

SYLLABUS
(For Candidates to be admitted from 2016 Onwards)
PG DEPARTMENT OF ZOOLOGY, NATIONAL COLLEGE (AUTONOMOUS)
NATIONAL COLLEGE (Autonomous)
Nationally Accredited at 'A' level by NAAC, Tiruchirappalli-620 001
POST GRADUATE AND RESEARCH DEPARTMENT OF ZOOLOGY
M.Sc., Zoology - Programme Structure under CBCS
(For Candidates admitted from the academic year 2016 onwards)

SEM.	COURSE	COURSE TITLE	Instr. Hours/ Week	Credit	Exam Hours	Marks		Total
						Int	Ext	
I	CC1 P16ZY1	Biology of Invertebrates and Chordates and Paleontology	6	5	3	25	75	100
	CC2 P16ZY2	Cell and Molecular Biology	6	5	3	25	75	100
	CC3 P16ZY3	Genetics	6	5	3	25	75	100
	CC4 P16ZY4P	Practical – I - Pertaining to CC1, CC2 & CC3	6	5	3	25	75	100
	EC1 P16ZY5E	Bio-Instrumentation and Research Methodology	6	4	3	25	75	100
TOTAL			30	24				500
II	CC5 P16ZY6	Animal Physiology	6	5	3	25	75	100
	CC6 P16ZY7	Biotechnology	6	5	3	25	75	100
	CC7 P16ZY8	Microbiology	6	5	3	25	75	100
	CC8 P16ZY9P	Practical – II Pertaining to CC6, CC7 & CC8	6	5	3	25	75	100
	EC2 P16ZY10E	Bio-statistics & Bio-informatics	6	4	3	25	75	100
TOTAL			30	24				500
III	CC9 P16ZY11	Developmental Biology and Evolution	6	5	3	25	75	100
	CC10 P16ZY12	Biochemistry & Biophysics	6	5	3	25	75	100
	CC11 P16ZY13P	Practical – III Pertaining to CC11 and CC12.	6	5	3	25	75	100
	EC3 P16ZY14E	Aquaculture	6	4	3	25	75	100
	EC4 P16ZY15E	Environmental Biology and Management	6	4	3	25	75	100
TOTAL			30	23				500
IV	CC12 P16ZY16	Immunology	6	5	3	25	75	100
	CC13 P16ZY17	General and Applied Entomology	6	5	3	25	75	100
	EC5 P16ZY18E	Wildlife Biology	6	4	3	25	75	100
	P16ZYP19	Project Work	12	5		75	25	100
TOTAL			30	19				400
GRAND TOTAL			120	90				1900

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CC - CORE COURSE, CCE - CORE COURSE ELECTIVE**

For the science program oral test will be conducted for the practical papers and 5 marks will be allotted and to be included in the external 75 marks i.e., 70 for the practical lab + 5 for the oral test = 75 marks

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CLASS	I – M.Sc., Zoology	
Semester	I	
Course & Code	Core Course – (CC1)	Code: P16ZY1
Course Title	BIOLOGY OF INVERTEBRATES AND CHORDATES AND PALEONTOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT - I : Biology of Invertebrates

Symmetry in animal organization – Origin, types, and significance of coelom – Evolution of Metamerism – Locomotion in Annelids – Feeding mechanism in Polycheates, Molluscs and Echinoderms.

UNIT - II

Comparative study of respiration, circulation, excretion, nervous systems of invertebrates.

UNIT - III : Biology of Chordates

Integumentary system: Structure – Derivatives (Glands, Hairs, Scales, Horns, Skin Pigments). Dentition in Mammals – Stomach in Mammals – Evolution of Aortic Arches. Comparative study of digestive system and circulatory system of chordates.

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: Paleontology

Minor Phyla: Rotifera, Phoronida and Cheatognatha - Invertebrate fossils- Evolutionary trends and Phylogenetic importance of Trilobites, Ammonoids, Belemnoids, Nautiloids, Echinoid fossils and Vertebrate fossils.

References

1. Ayyar, E.K., and Ananthkrishnan, 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. Hymen, 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.

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CLASS	I – M.Sc., Zoology	
Semester	I	
Course & Code	Core Course – (CC2)	Code: P16ZY2
Course Title	CELL AND MOLECULAR BIOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Plasmamembrane and Nucleus

Plasmamembrane: Ultra structure – Modifications (Trilaminar Model, Lattice Model, Micellar Model, Fluid Mosaic Model) – Functions (Permeability, Osmosis, Passive transport, Active transport, Permease system, Endocytosis, Exocytosis and Phagocytosis).

Nucleus: Ultra Structure and composition – Functions of nuclear pore complex - Nucleolus ultra structure and function.

UNIT – II: Mitochondria, Endoplasmic Reticulum, Golgi complex, Lysosome, and Centrosome

Mitochondria: Structure – Electron transport system, oxidative phosphorylation. Endoplasmic reticulum: Morphology – Function in protein secretion and transport to golgi complex.

Golgi complex: Morphology - Function in protein sorting and transport from Golgi Apparatus.

Lysosome and Centrosome – Morphology, Chemistry and functions.

UNIT – III: DNA and RNA

Watson and Crick's model for DNA replication (Meselson and Stahl's experiment) – Enzymes involved in DNA replication (Nucleases, polymerases, ligases) - Types of Non genetic RNA - Mechanism of transcription in prokaryotes and eukaryotes – Mechanism of protein synthesis.

UNIT – IV: Cancer Biology

Characteristics of cancer cells - Types of tumors - Apoptosis and its relevance in cancer – Carcinogens - Cellular oncogenes – Tumor suppressor genes (RB and P53) – Tumor viruses - Application of molecular biology to cancer prevention and treatment.

UNIT – V: Cytological Techniques

Microtomy – Cell fractionation – Autoradiography – Cytochemical staining and detection methods of Carbohydrates, protein, lipids, DNA and RNA.

References

1. De Robertis, E.D.P. and De Robertis, E.M.F. (1987), Cell and Molecular Biology, VIII Ed. Lea and Febiger, Philadelphia.
2. Cooper, J.M., Hausman, R.E. 2009. The Cell. Sinauer Associates, Inc., USA.
3. Bruce Alberts and Dennis Brey, (1994), Molecular Biology of the Cell. 3rd Edition. Garland Publishing, Inc. New York and London.
4. Becker and Deamer, (1991), The World of the Cell. 2nd Edition. The Benjamin and Cumming Publishing Company, Inc. California.
5. Alberts, B., Johnson, A., Luwis, J. Raff, M. Robertis, K., Walter, P. 2002. Molecular Biology of Cell. Garland Science (Taylor & Francis Group), New York.

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CLASS	I – M.Sc., Zoology	
Semester	I	
Course & Code	Core Course – (CC3)	Code: P16ZY3
Course Title	GENETICS	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Genetic interaction, Linkage, and Crossing over

Gene interaction and types (Complementary genes, supplementary genes, Duplicate genes, Lethal genes, and Epistasis) - Mechanism of crossing over and its theories (Chiasma, Breakage, Contact-first, Strain, and differential contraction theories) - Kinds of linkage (Complete and incomplete) - Gene Mapping in Chromosome by crossing over method - Somatic Cell Hybridization.

UNIT – II: Gene concept and regulation of gene expression

Structure of Gene (cistron, muton, recon, introns and exons) - Functions of genes – Genetic code (Wobble hypothesis) - Gene Regulation in Prokaryotes: The Operon concept *lac* operon, *trp* operon and *ara* operon system in bacteria.– Gene regulation in eukaryotes: Short term and long term regulation.

UNIT – III: Mutation and Population genetics

Molecular basis of mutations – Genetic basis of cancer – Chromosomal aberrations – DNA Damage and repair mechanisms (Direct, Excision, Mismatch, and Recombinational repair) – Genes in populations – Hardy-Weinberg principle and gene frequency – Factors affecting Hardy-Weinberg equilibrium.

UNIT – IV: Microbial genetics

Biology of Plasmids – Transposon – Types and mechanism of transposition.
 Bacteria: Genetic material – recombination (transformation (Griffith experiments and Avery, Macleod, and McCarthy experiments), conjugation, sexduction and transduction).
 Phages: Genetic material – Lytic and Lysogenic cycle.

UNIT – V: Human genetics

Inborn errors of metabolism (Phenylketonuria, alkaptonuria, albinism, Lesh-Nyhan syndrome, ADA deficiency, galactosemia, G6PD deficiency, Tay Sach's disease and Gaucher's disease).
 Maternal inherited disorders, x-linked disorders.
 Human Karyotype: preparation and analysis. Chromosomal syndromes in man - Genetic counseling - Prenatal diagnosis (Aminoscentosis, CVS).

Reference Books

1. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. 2014. Genes XI. Oxford University Press, New York.
2. Daniel L.Hartl (1996) Genetics, III Ed., Jones Barlett Publishers. Boston.
3. David Friefelder (1998) Microbial Genetics, Narosa Publishing House, New Delhi.
4. Jenkins, J.B. (1983) Human genetics, The Benjamin Cummings Publishing Co.
5. John D. Hawkins (1996) Gene Structure and Expression, III Ed., Cambridge University Press.
6. Strickberger Monnroe, W. (1996) Genetics, Prentice Hall of India Pvt. Ltd., New Delhi.
7. Watson J D et al (1987) Molecular Biology of gene, IV Ed., The Benjamin Publishing Company Inc., UK.

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CLASS	I – M.Sc., Zoology	
Semester	I	
Course & Code	Core Course – (CC4)	Code: P16ZY4P
Course Title	Practical - I (Pertaining to Biology of Invertebrates and Chordates and Palaeontology, Cell and Molecular Biology and Genetics).	
Hours: 6	Credits : 5	Max Marks : 75

1. INVERTEBRATES AND CHORDATES.

- A. Mounting : Teleost – Scales
Honey bee - sting.
- B. Dissection : Frog - V Cranial and spinal nerves using virtual laboratory.
Spotters: Frog – V Cranial and spinal nerves.

2. CELL BIOLOGY

- A. Cytological techniques : Micrometry – Measurements using ocular and stage micrometers – cell volume (Embryonic Cells separated from early gastrula of frog)
Spotters: Ocular micrometer and Stage micrometer.
- B. Histochemical techniques : Fixation – Chemical fixation – Freezing, Drying, Freeze-drying, staining, Conventional and cytochemical. – Histochemical localization of DNA, RNA, Lipids, proteins vital staining.
- C. Study of different types of cells. – Blood cells – Differential count in human samples.

3. MOLECULAR BIOLOGY

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

4. 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.
Spotters: Drosophila - male and female, Human karyotyping - male and female.

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CLASS	I – M.Sc., Zoology	
Semester	I	
Course & Code	Core Course Elective – (EC1)	Code: P16ZY5E
Course Title	BIO-INSTRUMENTATION AND RESEARCH METHODOLOGY	
Hours: 6	Credits : 4	Max Marks : 75

UNIT – I: Analytical instruments

Principles and uses of analytical instruments: Balances, pH meter, Spectrophotometer, Densitometric Scanner, Radioactive counters (Geiger Muller and Scintillation counters), Microscopic principles and applications (SEM, TEM). Principle of centrifuges.

UNIT – II: Separation techniques

Molecular separation by Chromatography, (Paper, Column, Thin Layer, Adsorption, Ion Exchange, HPLC), Electrophoresis, (native, SDS, - PAGE, AGAROSE), Organelle separation by centrifugation.

UNIT – III: Physiological Measuring System

Electroencephalography (EEG) – Brain Imaging using MRI – Electroretinogram (ERG) – Electromyography (EMG) – Electrocardiogram (ECG) – Electromagnetic Flowmeter – Hemodialysis.

UNIT – IV: Research Methodology

Research: Definition, Sources for Literature collection, Selection of research theories, Experimental Design, Components of research report (Introduction, Materials and Methods, Results and Discussion, Summary, References), Presentation of results (in the form of Tables, Figures), Evaluation of Data (Statistical Analysis).

UNIT – V: Journals and Online browsing of research articles

Details of Popular Magazines and periodicals (monthly, quarterly and half-yearly journals and reviews). Online browsing of research articles: infonet, infolibnet and Pubmed. Peer-reviewed journals, indexed and non-indexed journals.

References

1. N. Gurumani 2006. Research Methodology for Biological Sciences MJP Publishers.
2. Veerakumari, L. Bioinstrumentation.
3. Webster, J.G. 2004. Bioinstrumentation. Wiley, India.

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CLASS	I – M.Sc., Zoology	
Semester	II	
Course & Code	Core Course – (CC5)	Code: P16ZY6
Course Title	ANIMAL PHYSIOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT - I: Thermoregulation and Osmoregulation

Classification of animals based on thermoregulation – Temperature compensation in poiklotherms - Temperature regulation in homeotherms.

Mechanism of osmoregulation in freshwater animals - Mechanism of osmoregulation in marine animals.

UNIT – II: Nervous coordination

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: Excretion and Receptors

Ammonia toxicity – detoxification pathways – excretion to different habitat.

Chemoreceptors, Olfactroreceptors, Photoreceptors (Photochemistry of vision) - Mechanoreceptors (Tangoreceptors, Phonoreceptors, and Rheoreceptors).

UNIT - IV: Bioluminescence and Chronobiology

Bioluminescence: Occurrence – Structure of bioluminescent organs - Chemistry of light production- Functional significance. Animal behaviour: Taxis, Kinesis, Reflexes, physiological basis of learning and memory.

Biological rhythms: Circadian, Lunar, Circannual rhythms - Biological clock.

UNIT - V: Physiology of Reproduction

Mammalian reproductive physiology – Reproductive cycles - Hormonal control – Molecular mechanism of hormone action - Prostaglandins, Reproductive disorders.

Reference

1. Hoar, W.S. 1987, General and Comparative Physiology, Prentice Hall.
2. Turner, C.D.& Bagnara, J.T. 1976, General Endocrinology, 6th Ed. W.B.Saunders Co.
3. Beck, 1971, Human Design, Harcourt Brace Joranorich Inc.
4. Dawson, H. 1964, General Physiology, Little Brown Co. Boston
5. Echert, R. and Randall, D. 1987, Animal Physiology, CBS Publishers and Distributors.
6. F.N. 1971. Animal Function, Principles and Adaptation, Macmillan Co. London.

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CLASS	I – M.Sc., Zoology	
Semester	II	
Course & Code	Core Course – (CC6)	Code: P16ZY7
Course Title	BIOTECHNOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT - I: Introduction to Biotechnology

Scope – Branches – Current developments – Commercial applications of biotechnology. Strategies of Recombinant DNA technology – Preparation of DNA, vector, types of vectors – Transgenic animals – production (Microinjection, Embryonic stem cell methods) and its applications. Genomics – Human Genome Project - Methods of gene sequencing (Random shotgun, Whole genome Shotgun sequencing).

UNIT - II: Enzyme Biotechnology

Microorganisms producing enzymes, Enzyme: Properties - Methods of enzyme production - Immobilization - Application. Production of secondary metabolites (Bacterial and fungal toxins) – Product recovery and purification – Production of vitamins and single cell proteins.

UNIT - III: Pharmaceutical Biotechnology

Monoclonal Antibodies Production (Hybridoma Technology) – Pharmaceutical products of DNA Technology – Insulin, Human Growth hormone, Interferon. Recombinant vaccines (Subunit, DNA and Attenuated vaccines).

UNIT - IV: Molecular Markers and Gene Therapy

Diagnosis of genetic disorders by RFLP, PCR, OLR assay and Northern, Southern and Western Blotting – Treatment of Cancer – Bone marrow transplantation – GVH diseases, Gene Therapy: *Ex vivo* and *in vivo* gene therapy, Embryonic stem cell methods, Gene silencing.

UNIT - V: Nanobiotechnology

Introduction to Nanobiotechnology – Nanobiotechnological devices – Types and applications of Nanobiosensors - Drug delivery technologies – Cancer diagnosis and therapy – Preparation and uses of DNA microarrays.

Reference Books

1. Brown, C.M., Campbell, I and Priest, F.G. (1988) Introduction to Biotechnology, Blackwell Scientific Publications, U.K.
2. Babiuk, L.A. John, P. Phillips and Murray (1989) Animal Biotechnology, Pergamon Press, Oxford.
3. Higgins, I.J., Best, D.J. and Jones, J. (1988) Biotechnology-Principles and Applications. Blackwell Scientific Publications, Oxford, London, Edinburgh.
4. Keshav Trehan (1996), Biotechnology, New Age International Pvt. Ltd. Publishers, New Delhi.
5. Primrose, S.B.(1989) Modern Biotechnology. Blackwell Scientific Publications, Oxford, London, Edinburgh.
6. Satyanarayana, U. 2007. Biotechnology. Books and Allied (P) Ltd.
7. Shanmugam, S. 2011. Nanobiotechnology. MJP Publishers, Chennai.

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CLASS	I – M.Sc., Zoology	
Semester	II	
Course & Code	Core Course – (CC7)	Code: P16ZY8
Course Title	MICROBIOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT - I: Characteristics of Microorganisms

General Features and Classification of Bacteria, Virus, Yeast, Actinomycetes and Fungi.
 Structure of Bacteria (*E. coli*) - Structure of Virus: T₄ Bacteriophage, Adenovirus.

UNIT - II: Culture Techniques

Bacterial growth and nutritional requirements - Types of culture media - preparation of culture media - methods of maintenance of culture - culture characteristics of bacteria : Gram's staining techniques.

UNIT - III: Food Microbiology

Microbial examination of food – Food Spoilage (Meat, Fish, milk, egg, and bread) – Food Poisoning (Botulism, *Staphylococcal* poisoning, and Mycotoxicosis) – Food Preservation – Bacteriology of Milk – Bacteriological examination of Milk – Pasteurization of Milk.

UNIT - IV: Industrial and Agricultural Microbiology

Fermentation technology – Stages of fermentation - Fermentation products (alcohol, vinegar, pharmaceuticals, organic acids, amino acids, and fuels).
 Biological nitrogen fixation; *Nif* genes, Nitrogen fixers – Bio fertilizers (*Rhizobium*, *Azotobacter*, *Azospirillum*, VAM) - Bio pesticides (Bacterial, Fungal, Viral).

UNIT - V: Medicinal Microbiology

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

Reference Books

1. Pelezar, Chan and Kreig, 1993. Microbiology, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
2. Suila, S.B. & Santhanam, S. 2001, General Microbiology, Oxford and IBH.
3. Thomas, C.G.A, 1998, Medical Microbiology, ELBS Publications.
4. Ananthanarayanan, R. and Jayaram Panikar, C.K. 2000. Text Book of Microbiology, Orient Longman, Chennai and Hyderabad.
5. Pelezer, M.J. & Reid, R.D. 1965, Microbiology, Mc Graw Hill Company. New York.
6. Powar, C.B. and Diginawala, H.F. 1987, General Microbiology-Vol.I & II. Himalaya Publishing House, Bombay.
7. Sharma, P.D. 1993, Microbiology – Rastogi Publications, Meerut.
8. Ananthanarayanan, R. and Jayaram Panikar, C.K. 2013. Text Book of Microbiology. University Press, Hyderabad.

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CLASS	I – M.Sc., Zoology	
Semester	II	
Course & Code	Core Course – (CC8)	Code: P16ZY9P
Course Title	PRACTICAL – II (Pertaining to Animal Physiology, Biotechnology and Microbiology).	
Hours: 6	Credits : 5	Max Marks : 75

A. ANIMAL PHISIOLOGY

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

B. BIOTECHNOLOGY

Demonstration of Agarose gel electrophoresis, SDS PAGE
Spotters : Models of PCR, Southern Blotting, Vectors.

C. 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.
Spotters:- Inoculation loop – Autoclave – Laminar flow hood.
Analysis:- Estimation of coliform bacilli in sewage water and drinking water, Replica plating.

Reference Books:

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

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CLASS	I – M.Sc., Zoology	
Semester	II	
Course & Code	Core Course Elective – (EC2)	Code: P16ZY10E
Course Title	BIO-STATISTICS & BIO-INFORMATICS	
Hours: 6	Credits : 4	Max Marks : 75

BIO-STATISTICS

UNIT – I: Sampling and Presentation of data

Sampling methods, Graphic presentation of Data- Scatter diagram, Bar diagram, frequency polygon, line graphs and Pie charts – Descriptive statistics: Measures of central tendency – mean, median and mode. Measures of dispersion: Range, variance, Standard deviation, Standard error.

UNIT – II: Testing Hypothesis

Test of hypothesis and test of significance (Null hypothesis and Alternative hypothesis): Student's t test (paired and unpaired tests). Chi square test, One way and two way analyses of variance (F-values) – Regression analysis.

BIOINFORMATICS

UNIT – III: Bioinformatic Tools

Bioinformatics: Definition, Scope, Data base, Sequence Databases – Nucleotide and Protein. Sequencing Analysis: Genomics and Proteomics, Tools of Bioinformatics: FASTA and BLAST format, NCBI, GENE BANK.

UNIT – IV: Biological Sequence Analysis

Biological sequence analysis: Pair-wise sequence alignment (Dot matrix method), Dynamic programming (Optimal global alignment and optimal local alignment) – Word method. Multiple sequence alignment (dynamic programming, progressive method, and iterative method). Database - Drug Discovery.

UNIT- V: Phylogenetic Analysis

Homology, Phylogeny and Evolutionary Tree: Homology and Similarity, Phylogeny and relationships, Molecular Approaches to Phylogeny and Phylogenetic Analysis.

Reference Books:

1. Sokal, R.R. and F.J. Rohlf 1981, Introduction to Biostatistics, WH Freeman & Co. USA.
2. Zar, J.H. 1984, Biostatistical analysis, Prentice Hall, New Jersey, USA.
3. Anderson, T.W. 1983, An Introduction to Multivariate Analysis, John Wiley.
4. Irfan Ali Khan and Atiya Khanum 2003, Fundamentals of Bioinformatics, Ukaaz Publications Hyderabad, India.
5. Murthy, C.S.V. 2003, Bioinformatics, Himalaya Publishing House, Mumbai, Delhi, Nagpur, Bangalore- India.
6. Subramanian, C. 2004, A Text Book of Bioinformatics, Dominant Publishers and Distributors, New Delhi, India.
7. Gurumani, N. 2010. An Introduction to Biostatistics. MJP Publishers, Chennai.

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CLASS	II – M.Sc., Zoology	
Semester	III	
Course & Code	Core Course – (CC9)	Code: P16ZY11
Course Title	DEVELOPMENTAL BIOLOGY AND EVOLUTION	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Reproduction and Assisted Reproductive Technologies

Ultra structure of human sperm and egg. Fertilization - Activation of egg cytoplasm, Infertility (Male and Female) - Artificial Insemination, Intra Cytoplasmic Sperm Injection, Gamete Intra Fallopian tube Transfer, Embryo Transfer, Invitro Fertilization.

UNIT – II: Metamorphosis and Regeneration

Hormonal control on growth and metamorphosis of insects and amphibians - Formation of limb bud in amphibian, Induction of early limb bud, Cell death and ageing. Regeneration in various Invertebrates and Vertebrates, Mechanism and factors influencing regeneration.

UNIT – III: Cell Differentiation

Embryonic stem cell and stem cell differentiation - Significance of Stem cells. Drosophila: Early embryonic development (Cleavage, Gastrulation) – Early anterior-posterior axis specification (Maternal effect genes) – Segmentation genes – Homeotic selector genes. Organizer and its function – Induction – Spemann and Mangold experiments.

UNIT – IV: Origin of Life and its Theories

Origin of Life: Process and Theories. Population genetics and evolution: Classical model hypothesis, Balance model hypothesis, Natural mutation model hypothesis, Genetic drift. Selection in action in evolution

UNIT – V: Adaptive patterns and Speciation

Races to species, Adaptation pattern, Behavioral adaptations and strategies, Sexual competition and Selection, Isolating mechanisms, Mode of speciation. Evolution of man and future evolution of man.

References

1. Gilbert, S.F. 2010. Developmental Biology, 9th Edn. Sinamer Associates Inc. Publishers. Massachusetts, USA.
2. Balinsky, B.L. 1981. An introduction to Embryology V Ed. Saunders Co. Philadelphia.
3. Berrill, N.J. 1986. Developmental Biology, Tata McGraw Hill, New Delhi.
4. Gurubachan. S. Miglani, 2006. Developmental Genetics. I.K. International Publishing House Pvt.Ltd.
5. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Nalentine, J.W. 1975. Evolution. Surjeet Pub. and Co., New York.
6. Strickberger, M.W. 1996. Evolution: Jones and Barlett Pub.Inc., London.
7. Chattopathyay, S. 2008. LIFE: Evolution, Adaptation & Ethology. Arunabha Sen Books and Allieded, Pvt., LTD., Kolkata.

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CLASS	II – M.Sc., Zoology	
Semester	III	
Course & Code	Core Course – (CC10)	Code: P16ZY12
Course Title	BIOCHEMISTRY AND BIOPHYSICS	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Proteins and Lipids

Proteins: Structure and classification, Physicochemical properties of amino acids, Essential amino acids, Glycogenic and Ketogenic amino acids, Metabolism of tyrosine, Functions of proteins and amino acids.

Lipids : Classification, Fatty acids, Triglycerides, Compound lipids, Phospholipids, Sphingolipids, Glycolipids, Steroids, Prostaglandins, Oxidation of fatty acids and Ketosis.

UNIT – II: Carbohydrates

Classification – Structure and Properties of monosaccharides, disaccharides (Maltose, Lactose, Sucrose), and polysaccharides (Starch, Glycogen, Chitin, Proteoglycan, Glycoproteins) – Acid Mucopolysaccharides. Biosynthesis of Glycogen, Glycolysis, Kreb's cycle, HMP pathway, and Gluconeogenesis.

UNIT – III: Enzymes and Hormones

Enzymes: Classification of enzymes – Properties of enzymes – Enzyme activation - Mechanism of enzyme action, Enzyme kinetics - Enzyme Inhibition (Competitive, Non-competitive, Allosteric inhibition).

Hormones: Hypothalamic releasing hormones and function, Mechanism of hormone action, Peptide hormones, Adenylate cyclase, cyclic AMP mechanism- Ca^{++} , Phosphoinositol, Steroid hormones and Transcriptional control.

UNIT – IV: Thermodynamics and Radioactive isotopes

Concept of free energy: Laws of Thermodynamics, Biological energy transducers, Radiation biophysics, Ionizing radiation, Interaction of radiation with matter, Measurement of radiation (Dosimetry), Radioactive isotopes (Radio nuclides), Biological effects of radiation, Radiation protection and Therapy.

UNIT – V: Microscopy and Spectroscopy

Principles and applications of light, Fluorescence, Phase contrast microscopes. Principles of X-ray diffraction, Mass, Atomic Absorption, NMR and ESR Spectroscopies.

References

1. Lehninger, A. L., Nelson D.K and Cox, M.M., 1993. Principles of Biochemistry, CBS Publishers and Distributors, New Delhi.
2. Stryer, L., 1988. Biochemistry, W.H. Freeman and Company, New York.
3. Veerakumari, L. 2005. Biochemistry. MJP Publishers.
4. Gopalakrishnan, 2002. Radiation Biology.
5. Daniel, M. 1992. Basic Biophysics for Biologists, Wiley International, New Delhi.
6. Narayanan, P. 2007. Essentials of Biophysics. II Edn. New Age International Pub.

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CLASS	II – M.Sc., Zoology	
Semester	III	
Course & Code	Core Course – (CC11)	Code: P16ZY13P
Course Title	PRACTICAL – III (Pertaining to Developmental Biology & Evolution, Biochemistry & Biophysics).	
Hours: 6	Credits : 5	Max Marks : 75

Developmental Biology

Preparation of sperm suspension in frog / bull and observation of the spermatozoa, Sperm motility study in frog semen. Storage methods (Theory).

Effect of thyroxin or iodine on metamorphosis of frog (Demonstration only).

Spotters: Regeneration in Tadpole, Frog spermatozoa, and Cryopreservation tank.

Evolution

Spotters: Fossils (Nautiloid, Ammonoid, and Trilobite).

Biochemistry

Preparation of solutions – normality, molarity, percentage.

Buffer preparation – determination of pH using pH meter and Paper

Quantitative estimation of amino acid, protein, carbohydrate and lipids in tissue samples.

Biophysics

Colorimeter : Determination of optical density of samples using standards. Draw a standard curve.

Experimental verification : Beer and Lambert’s law.

Chromatography – Separation of aminoacids in different samples (Paper) and TLC

Electrophoresis: Separation of serum proteins (Demonstration only).

Spotters: Paper Chromatography, Electrophoresis, and Spectrophotometer.

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CLASS	II – M.Sc., Zoology	
Semester	III	
Course & Code	Core Course Elective – (EC3)	Code: P16ZY14E
Course Title	AQUACULTURE	
Hours: 6	Credits : 4	Max Marks : 75

UNIT – I: Introduction to Aquaculture

Scope of Aquaculture, Cultivable species of fishes and shrimps, Advantages of Aquaculture, Production trends - National and International Scenario.

UNIT – II: Hatchery and Farming Techniques

Hatchery techniques : Post Larval shrimps production.
 Culture methods of various fresh water fishes and Marine shrimps, Selection of site, Selection of species, Types of farming : Traditional, Semi intensive, Intensive and Integrated farming.

UNIT – III: Ornamental fish and Pearl Oyster culture

Requirements for an aquarium – Aquarium fishes (Gold, Angel, Figher, Koi, Tiger Barb).
 Types of pearls - Pearl oyster culture.

UNIT – IV: Farm management

Farm management: Construction of semi intensive earthen ponds, Water source, daily management practices and Drainage system. Stocking of Post Larval shrimps in culture pond. Composition of feed: Types of feed: Live feed Wet and dry feeds. Harvesting, Processing, Preservation and marketing.

UNIT – V: Fish diseases and Government Organisations

Protozoan diseases (White spot, Whirling disease, Cryptobiosis.) - Fungal diseases (Fungal Gill Rot, Saprolegniasis) - Bacterial diseases (Bacterial Gill Rot, Erythroderma, Enteritis) - Viral Diseases (Epizootic Ulcerative Syndrome, Infectious Pancreatic Necrosis, Infectious Dropsy). Government organizations : MPEDA, CIBA, CIFA, NIOT, NIO and CMFRI.

References

1. Baradach, JE, JH Ryther and WO McLarney, 1972, Aquaculture. The farming and Husbandary of Fresh water and Marine Organisms. Wiley Interscience, New York.
2. Rath, R.,K. 2000. Freshwater Aquaculture. Scientific Publishers, PO No 91, Jodhpur. India.
3. Jhingran, AVG, 1991, Fish and Fisheries of India, Hindustan Publishing Co.
4. Arumugam.N. 2008. Aquaculture, Saras Publications.

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CLASS	II – M.Sc., Zoology	
Semester	III	
Course & Code	Core Course Elective – (EC4)	Code: P16ZY15E
Course Title	ENVIRONMENTAL BIOLOGY AND MANAGEMENT	
Hours: 6	Credits : 4	Max Marks : 75

UNIT – I: Environmental Factors and Animal Relationships

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 Ecology

Ecosystem: Concept – Structure. Food chain, Food web, Trophic levels, Energy Flow in grassland food chain and detritus food chain. Fresh water ecosystem: Pond and River. Intertidal fauna: Rocky, Sandy, and muddy shore fauna. Biogeochemical cycle: Carbon, Nitrogen, Phosphorous.

UNIT – III: Population Ecology and Biodiversity

Population: Definition, Natality, Mortality, Population fluctuation, Dispersal and Age. Community ecology: Types and Characteristics, Ecological succession. Natural resources: Renewable and non renewable, resources management. Remote sensing techniques. Biodiversity: Types, Mega diversity with reference to India and Conservation of biodiversity.

UNIT – IV: Applied Ecology

Pollution: Types, Biological effects and control. Air pollution, Water pollution, Sewage and Solid waste disposal and management, Green House Effect, Ozone layer and its significance. Global warming, Acid rain. Biomagnification, Eutrophication, Environmental Impact Assessment (EIA), Biological indicators and their role in environmental monitoring, Bioremediation, Biodegradation of heavy metals and oil pollution.

UNIT – V: Radiation Biology

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

Reference Books

1. Clarke, G.L. 1954, Elements of Ecology. John Wiley & Sons. NY.
2. Odum, E.P and Barrett, G.W. 2005. Fundamentals of Ecology. Thompson Brooks Cole (EWP) 5th Ed.
3. Kormondy, E.J. 1996. Concepts of Ecology, 4th edition. Pearson Education, Inc., USA.
4. Shan, V.C. (1985) Elements of Radiation Biology, Today's & Tomorrow's Printers & Publishers, New Delhi.
5. Grosh, D.S. (1965) Biological Effects of Radiation, Blaisdell Publishing Co. Sharma, A.K. (1998) Guest Editor Preservation of Food by Ionising Radiation, IANCAS Bulletin, 14(1).

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CLASS	II – M.Sc., Zoology	
Semester	IV	
Course & Code	Core Course – (CC12)	Code: P16ZY16
Course Title	IMMUNOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Lymphoid organs

Immunity : Innate, acquired and passive. Immune system: Lymphoid organs: Primary and secondary- structure and functions, Cells of the immune system: Lymphocytes, T & B - Lymphocytes, Polymorphonuclear cells, Macrophages and Lymphokines.

UNIT – II: Antigens and Immunoglobulins

Antigen: Antigenic determinants, Types.

Antibody: Immunoglobulins – structure and functions.

Complement: Nomenclature, classification activation and function.

UNIT – III: Immune response

Immune response: Primary and secondary, Mechanism of humoral and cell mediated,. Immunity to infections- bacterial and viral. Immunoprophylaxis: Toxoids and Vaccine, Immunization schedule.

UNIT – IV: Immune Disorders

Hypersensitivity: Types – I, II, III and IV - Autoimmune disorders - Immunodeficiency diseases - Tumor immunity - Transplantation immunity - Major Histocompatibility Complex.

UNIT – V: Immunotechniques

Antigen-Antibody reactions – Precipitation reaction (Immunodiffusion, Immunoelectrophoresis), VDRL test. Agglutination reaction (Slide and Tube Agglutination), Widal test - Immunofluorescence. Radioimmunoassay, Enzyme Linked Immunosorbant Assay (ELISA).

References

1. Roitt, (3rd Edition) 2002. Immunology Crover Medical Publishing Company, London.
2. Kuby, J. 1994, Immunology, WH Freeman and Co, New York.
3. Barret, J. T., 1983, A text book of Immunology. (5th Edition) The C.V. Mosly Company.
4. Weinn, D.M. and Steward, L. 1993. Immunology. Singapore Publishers Private Ltd.
5. Kannan, I. 2008. Immunology. MJP Publishers, Chennai.
6. Kannan, R. 2011. Immunology. Oxford University Press, New Delhi.
7. Lal, S.S., Kumar, S. 2012. Immunology. Rastogi Publication, Meerut.
8. Kindt, T.J., Goldsby, R.A., Osborne, B.A. 2007. Kuby Immunology. W.H. Freeman & Co., New York.
9. Male, D., Brostoff, J., Roth, D.B., Roit, I. 2006. Immunology. Elsevier, Philadelphia.

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CLASS	II – M.Sc., Zoology	
Semester	IV	
Course & Code	Core Course – (CC13)	Code: P16ZY17
Course Title	GENERAL AND APPLIED ENTOMOLOGY	
Hours: 6	Credits : 5	Max Marks : 75

UNIT – I: Insects Taxonomy and Morphology

Basis of insect classification - Key characteristics with common South Indian examples - Morphology: Head, Thorax, Abdomen. Wings: Forms and Venation. Abdominal appendages of Apterygotes.

UNIT – II: Physiology of Insects

Integumentary system, Structure and chemistry, Physiology of moulting. Digestive system: Structure and physiology. Respiration (Aerial and Aquatic) - Circulatory system: Structure of heart, Mechanism of haemolymph circulation. Haemolymph and its composition: Haemocytes and their functions.

UNIT – III: Physiology of Insects

Excretory system: Malpighian tubules and their functions
 Nervous system: Structure, Neurotransmitters, Structure and function of compound eye.
 Reproductive system: Male and female reproductive systems.
 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 honey bee, Silk moth and Lac insect. Culture methods (Apiculture, Sericulture, Lac culture) and problems related to their cultures.
 Biology, damage caused and control methods of common insect pests of agricultural importance: Paddy, Sugarcane, Coconut, Brinjal and Pests of stored products.

UNIT – V: Pest Control Methods

Principles of Insect control: Prophylactic measures, Cultural, Mechanical, Physical and Biological methods. Parasites, Predators. Chemical methods: Pesticides, Classification, 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.

References

1. R. F. Chapman. 2013. The Insects: Structure and Function. Stephen J. Simpson, Angela E. Douglas. Cambridge University Press.
2. Snodgrass, R.F., 1985. Principles of Insect Morphology. McGraw Hill & Co. New York.
3. Wigglesworth, V.B. 1992, Physiology of Insects. IX Ed. Chapman and Hall London.
4. Nayar, K.K., Ananthkrishnan, T.N. and David, M., 1995. General and Applied Entomology. Tata McGraw Hill Pub. Co., Ltd., New York.
5. Vasantharaj David, B., 2001. Elements of Economic Entomology and Applied Entomology, Oxford and IBH Publishing Co., New Delhi.
6. Rathinaswamy, T.K., 1986. Medical Entomology, S. Viswanathan and co., Madras.
7. Mani, M.S. 1982. General Entomology, Oxford and IBH Publishing Co. New Delhi.

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CLASS	II – M.Sc., Zoology	
Semester	IV	
Course & Code	Core Course Elective – (EC5)	Code: P16ZY18E
Course Title	WILDLIFE BIOLOGY	
Hours: 6	Credits : 4	Max Marks : 75

UNIT – I: Wildlife Conservation

Wildlife concept, Importance of Wildlife conservation:- ecological, ethical, educational, scientific, commercial, aesthetic, and recreational.

Conservation methods:- In situ conservation-sanctuaries, national parks, biosphere reserves, Ex situ conservation-captive breeding, modern zoo, safari, nocturnal zoo.

UNIT – II: Inventory studies of animals

Inventory studies:-Total species list, total genera or families list, parallel-line searches, encounter rates, documenting rarities, sample collection: labeling, preservatives, collection of plants, collection of fungi, collection of invertebrates, collection of fishes, collection of amphibians, collection of reptiles, collection of birds and collection of mammals.

UNIT – III: Conservation priorities

Conservation priorities: IUCN classification - extinct, critically endangered, endangered, vulnerable, conservation dependent, low risk, data deficient, not evaluated. Flagship species, Umbrella species, Hotspots, Important Bird Areas, Tiger Reserves. Protected areas of Tamilnadu.

UNIT – IV: Wildlife census techniques

Wildlife census techniques: Direct count: Line transects, Point counts. Mark-recapture. Indirect count: pellet count, calls, sent mark, camera trap, radio telemetry, remote sensing. Behavioural sampling: Events, States, Focal-sampling, Scan sampling,

UNIT – V: Conservation projects

Conservation project: A. Tiger project- Tiger species, distribution, threats, conservation action taken, B. Elephant project: Elephants species, distribution, threats, conservation action taken. C. Crocodile Project-crocodile species, distribution, threats, conservation action taken. D. Vulture crisis in India, Wildlife Laws.

References

1. Varadharajan Gokula. 2013. Elementary Wildlife Biology. Lap Lambert Academic Publishing.
2. Sutherland W.J.2000. The conservation hand book: research, management and policy Blackwell Science Ltd
3. Andrawartha, H.C. and L.C. Birch. 1974. The distribution and abundance of animals. The University of Chicago press, London.
4. Agarwal, V.P. 1980. Forests in India. Oxford and IBH Publishing Co. New Delhi.
5. Giles, R.H. 1984. Wild life management techniques. The wild life society, Washington and Natraj Publishers, Dehra Dun.
6. Saharia, V.B. 1982. Wild life in India. Nataraj Publishers, Dehra Dun.

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CLASS	II – M.Sc., Zoology		
Semester	IV		
Project	Project Work	Code: P16ZYP19	
Title			
Hours: 12	Credits : 5	Max Marks : 100	

A dissertation should be submitted.