sc., Ph.D. F.Sc. (Bombay) E.F. (West Germany), 1992 published by *Smt. Manju Biswas*, Neral Main Road Goria, Calcutta.

3. Fish & Fisheries of India, V.G. Jhingran, Director, Central Inland Fisheries Research - institute, Barrackpore (W.B.), 1982 published by *Hindustan Publishing Corporation* (India) 6 UB, Jawahar Nagar, Delhi.

4. Biotechnology and Genetics in Fisheries and Aquaculture by A.R. Beaumont and K. Hoare, Blackwell Science (2003).

5. Production of Meal, Oil and Protein-Vitamin Preparation in Fishing Industries, Kuli Kev, *Oxford & IBH*. (2000)

6. Prawn Culture by C.V. Kurian and M.J. Sebastian, 1976.

7. Limnological Methods by Adoni *et. al.,* 1985. *McGraw Hill Book Co.,. Inc, New York.*

8. Freshwater Aquaculture in India – Srivastava *et. al.*, 1993. *Oxford and IBH Publishing, New Delhi.*

9. A Manual of Freshwater Aquaculture - Santhanam *et. al.,* 1996.

10. Marine Fishes in India - D. V. Bal & K. Birabhadra Rao, 1968. Tata McGraw Hill Publishing Company Ltd. New Delhi.

11. The Marine and Freshwater Plankton - Charles, C. David, 2001. *Michigan State University Press.*

BHARATHIAR UNIVERSITY: COIMBATORE - 641 046
Department of Zoology
M.Sc. Animal Biotechnology (CBCS Pattern)

07ZOOBC07 **Core: VII - Molecular Genetics**

Unit – I

Fundamentals of genes and chromosomes – DNA structure and function – Chromosome structure and function – Gene in pedigree.

Unit – II

Fundamentals of DNA cloning and molecular hybridization: Cell based BNA cloning – DNA hybridization assays – PCR based DNA cloning and DNA analyses.

Unit – III

Features of the human Genome: Organization and expression of the human genome – Human multigene families and repetitive DNA – Footprints of evolution – Mutation and instability of human DNA.

Unit – IV

Mapping of the human genome: Physical mapping - Genetic mapping – The human genome project.

Unit – V

Dissecting and manipulating genes: Studying human gene structure and function and creating animal models of disease – Gene theory and other molecular genetic based therapeutic approaches.

Practical:

1. Problems related to Mendilian inheritance
2. Pedigree Analysis
3. Buccal smear test.
4. Peripheral blood leucocyte culture for chromosomal.

5. Banding techniques G, C, and Q (Demonstration)
6. Micronucleus test
7. Sister Chromatid exchange.
8. Identification of drumstick chromosomes in human blood.
9. Estimation of DNA in a given sample
10. Estimation of RNA in a given sample
11. PCR technique - DNA analysis - Demonstration.

Reference Books:

1. Tom Strachan and Andrew. P. Read – Human Molecular Genetics – '*Bios' Scientific Pub.* UK. (1996).
2. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J. and Weinter, A.M. – Molecular Biology of Genes (4th edition) 1987. *The Benjamin/Cummings publishing Company inc*., Joky.
3. Lewin, B. Genes VI (1997). *Oxford University Press*, Oxford, New York, Tokyo.
4. Darvell, J. ***et. al.,*** Molecular Cell Biology (7th edition) 2002. *Garland Publishing iwc*., New York.
5. R.A. Meyers. Molecular Biology and Biotechnology, 1995. *VCH Publishers, New York.*

07ZOOBC08 Core: VIII- Immunology and Immunotechnology

Unit - I

Outlines of Immunology: Basics of Immunity – Types of Immunity - Structure and Types of Immune system - Lymphoid organs.

Unit - II

Antigens, Antibiotics and Complements: Antigens – Antibody reaction – Immunoglobulin-structure of Immunoglobulin - Structure, function and biological properties of Immunoglobulin classes - Salient features and Biosynthesis of Complement**.**

Unit - III

Immunopathology: Hypersensitivity - Types of hypersensitivity - Major Histocompatibility Complex (MHC) and its significance.

Unit - IV

Immunological disorders: Immunodeficiency diseases – Transplantation immunology - Types of graft - Mechanism of allograft rejection.

Unit - V: Immunotechnology

Active immunization - Passive immunization – Principles and Methods of vaccine preparation – Immunological techniques - RIA, ELISA, Immunocytochemistry and Immunoblotting.

PRACTICAL:

1. Blood group determination by slide agglutination; Rh factor determination by agglutination reaction.
2. Total count of blood cells. And differential counts.
3. Total hemoglobin determination.
4. Separation of lymphocytes.

5. Ag-Ab reaction (Model) – Raising antibodies of Ag injection (Model) – Booster injections- Collection of antiserum – Immunodiffusion- ring test.
6. Elisa Technique (Demonstration).
7. Immunoelectrophoresis- Western Blotting (Demonstration).
8. Widal test for typhoid fever.
9. **Chart** – Immunoglobulin (G, A, M, D and E) and AIDS.

REFERENCE:

1. Immunology, S.K. Gupta (1999). *Narosa Publishing House*, New Delhi.
2. Essential Immunology (8th Edition), Ivan Roitt, 1994. *Blackwell Scientific Publication*. Immunology W.H. Freemen and Company.
3. Abdul .K. Abbas. Andrew .K. Litchmen and Jordan, 1997, Cellular and Molecular Immunology, 3rd Edn. *W.B. Saunder Company*.
4. Weir, D.M. and Stewart, J., 1997, Immunology, 8th Edn., *Churchill Livingston*, New York.
5. Eryl Liddell and Ian Weeks., 1995, Antibody Technology, *BIOS Scientific Publishers*.
6. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts and James D. Watson.(Eds.), 1994, Molecular Biology of the cell, 3rd Edn., *Garland Publishing Inc*., New York.
7. Immunology, George Pinchuk (2004). *Tata McGraw-Hill Publishing Company Limited*, New Delhi.

07ZOOBC09 Core: IX- Genetic Engineering

Unit-I

Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification - Restriction endonucleases, DNA modifying enzymes, Ligases. Host-vector system - Cloning vectors for *E. coli*., Cloning vectors for Eukaryotes. Different Kinds of Vectors - Plasmids, Phage vectors, Cosmids, Phagemids, Virus vectors, Shuttle vectors and expression vectors.

Unit-II

Isolation and purification of DNA from animal cells, DNA sequencing and sequence analysis, Synthesis of gene, DNA finger printing, Different strategies of cloning**,** Direct and vector mediated gene transfer, Ligation strategies, Genomic libraries, cDNA libraries, Gene tagging, Expression of cloned genes, Isolation and purification of the expressed product. Site-directed mutagenesis. PCR technology, its principles and application. Molecular marker technology, Promoters and Operon systems. DNA forensics, DNA finger printing and paternity decisions.

Unit-III

Micro manipulation and cloning, Somatic cell cloning, Identification and isolation of genes of economic importance, Gene mapping, Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceuticals value, Gene transfer in fish, Expression of animal genes in bacteria, Biohazards and safeguards of genetic engineering.

Unit-IV

Conventional methods of animal improvement, predominantly selective breeding and cross-breeding. Embryo biotechniques for augmentation of reproductive efficiency and faster multiplication of superior germ plasm. Super ovulation. Oestrus synchronization. Embryo collection, evaluation and transfer. *In vitro* maturation of oocytes. *In vitro* fertilization and embryo culture. Embryo preservation, Embryo sexing.

Unit-V

Genetic diversity, Molecular taxonomy, Species and population biodiversity, Biodiversity and centers of origins of animals, Conservation of animal genetic resources, Morphological and molecular characterization of biodiversity. Bio-safety in relation to transgenic research and applications.

Practical:

1. Preparation of plasmid DNA and genomic DNA from *E.coli.*
2. Preparation of genomic DNA from animals/ human.
3. Agarose gel electrophoresis of plasmid and genomic DNA.
4. Restriction mapping of plasmid DNA.
5. PCR amplification, RFLP*.
6. Vector preparations*.
7. Insert preparations*.
8. Ligation*.
9. Transformation of *E. coli* with plasmid DNA using $CaCl_2$ *.
10. Isolation of the recombinant plasmid*.
11. Preparation of cDNA using RT-PCR*.

* Practical by demonstration only.

List of Suggested Reference Books:

1. Genetics (3rd Edition), Strickberger, M.W. 1996, *Printice Hall*, India Ltd., New Delhi.
2. Molecular Biology of the Cell (3rd Edition), Alberts, B. et. al., 1994, *Garland Publishing Inc.*, New York.
3. Genes VIII. Levine, B., 2004, *Oxford University Press.*
4. Genetics: Analysis of Genes and Genomes (5th Edn.), Hartl, D.L. & Jones, E.W., 2001, *Jones and Bartlett Publishers*, Sadbury, Massachusetts.
5. Gene Cloning and DNA Analysis, (5th Edn.)., T.A. Brown, 2001, *Blackwell Science Ltd.*,
6. Genetics. The Continuity of Life, D.J. Fairbanks & W.R. Andersen, 1999. *Books/ Cole Pub. Company.*
7. An Introduction to Genetic Analysis (7th Edn.)., A.J.F. Griffths et al., 2000. *W.H. Freeman & Co.*
8. Principles of Genetics (6th Edn.)., R.H. Tamarin, 1996. *WCB/ McGraw-Hill*, New Delhi.
9. Genetic Engineering, Boyer.H.W and Nicosia. S. 1978. *Elsevier/North Holl and Biomedical Press*, Amsterdam

10. Genetics of Industrial Microorganism, Seberk, O.K and Laskin, A.I., 1979. *American Society of Microbiology*, Washington.
11. Principles of gene manipulation, 3rd Edn., Old & Primrose, 1989, *Publishers Business Service.*
12. Recombinant DNA Technology, (2nd Edn.), J.D. Watson, M. Gilman, J. Witkowski & M. Zoller, 1992. *Scientific Americans Books*, New York.
13. Molecular Biotechnology, S. Maulik and S.D. Patel, 1997, *Wiley. Liss*
14. r - DNA technology and Biotechnology, K. Kreuzer & A. Massey, 1996, *ASM Press*, Washington. D.C
15. Dealing with genes, D. Berg & M. Singer, 1992, *Blackwell Scientific Publication.*
16. Molecular Biotechnology, B.R. Glick & J.J.Pasternak, 1994, *ASM Press*, Washington
17. Techniques for Engineering Genes, Butterworth. Heinemann, 1993, Open Universities Nederland.
18. Methods in Gene Biotechnology, W. Wu, M.J. Welsh, P.B. Kaufman & H.H. Zhang, 1997, *CRC Press*, New York.
19. Human Molecular Genetics (2nd Edn.), T. Strachan and A.P. Read, 1999. *John Wiley & Sons.*
20. Biomedical Ethics, (5th Edn.), Thomas A. Mappes and David DeGrazia, 2001, *McGraw-Hill publishers*.

07ZOOGE13 **Elective: III – Environmental Biotechnology**

This course provides the application of biotechnology to solve environmental problems like pesticides, metals, industrial effluents, solid waste, acid rain, global warming, ground water contamination etc., by environmental quality evaluation, monitoring, and remediation of contaminated environments. This course also provides detailed knowledge of environmental biology and pollution.

Unit – 1

Introduction: Ecology and Ecosystem, Environmental bcotechnology, Scope and importance, Current status, Future. **Environmental pollution**: Origin, Types, Air, Water, Soil, Noise and Thermal, their sources and effects.

Unit – 11

Sewage and waste water treatment: Introduction, Aerobic and anaerobic treatment, Conventional and advanced treatment technology, Use of microorganisms, Bioreactors, Use of immobilized enzymes.

Unit – III

Solid waste management: Introduction, Impact on global climate change, E-waste, Landfills, Composting, Earthworm treatment.

Unit – IV

Hazardous waste management: Introduction, Xenobiotics compounds, Hazardous waste, Biodegradation of xenobiotics compounds, Organisms involved in degradation of xenobiotics.

Unit – V

Novel methods for pollution control: Introduction, Vermitechnology, Application of environmental genetics and Aiming for biodegradable and eco-friendly products.

Text Books:

1. Fundamentals of Ecology by Eugene P. Odum, 1972, *W.B. Saunders Company*, London
2. Environmental Pollution by Hodges, L., 1977. *Holt, Reinhart Publishers,* USA. Environmental Pollution and Control by Jeffrey Peirce, J., Aarne Vesilind, P. and Ruth Weiner, 1997, *Elsevier*, The Netherlands.
3. APHA Standard Methods for the Examination of Water and Waste Water, 14th Education, 1985. American Public Health Association., Washington, USA.
4. Environmental Biotechnology by C. F. Forster and D. A. J. Wase, 1987. *Ellis Horwood Limited*, England
5. Environmental Microbiology by W.D. Grant and P.E. Long, 1985. *Blakie Glasgow,* London.
6. Industrial Microbiology by Casida, 1994, *Wiley Eastern Publishers.*
7. Microbial Gene Technology by H. Polasa, 1991. *South Asian Publishers*, New Delhi.
8. Biotreatment Systems, by D. L. Wise, 1988. *CRC Press, inc.*, USA

07ZOOGS16 Supportive: III – Marine Biotechnology

Unit-I

Basics of Aquaculture: Introduction to Biotechnology scope and its utility in Aquaculture - Indian and World Aquaculture-Role, Status and Importance of Aquaculture, Marine ornamental fishes of India.

Unit –II

Molecular Aspects of Growth and Reproduction in Aquatic Organisms: Gene sequence analysis and functions of Moult Inhibiting Hormone –Vitellogenesis Inhibiting Hormone - Mandibular Organ Inhibiting Hormone – Gonadotrophic Hormone I & II – Induced spawning – Ovaprim – Applications. GH Transgenic Fish - Embryonic Stem Cell Technology –Morpholino based gene knock down technology – Homologous Recombination and chimera formation – Nuclear Transfer Technology- Fish genetics and Bioinformatics

Unit-III

Marine Biodiversity: Marine Biodiversity - Defining and Measuring diversity, molecular methodologies - Maintenance of biodiversity and Conservation -Application-Marine food web dynamics - Primary, secondary and tertiary Production.

Unit – IV

Principles of Oceanography: Living resources of Indian sea - Application of ocean remote sensing, salinity and density-Horizontal, Vertical and temporal variations - Winds and general oceanic circulation - Marine food analysis - Spilage, quality control, ISO standard keeping export in consideration –Biodegradation.

Unit-V

Marine Biotechnology and its Potential: Probiotics bacteria and their importance in aquaculture – PCR and other techniques for identification of bacterial and viral pathogen in aquaculture- Vaccines for aquaculture – Marine virology - Cryopreservation technique-application of cryopreservation in aquaculture - Applied genetics of cultivated fishes – Commercial enzymes from marine microorganism – Marine organism as a source of polysaccharides - Marine food.

REFERENCES

1. Biological Oceanography, (1999) Lalli, C.M.
2. Textbook of Marine Ecology (1989) Nair, N.B and Thampis
3. An Introduction to Marine Sciences (1988). Medius, P.S & Campell, J. J.
4. General Oceanography- An introduction (1980) Sielder, G.
5. Drugs from Sea (2000). Fusetani, N.
6. Recent Advances in Marine Biotechnology.Vol.2 (1998) Nagabhushan.R
7. Biotechnology and Biodegradation (1990), D. Chakaraborthy.
8. Chemical Oceanography (1992). Millero & Saha, M.C.
9. Methods of Seawater Analysis (1995) . Grasshoff.K., Erhardt & Kremling

07ZOOBC10 Core: X- Bioinformatics and Genomics

Unit-I

Biology of cells – Biology of Environment – Cell energetics and respiration – Calculus integration.

Unit – II

Internet and intranet- Application of IT-Database Management systems and telecommunications – Searches on MEDLINE, CD-ROM

Unit – III

Chemical bonding and atomic and molecular orbital - X-ray crystallography of biomolecules – Molecular mechanics and molecular dynamics of protein pesticides, nucleotides.

Unit – IV

Concept of molecular modeling – genome data bank-microbial and cellular data banks analysis tools for sequence data banks

Unit – V

Introduction to genomics – biological data modeling – genomic mapping and single nucleotide polymorphisms – micro array gene expression analysis – genomics databases.

Practical:

1. Bioinformatics and the Internet.
2. Protein sequence analysis.
3. Molecular graphics and evaluating protein structure.
4. Small molecule generation and assessment.
5. Free energy calculations.

References:

1. Jurnak, F.A. and McPherson, A. 1985. Biological macromolecules and assemblies., New Delhi.
2. Powell, HTML, The complete reference, Tata Mac – Graw Hill, 1988.
3. Winter, M.J. 1996. Chemical bonding,, Oxford University Press, Inc., New York, 91 pp.
4. Setubal, J., Meidanis J. Introduction to Computational Molecular Biology. PWS publishing Co., Boston (1996).
5. Molecular Modeling on the PC & Introduction to database systems, Matthew and F. Schlecht, 1998. *J.M. Martin, Princeton – Hall.*