

GURU NANAK COLLEGE (AUTONOMOUS)

VELACHERY ROAD, CHENNAI – 600042

(Re-accredited at 'A-Grade' by NAAC) Affiliated to University of Madras



M.Sc. Zoology

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

SYLLABUS

(For the candidates admitted for the Academic year 2022-23 and thereafter)

PREAMBLE

M.Sc., Zoology is a degree programme whose curriculum involves different functions, forms, and behaviour of animal species which is used as an application to understand the biological principles of animals and derive result proof observations. This degree programme is well structured and provides students hands-on experience for understanding different concepts related to zoology and animal science. After the completion of M.Sc., Zoology, candidates have various options from working as a professional to studying as a research student. The course has different levels of opportunities in terms of higher education. Some of the most popular areas in zoology are animal behaviors and neurology, ecology and evolutionary biology, marine biology, genetics, biomedical science, and more. Candidates who wish to move towards the research side of zoology must consider pursuing a Ph.D since it offers great research opportunities and faculties that might help students dive deeper into the research area of zoology. The degree programme offers different types of career development options which can be easily accessed by students when looking for work opportunities. Some of the most popular career options when it comes to M.Sc., zoology graduates are wildlife conservation, ecosystem monitoring, environment management, animal diversity prospecting, and more. Candidates also have the opportunity to work as zoologists in pharmaceutical companies. Research associate is also a popular career option among M.Sc., Zoology students. Apart from working in the industry, candidates can also choose to work as a lecturer or professor in colleges or universities. Zoologist: A zoologist is a professional who is responsible for conducting research and studies on different animal species. A zoologist is responsible for studying the evolution, origin, behaviours, diseases, and life cycles of the animals.

Lab Technician: A lab technician is a professional who is responsible for maintaining and organizing laboratory equipment. A lab technician also performs minute experiments involving technical knowledge. Research Associate: A research associate is a professional who is responsible for conducting extensive research in the field of zoology involving certain specializations such as animal behaviour, animal reproduction, animal genetics, and more. Zookeeper: A zookeeper is a professional who is responsible for taking care and looking after the animals living in a zoo. A zookeeper is responsible for ensuring that all the rules are followed and guidelines are met from the visitors.

**LEARNING OUTCOME BASED CURRICULUM
FRAMEWORK**
From the Academic Year (2021- 22) and there after

Vision

Promotion of excellence in education and research by inculcating independent thought and Scientific temper.

Mission:

- To provide transformative, holistic and value-based learning experiences to students
- To undertake research projects in different fields and conduct quality research in frontier areas.
- To inculcate eco-concern and conservation of natural resources among students.
- To unravel hidden research potentials & Entrepreneurial avenues in zoology.
- To inculcate awareness on the issues on local environmental problems, skill enhancement through field visits, discussion, online courses and web resources.

PROGRAMME OUTCOMES
M.Sc., ZOOLOGY

- PO1:** To distinguish between the Structure, Function, Behavior and evolution of different animals
- PO2:** To acquire knowledge on conservation biology and ecology, of those most closely related programmes
- PO3:** To apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Publishing, Teaching and Research
- PO4:** To Perform, Assess and implement practical techniques and procedure to solve biological problems and analyze and quantify data collected during any project.
- PO5:** To understand the applications of Biological techniques to various fields of biology and also to establish employment opportunities in Industries, Research and Education, Bioethics, Patenting, Environmental Protection, Conservation, Technical and Medical Profession.

PROGRAMME SPECIFIC OUTCOMES
M.Sc., ZOOLOGY

- PSO1:** To Understand Nature, environment natural resources and their conservation, Classification & Behavior of different animals, Human genetics, Cytology and Evolution.
- PSO2:** To carry out research in the thrust areas of Life Sciences like Fishery biology, Animal diversity, Environmental Monitoring, Cell and Molecular Biology, Biotechnology, Bioinformatics and exposing them to research activities through Training on various Research Methodological tools, Organizing National and International Conferences and Workshops and to apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Publishing, Teaching and Research.

M.Sc., DEGREE Course in ZOOLOGY 2021-2022 onwards

Semester	Course Component	Subjects	Credits	Hours	Internal	External	Total
I	Core-1	Invertebrata and Chordata	4	4	50	50	100
	Core-2	Cell and Molecular Biology	4	4	50	50	100
	Core-3	Genetics and Evolution	4	4	50	50	100
	Elective Paper-1	Fishery Biology	4	4	50	50	100
	Core practical- 4	Invertebrata, Chordata, Fishery Biology and Animal Physiology	*	6	*	*	*
	Core practical-5	Cell and Molecular Biology, Genetics, Microbiology, Immunology and Genetic Engineering	*	6	*	*	*
	Soft Skill-1	Personality Enrichment	2	2	50	50	100
	Total		18	28			
II	Core Paper-6	Animal Physiology	4	4	50	50	100
	Core Paper-7	Microbiology and Immunology	4	4	50	50	100
	Elective Paper-2	Genetic Engineering	4	5	50	50	100
	ED-1	Wild Life Management	3	3	50	50	100
	Core practical-4	Invertebrata, Chordata, Fishery Biology and Animal Physiology	4	6	50	50	100
	Core practical-5	Cell and Molecular Biology, Genetics, Microbiology, Immunology and Genetic Engineering	4	6	50	50	100
	Soft skill-2	Workplace Communication Skills	2	2	50	50	100
	Total		25	30			
III	Core Paper- 8	Developmental Biology and Environmental Biology	4	4	50	50	100
	Core Paper-9	Economic Entomology and Pest Management	4	4	50	50	100
	Elective Paper-3	Biophysics and Biostatistics	4	3	50	50	100
	Elective Paper-4	Aquaculture	3	2	50	50	100
	ED-2	Public Health and Hygiene	3	3	50	50	100
	Core practical-10	Developmental Biology, Environmental Biology and Entomology	*	6	*	*	*
	Core practical-11	Biophysics, Biostatistics, Biochemistry and Bioinformatics	*	6	*	*	*
	Soft Skill-3	Self and Time Management Skills	2	2	50	50	100
		Internship	2	*	-	100	100
	Total		22	30			
IV	Core Paper -12	Biochemistry and Bioinformatics	4	4	50	50	100
	Core Paper-13	Research Methodology	4	4	50	50	100
	Elective Paper- 5	Applied Zoology	4	4	50	50	100
	Core practical-10	Developmental Biology, Environmental Biology and Entomology	4	6	50	50	100
	Core practical-11	Biophysics, Biostatistics, Biochemistry and Bioinformatics	4	6	50	50	100
	Soft Skill-4	Spoken and Presentation Skills	2	2	50	50	100
	Core-14	Project	6	4	--	100	100
	Total		28	30			
	Total Credits		93	120			

**END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS
WITHOUT PRACTICAL**

QUESTION ALLOTMENT	MAXIMUM 100 MARKS PASSING MINIMUM 50 MARKS THREE HOURS DURATION
QUESTIONS 1-12 Answer any 10 out of 12	PART-A (10X3=30MARKS) ANSWER ANY TEN QUESTIONS EACH QUESTION CARRIES 3 MARK
QUESTIONS 13-20 Answer any 5 out of 8	PART-B (5X 6=30) ANSWER ANY FIVE QUESTIONS EACH QUESTION CARRIES 6 MARKS
QUESTIONS 21 - 26 Answer any 4 out of 6	PART-C (4X10=40 MARKS) ANSWER ANY FOUR QUESTIONS EACH QUESTION CARRIES 10 MARKS

SEMESTER- I
INVERTEBRATA AND CHORDATA

Subject Code:	Core Paper 1: Theory	Marks: 100
Semester: I	Credits: 4	Total Hours : 60

COURSE FRAMEWORK:

To relate the morphological adaptations with phylogenetic study of Invertebrata and Chordata.

COURSE OUTCOME:

1. To explain the reproduction, cell differentiation and biology in Protozoa, Porifera and Coelenterata.
2. To discuss the parasitism in Platyhelminthes and Nematodes, to explain the polymorphism in Annelids and pheromones and endocrine organs in Arthropods.
3. To discuss the biology of Mollusks, Echinoderms and Minor phyla.
4. To describe the origin, evolutionary significance, phylogenetic affinities and classification of Chordates.
5. To analyze the Comparative anatomy of Vertebrates.

UNIT I

10 Hrs

Levels of organization: Development of coelom- Acoelomate- pseudocoelomate and coelomate organization - Radial and bilateral symmetry. **Protozoa** – Mode of feeding and Locomotion. **Porifera** – Canal System and Reproduction in Sponges; in sponges. **Coelenterata** – Metridium; Polymorphism; Coral and Coral Reefs and their Theories.

UNIT II

10 Hrs

Platyhelminthes: Parasitism in Platyhelminthes; Reproduction in Platyhelminthes. **Nemertoda:** Ascaris. **Annelida:** Nephridia and Coelomoducts – Adaptive Radiation in Polychaetes. **Arthropoda:** Polymorphism; Crustacean larvae and their Significance; Pheromones in insects – Endocrine organs in Crustacea.

UNIT III

10 Hrs

Mollusca: Filter Feeding in Mollusca; Advanced features of Cephalopods; Gastropoda; Adaptive Radiation in Mollusca. **Echinodermata:** Larval forms and their Evolutionary Significance. **Minor Phyla:** Rotifera, Acanthocephala, Ectoprocta, Entoprocta, Phoronida, Brachiopoda, Chaetognatha. Invertebrate fossils. Trilobites and cephalopods. Regeneration in invertebrates.

UNIT IV

15 Hrs

Origin of Chordates- Theories. Broad classification of Chordates – Phylogenetic Affinities of Cephalo chordata and Urochordata. Evolutionary and structural peculiarities of Cyclostomata and affinities – Petromyzon, Economic importance of fishes. Migration and Parental care in fishes. Respiration and Parental care in Amphibians. Fossae in Reptiles. Evolutionary significance of Archaeopteryx.

UNIT V

15 Hrs

Aves – Migration - Flight adaptation - Types of beaks in birds. Flightless birds. Origin and evolution of Mammals critical account of Prototheria, Metatheria and Eutheria. Adaptive radiation in mammals. Comparative anatomy of Vertebrates - Respiratory organs - Kidney, Urinogenital organs, Brain, Heart and Aortic arches.

TEXTBOOKS:

1. Barrington, E.J. W. 1969. Invertebrate Structure and Functions. English Language, Book Society.
2. Newman, The Phylum Chordata, Mac Millan and Co.

REFERENCE BOOKS

1. Barnes: Invertebrate Zoology – Toppan International Co.,
2. Hyman L. H. The Invertebrata, Vol. I to IV.
3. Carter, G. S. A General Zoology of Invertebrates, (Sidewick and Jackson Ltd., (London)
4. Borradile, L. A. The Invertebrata. Cambridge University Press.
5. Gardinar, M. S. 1972 Biology of the Invertebrates, Mc Graw Hill Book Co., New York.
6. R. L. Kotpal: Protozoa, Porifera, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Minor Phyla. Rastogi Publications.
7. Moore, R. C. Lalilcker, C.G. and Fisher, A. G. Invertebrate Fossils, Mc. Graw Hill Book Co., New York.
8. Colbert, E.H. Evolution of Vertebrates. Wiley Eastern Limited.
9. Hyman, L.H – Comparative Vertebrate Zoology. University of Chicago Press.
10. Romer, A.S. Vertebrate body. Saunders Company.
11. Young, J.A- Life of Vertebrates. Oxford press.
12. Waterman, A.J – Chordate structure and Function. Mac Millan and co.

E-LEARNING RESOURCES

1. https://www.youtube.com/watch?v=q_rt8GzYcgg
2. <https://youtu.be/fWVMKLsRE6s>
3. https://youtu.be/YCq0HQsu4_4
4. <https://youtu.be/kgZRZmEc9j4>
5. <https://www.youtube.com/watch?v=STHu4dESJH0>

Question Paper Pattern
INVERTEBRATA AND CHORDATA

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION - A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	2	-	1	-
II	2	-	1	-	1	-
III	3	-	2	-	1	-
IV	3	-	1	-	2	-
V	2	-	2	-	1	-
TOTAL	12	-	8	-	6	-

CELL AND MOLECULAR BIOLOGY

Subject Code:	Core Paper 2 / Theory	Marks: 100
Semester: I	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To impart knowledge of cellular organelles, cancer and signaling concepts in cell and Molecular Biology.

COURSE OUTCOME:

1. To explain the structural organization and function of intracellular organelles.
2. To explain the cancer cell, tumor suppressor genes, metastasis and molecular treatment of cancer
3. To discuss the enzymology of DNA and RNA, replication and types of RNA.
4. To explain the Genetic code, RNA processing, information transfer in prokaryotes and eukaryotes
5. To evaluate the signaling concepts, cell surface receptors and pathways of intracellular signal transduction.

UNIT I

5 Hrs.

Structural organization and function of intracellular organelles: Structure of model membrane, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes, Endoplasmic reticulum, structure & function of cytoskeleton and its role in motility.

UNIT II

15 Hrs.

Cancer: Cancer cell- Characteristics, Differences between normal and cancer cell, Membrane and Biochemical changes in cancer cells, Apoptosis, Nuclear and Chromosome changes, Carcinogenesis - Tumor viruses, Oncogenes, Tumor Suppressor genes, Hormones in relation to cancer, Treatment of cancer at molecular level.

UNIT III

15 Hrs.

Informational macromolecules: Chemistry of DNA, Polymorphism of DNA, A, B, C and Z forms of D.N.A. Mechanism and Enzymology of DNA Replication - Role of Helicases, Primases, Nucleases, Ligases and Telomerases. Chemistry of RNA, Different types of RNA- mRNA, tRNA, rRNA and their functions.

UNIT IV

15 Hrs.

Information transfer: Genetic code and its characteristic features. Information transfer in prokaryotes and eukaryotes. Transcription – promoters, initiators, terminators. RNA processing – trimming of introns, splicing of exons, Ribozyme. Transcription and Translation in Prokaryotes and Eukaryotes.

UNIT V

10 Hrs.

Cell Signaling: Signaling molecules and their receptors – functions of cell surface receptors – Pathways of intracellular signal transduction.

TEXT BOOK:

1. Cooper: The Cell, A Molecular approach.

REFERENCE BOOKS:

1. David Frifielder: Molecular Biology.
2. Gerald Karp: Cell Biology- Mc Graw Hill.
3. Lodish, Berk, Zipursky, Matsuda and Baltimore, Molecular cell biology IV edition.
4. W. H. Freeman and Company. George M. Malinski, 2010. Essential of molecular biology Watson: Molecular Biology of the Gene, 4th edition, Narosa publication.

E – Learning Resources:

1. https://www.researchgate.net/profile/Mohamed_kotb_Kotb-El-Sayed2
2. <https://www.ncbi.nlm.nih.gov/books/NBK9553>
3. <https://www.khanacademy.org/science/ap-biology>
4. <https://www.slideshare.net/rohinisane/prokaryotic-and-eukaryotic-transcription-with-their-clinical-applications-219180096>
5. <https://slideplayer.com/slide/4663228/#.YwhNb9TVHfg.gmail>

Question Paper Pattern
CELL AND MOLECULAR BIOLOGY

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION - A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	3	-	2	-	1	-
III	3	-	2	-	1	-
IV	2	-	2	-	2	-
V	2	-	1	-	1	-
TOTAL	12	-	8	-	6	-

GENETICS AND EVOLUTION

Subject Code:	Core Paper: 3 / Theory	Marks: 100
Semester: I	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To understand the fine structure of genetic materials and regulation of their action. To know the chromosomal basis of genetic disorders, development and differentiation. Also, to know the importance of population genetics and nuances of genetic engineering and applied genetics. To explore the process and product of evolution since nothing in biology makes sense except in the light of evolution.

COURSE OUTCOME:

1. To explain the Molecular structure of Nucleic acids and identification of DNA and RNA as the Genetic material.
2. To discuss the regulation of gene expression, principles and methods of pedigree analysis.
3. To analyze the molecular mechanism of mutation and the concept of Hardy Weinberg equilibrium.
4. To evaluate the different theories of Evolution, Paleontology and genetic speciation.
5. To explain the adaptive radiation in animals and isolating mechanisms for speciation.

UNIT I

10 Hrs

Gene Structure and Function: Molecular structure of DNA and RNA -Replication, theories, Gene concept -One gene one polypeptide concept. Identification of DNA and RNA as the genetic material. Microbial Genetics-Conjugation, transformation and transduction and Packaging DNA molecules into chromosomes. Chromosome mapping in prokaryotes (Virus, Bacteria) and eukaryotes (Neurospora, and Man)

UNIT II

10 Hrs

Enzyme regulation of gene action. Gene regulation of gene action -Operon concept-GA L and LAC Operon system. Evidence of regulation of gene action. Hormonal control of gene action. Genes and metabolism. Inborn errors of metabolism in Man. Regulation of gene expression in prokaryotes (*E. coli*) and eukaryotes (*Drosophila*). **Human Genetics:** Polygenic inheritance, Genetic counseling. Principles and methods of pedigree analysis.

UNIT III

15 Hrs

Genes in development and differentiation: Mechanism of chromosomal breakage -physical chemical and biological factors or agents. Mutagens and mutagenesis and carcinogenesis. Radiation induced mutations. Population genetics: Population and gene pool. Hardy Weinberg Law-Genetic equilibrium. Calculation of gene frequencies for Autosomal (Complete dominance, Codominance and multiple alleles) and sex linked genes. Factors affecting Hardy Weinberg equilibrium.

UNIT IV

15 Hrs

Evolutionary Thought and Causal Factors: Neo- Lamarckism- Neo- Darwinism; Adaption, struggle, fitness and natural selection. **Paleontology:** Geological time scale- Fossil records (nature; conditions and dating) - Man in the fossil records- mass extinction. **Polyploidy and evolution** – genetic assimilation – genetic speciation – species concept – evolutionary trends – canalization of selection – orthoselection. Genetic Polymorphism - genetic drift- Animal coloration and mimicry- Micro and Macro evolution. Adaptation, Pre - adaptation and Post-adaptation.

UNIT V

10 Hrs

Adaptation, Speciation, Man and Natural Selection: Adaptive radiation in reptiles and mammals- Convergence- Parallelism - Co-evolution - evolutionary constancy- speciation and Isolating mechanisms - Hybridization as an evolutionary catalyst- Evolutionary genomics- Evolution of population – from races to species, adaptation pattern, behavioral adaptations and strategies, sexual competition and selection, isolating mechanisms, mode of speciation and evolutionary rate.

TEXT BOOK:

1. Peter J. Russel W.W. Genetics. Benjamin Cummings. 2002. **Website:**www.geneticsplace.com.
2. Darwin, C.R. 2000. On the Origin of species by meansof natural selection (Revised edition) Collier Books, New York.

REFERENCE BOOKS:

1. Anna.C. Pai: Foundation Genetics, Mc Graw Hill Book Company.
2. Burns, G.W. - The Sciences of Genetics, Mac millan publications.
3. Gardner: Principles of Genetics. 8th Edition, John Wiley and Sons.
4. Ursula Good enough: Genetics, Saunders College Publishing.
5. Benjamin Lewin Gene VII (2000). Oxford University press.
6. Griffiths, Gelbart, Lewontin and Miller. Modern Genetic Analysis. W.H. Freeman andCompany.
7. P.K.Gupta. Biotechnology and Genomics. Rastogi publications.
8. Dodson, E.O. 1990. A Text Book of Evolution, W.B. Saunders, Philadelphia.,
9. Lull.R.S.1984.Organic evolution, Seema publications.

E – Learning Resources:

1. https://www.youtube.com/watch?v=xvWdIi6_fGg&t=2000s
2. <https://www.youtube.com/watch?v=0MC5OBblol0&t=3s>
3. https://www.youtube.com/watch?v=UXI3_tbsi0E
4. <https://www.youtube.com/watch?v=J9jhg90A7Lw>
5. <https://www.ncbi.nlm.nih.gov/books/NBK26821/>
6. https://www.youtube.com/watch?v=bRuSmxJo_iA

Question Paper Pattern
GENETICS AND EVOLUTION

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION - A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	2	-	2	-	1	-
III	3	-	2	-	1	-
IV	3	-	1	-	2	-
V	2	-	2	-	1	-
TOTAL	12	-	8	-	6	-

FISHERY BIOLOGY

Subject Code:	Elective Paper – 1 / Theory	Marks: 100
Semester: I	Credits:4	Total Hours: 45

COURSE FRAMEWORK:

This subject gives the in-depth knowledge about fishes and fish farming systems.

COURSE OUTCOME:

1. To analyze the current status of Indian fisheries and classify fishes based on Berg's classification.
2. To describe the bionomy, taxonomy and economic importance of certain marine and shell fishes.
3. To discuss the breeding techniques involved in inland fisheries like freshwater, estuarine and brackishwater.
4. To explain the different sampling methods, age determination of fish using scales, otolith, marking and tagging methods in population studies for the assessment of fish stocks.
5. To study the culture and capture fisheries of India, fish endocrinology, induced breeding techniques and fish pathological studies.

UNIT - I

5 Hrs

World and Indian Fisheries – Prospects and Problems – Plans, Policies and Current Status of Indian Fisheries. Definition – salient features of the fishes - classification- Berg's classification.

UNIT - II

7 Hrs

Marine fisheries; Bionomy, Taxonomy and Economic importance: Fish - Sardines, Mackerels, Bombay duck, Pomfrets, and Sea Bass: Prawn – *Penaeus monodon*, Crabs, Lobsters, Oysters, and Mussels.

UNIT - III

10 Hrs

Inland fisheries; Freshwater – riverine, reservoir, pond and Coldwater fisheries – Spawning and breeding habits of fishes. Estuarine and brackish water fisheries and their economics. Fish Gears and Crafts used in South Indian Fisheries. Ornamental fish culture and economics.

UNIT- IV

10 Hrs

Assessment of fish stocks: Marking and recapture method, area sampling method, biostatistical method, egg count method, hydroacoustic method, remote sensing. Age and Growth: Scale method, otolith method, other skeletal parts as age indicators, length – frequency method, length – weight relationship and condition factor. Population studies: estimation of population size, marking, tagging, population dynamics, population models.

UNIT V – Culture and Capture fisheries in India:

13 Hrs

Culture fisheries: Integrated fish farming technology – rice – cum – brackish water fisheries, rice-cum-common carp culture, fish –cum-duck culture, Sewage – fed fisheries – monosex culture – polyculture. Fish endocrinology – Induced breeding – techniques – examples. Fish Processing and Preservation – fish by – products – brief account on transport and marketing. Effect of pollution of fisheries. Fish Pathology: Parasites – Protozoan, fungal, bacterial, worms and arthropods.

REFERENCE BOOKS:

1. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
2. Hanifa, M.A, 2011. Aquatic resources and aquaculture, Dominant, New Delhi.
3. Pandey. K and Shukla, J.P. 2010. Fish and fisheries, Rastogi Publications, Meerut.
4. Parihar, R.P. 1996. A text book of fish biology and Indian fisheries, central publishing house, Allahabad, India.
5. Khanna, S.S., and Singh H.R. 2012. A text book of fish biology & fisheries, Narendra publishing house.
6. Baluyut, E. A. (1989). Aquaculture systems and Practices. A selected review Publishing House, New Delhi.
7. Chondar. A (1970). Handbook of breeding of Indian major carps by pituitary hormone injection. Agra Satish Book Enterprise.
8. Day. F (1958). Fishes of India, Vol. I and Vol. II. William Sawson and Sons Ltd., London.
9. Jhingran, C. G. (1981). Fish and Fisheries of India. Hindustan Publication Co., India.

E – Learning Resources:

1. <https://www.fisheriesindia.com/2019/12/fisheries-statistics-of-world-and-india.html>
2. <https://timesofindia.indiatimes.com/india/central-marine-fisheries-research-institute-releases-annual-marine-fish-landings-data-from-indian-coasts/articleshow/70193648.cms>
3. https://en.wikipedia.org/wiki/Fishing_in_India
4. https://www.researchgate.net/figure/Fish-stock-assessment_fig1_267687234/download
5. <https://ariesagro.com/rise-of-aqua-culture-in-india/>

**Question Paper Pattern
FISHERY BIOLOGY**

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	2	-	1	-	1	-
III	3	-	2	-	2	-
IV	3	-	2	-	1	-
V	2	-	2	-	1	-
TOTAL	12	-	8	-	6	-

**PRACTICAL I – INVERTEBRATA, CHORDATA, FISHERY BIOLOGY
AND ANIMAL PHYSIOLOGY**

Subject Code:	Core Practical : 4	Marks: 100
Semester: I &II	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To understand the anatomy of invertebrates, chordates, economically important fishes, shell fishes and physiology of animals with reference to respiratory quotient and oxygen consumption.

COURSE OUTCOME:

1. To identify the different types of larval forms in invertebrates and its evolutionary significance.
2. To explain the digestive and nervous system of Earthworm, Prawn, Pila globosa and Freshwater Mussel through dissection.
3. To identify the Chordates and explain the digestive, arterial and venous system of teleost fish by dissecting and displaying the system.
4. To describe the morphometric and meristic characteristic features of fish, gut content analysis, ectoparasites of fish, seaweed species, live feed organisms and its use in research, to determine the fish gonado-somatic index, fecundity and the age of fish using scale method.
5. To determine the respiratory quotient of Aquatic and Terrestrial animals with reference to temperature; to determine the amino acids in the animal tissues.

INVERTEBRATA

1. Identification study and medical importance of selected Protozoans and Helminthes.
2. Identification study and sections of Coelenterata, Aschelminthes and Annelidato understand the evolution of different types of Coelom.
3. Identification study and larval forms from all Major Phyla of Invertebrates.
4. Identification study of Invertebrate Fossils.
5. Commercially important Invertebrates: Crab, Lobsters, Pearl Oyster, Edible Oyster, Mytilus, Sepia and Loligo.
6. Dissection and mounting of Digestive and Nervous in 1. Earth worm 2. Prawn 3. Pila globosa and 4. Fresh Water Mussel
7. Mounting of Body setae and Penial setae of Earth Worm.
8. Mounting of salivary gland of Cockroach.
9. Mounting of Radula of Pila globosa.
10. Mounting of appendages of Prawn.

CHORDATA

1. Identification of important Prochordates, Fishes, Amphibians, Reptiles, Birds and Mammals.
2. Digestive system of Teleost Fish.
3. Dissection and Display of Arterial and Venous System, in Teleost fish.
4. Mounting of brain of fish.
5. Mounting of different types of Scales in Fishes.

FISHERY BIOLOGY

1. Morphometric and Meristic characteristic features of Fish.
2. Identification of: a) Marine, fresh water and estuarine fishes up to species level.
b) Cultivable prawns.
3. Age determination in fishes by Scale method and Otolith method.
4. Mounting of Weberian Ostricles in fishes.
5. Observation of maturity stages of gonads and determination of Gonadosomatic index and fecundity in Fishes.
6. Observation of maturity stages of gonads and determination of Gonadosomatic index and fecundity in Crabs.
7. Gut content analysis of fishes in relation to feeding habits.
8. Observation of Gears and Crafts.
9. Observation of fish ectoparasites.
10. Observation of Larvivorous fishes and Aquarium fishes.
11. Observation of seaweed species and their economic importance.
12. Observation of Live feed organisms.

ANIMAL PHYSIOLOGY

1. Estimation of Respiratory Quotient in fish with reference to Temperature.
2. Oxygen consumption in a terrestrial animal (cockroach).
3. Ciliary activity of Fresh Water Mussel in relation to Temperature.
4. Salt loss and salt gain in fish.
5. Estimation of excretory products in Chordates.
6. Determination of amino acids in the tissues (Liver/muscle) of fish/egg albumin (paper chromatography).
7. Principles and applications of the following instruments:
 - a. Kymograph,
 - b. Spectrophotometer,
 - c. Sphygmomanometer,
 - d. Electrophoretic Unit.

STUDY TOUR

Report on field visit for studying the adaptation of animals.

PRACTICAL II: CELL AND MOLECULAR BIOLOGY, GENETICS, MICROBIOLOGY, IMMUNOLOGY AND GENETIC ENGINEERING

Subject Code:	Core Practical : 5	Marks: 100
Semester: I & II	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To understand different cytological techniques, Microbial techniques, observation and interpretation of syndromes.

COURSE OUTCOME:

1. To estimate various cytological techniques like micrometry, mitosis, meiosis, total WBC and RBC Count, Differential count and buccal epithelial cells.
2. To demonstrate the histological techniques in animal tissues.
3. To analyze abnormal karyotypes, preparation of culture media for drosophila and to study giant chromosomes.
4. To study microbial techniques like media preparation, culture, staining techniques and enumeration of bacterial colonies.
5. To discuss the histology of lymphoid organs, Haemagglutination reactions and immuno-electrophoresis.

CELL AND MOLECULAR BIOLOGY

I. Cytological techniques

- a) Microscopy – Compound and Light Microscope.
- b) Study on Camera Lucida.
- c) Micrometry: Microscopic calibration and Measurements of cell size using ocular and stage micrometers.
- d) Estimation of total RBC count in human blood.
- e) Estimation of total WBC count in human blood
- f) Blood cells – Differential count in man.
- g) Sandwich Eliza Test by Pregnancy Kit method.
- h) Mounting of Human Buccal Smear for squamous epithelial tissue.
- i) Study of mitotic cell division by Squash preparation Onion root tip.
- j) Study of meiotic cell division by mounting of testis of Grasshopper.

II. Histological techniques in animal tissues

- a) Fixation,
- b) Dehydration,
- c) Embedding,
- d) Staining and
- e) Mounting.

*Each student should produce at least five histological slides.

GENETICS

1. Preparation of culture medium and culture of Drosophila-methods of maintenance.
2. Identification of Drosophila species and mutants.
3. Preparation of Human karyotypes – Analysis of Normal and abnormal karyotypes (Down's syndrome, Turner's syndrome, Klinefelter's syndrome).
4. Study of Giant Chromosome – Chironomous larva.

MICROBIOLOGY

- I. Sterilization of Glass wares and media

II. Culture medium and preparation

- a) Peptone water
- b) Nutrient broth
- c) Solid media
- d) Serial Dilution

III. Staining Techniques

- a) Simple Staining
- b) Grams Staining

IV. Biochemical Tests

- a) Motility
- b) Catalase
- c) Oxidase
- d) Indole
- e) Methyl Red
- f) Voges Proskauer
- g) Triple Sugar Ion
- h) Citrate
- i) Urease

V. Enumeration of bacterial colonies

- a) Direct Plate count
- b) Observation of colony morphology (Colour, margin and diameter)
- c) Enumerate bacterial colonies and entry on record

VI. Microscopic observation for identification and characterization of following microorganisms.

- a) Staphylococcus aureus
- b) Escherichia coli
- c) Rhizopus
- d) Aspergillus niger
- e) Aspergillus flavus
- f) Penicillium
- g) Nostoc
- h) Oscillatoria
- i) Volvox

IMMUNOLOGY

1. Histology of Lymphoid organs (Spotter study)
2. Haemagglutination - Qualitative analysis – ABO Blood groupings.
3. Haemagglutination - Quantitative analysis – haemagglutination titration.
4. Preparation of Antiserum.
5. Antigen-Antibody reaction Immuno-Electrophoresis - Demonstration.

**SEMESTER-II
ANIMAL PHYSIOLOGY**

Subject Code:	Core Paper: 6 / Theory	Marks: 100
Semester: II	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To enlighten the functional aspects of organ system in the body of animal and man.

COURSE OUTCOME:

1. To discuss homeostasis with reference to osmoregulation, temperature and pH in animals.
2. To explain the metabolic pathways of carbohydrates, protein and lipids.
3. To describe the physiology of respiration, circulation and excretion.
4. To study the mechanism of muscle contraction, action potential and nervous coordination.
5. To list out the endocrine glands in Mammals, hormones and its functions.

UNIT I

15 Hrs

Homeostatic mechanisms: ionic and osmoregulation in crustaceans and fishes – temperature and pH regulations in animals. Light – photobiological processes – pressure – acclimatization to high altitudes – Hydrostatic pressure – Buoyancy.

UNIT II

10 Hrs

Carbohydrate metabolism – Glycogenesis, Glycogenolysis, Glycolysis, Krebs's cycle, HMP pathway, Gluconeogenesis.

Protein metabolism – Deamination, transamination and transmethylation of amino acids.

Lipid metabolism - Oxidation and biosynthesis of fatty acids. Integrated metabolism – Mineral metabolism (with special reference to Na⁺, K⁺ and Ca²⁺).

UNIT III

10 Hrs

Respiration: Respiratory pigments and their functions – Exchange of gases – Transport of oxygen and carbon-di-oxide – Regulatory mechanisms.

Circulation: Chemistry of blood – inorganic and organic components their regulations and functions -blood pigments and functions – Types of transport mechanisms – Cardiac cycle –Blood Pressure –ECG.

Excretion: Excretion in relation to different habitats – Detoxication pathways of ammonia –Regulation of nitrogen excretion.

UNIT IV

15 Hrs

Muscles: Mechanism of muscle contraction- Regulation and energetics of contraction – Electric organs in Nereis. Nervous co-ordination: Neurons, action potential, gross neuro- anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Propagation and transmission of nerve impulse – Synaptic transmission. Bioluminescence – Biological clocks.

UNIT V**10 Hrs**

Endocrine glands in mammals – hypothalamus, Pineal, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovary-Location and structure – Hormones and functions. Physiology of reproduction: Mammalian reproductive physiology – Reproductive cycles – Hormonal control. Molecular mechanism of hormone action.

TEXT BOOK:

1. Hoar, W.S. General and Comparative Physiology.

REFERENCE BOOKS:

1. David Saunders: An Introduction to Biological Rhythms.
2. K. Nagabushanam, M.S.Kodarkar and R.Sarojini: An Introduction to Animal Physiology.
3. Prosser C.L. Comparative animal physiology.
4. Schmidt-Nielsen: Animal physiology.

E – Learning Resources:

1. <https://www.youtube.com/watch?v=cp5tmRsnyK0>
2. <https://www.youtube.com/watch?v=YcPicFL5Jnw>
3. <https://www.ncbi.nlm.nih.gov/books/NBK10095/>
4. <https://www.youtube.com/watch?v=6tZusX4Md28>
5. <https://www.youtube.com/watch?v=GpVXiYtHxBc>

Question Paper Pattern - Animal Physiology

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	3	-	2	-	1	-
III	3	-	2	-	1	-
IV	2	-	1	-	1	-
V	2	-	2	-	2	-
TOTAL	12	-	8	-	6	-

MICROBIOLOGY AND IMMUNOLOGY

Subject Code:	Core Paper: 7/Theory	Marks: 100
Semester: II	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To gain knowledge about the morphology of microbial pathogens, its role in ecology and industrial biotechnology; to know about the human immune system and Immune Deficiency Diseases.

COURSE OUTCOME:

1. To discuss the milestones in microbiology, classification system, enumeration of bacteria and pathogenic microbes, its cure, control and prevention.
2. To list out the role of microbes in the environment and microorganisms in food production.
3. To evaluate the industrial uses of microbes and the types of bioreactors.
4. To describe the scope of immunology, types of immunity, about lymphoid organs and Antigen class determinants.
5. To determine the structure, functions and types of Immunoglobulins and antigen antibody reactions.

UNIT-I

15 Hours

History and Scope: Milestones in Microbiology- Microbial Taxonomy- Classification system-Phenetic- Numerical- phylogenetic. Morphology-Ultra structure of Bacteria, Fungi and Viruses- Enumeration of bacteria – Viable plate count-MPN procedure. **Medical Microbiology-** Pathogenic Microbes in Bacterial- Tuberculosis,. Viral- HIV. Protozoan- Amoebiasis and Malaria. Cure, Control and Prevention.

UNIT-II

10 Hours

Microbial Ecology and Environmental Microbiology- Role of microorganisms in Carbon, Nitrogen and Sulphur cycle. Population interaction – Commensalism, Co-metabolism, Epiphyte, Synergism, Mutualism, Competition, Predation and Parasitism.

UNIT-III

15 Hours

Food and Dairy Microbiology- Dairy and Non-dairy-Fermented food and Alcoholic beverages. Microorganisms and Food spoilage. **Industrial Microbiology-** Industrial uses of microbes- Fermentation products. Production of Penicillin, Ethanol and Vinegar. Types of Reactors: Animal and Plant Cell Bioreactors.

UNIT IV

10 Hours

Scope of Immunology – Types of Immunity - Innate and Acquired, Passive and Active. Primary and Secondary Lymphoid Organs – Structure and Function of Bone Marrow, Thymus, Spleen, Bursa of Fabricius, GALT, BALT, MALT and Lymph Nodes. Cells of Immune System Origin and Differentiation of T & B Cells and Macrophage. Antigens- Haptens - Antigenic determinants – Adjuvants. Antibody – Immunoglobulin – Primary Structure – Classes, Functions, Synthesis. Cell mediated immunity, Humoral immunity and Autoimmune disorders.

UNIT V

10 Hours

Humoral and cell mediated immunity – regulation of immune response – Tolerance –Antigen and antibody reaction – Physical and Biological – Vaccination – Allergy – AIDS – Congenital immune deficiencies.

TEXT BOOK:

1. Michael. J. Pelczar Jr, Chan. E.C.S, Kriej, Noel.R. Microbiology. Tata Mac Grawhill.
2. T.A. Brown – Gene cloning an Introduction (1995), Third edition Stanley ThornesPublishers.

REFERENCE BOOKS:

1. Dubey, R.C. and Maheswari, D.K, A text book of Microbiology.
2. Lansing, M. Prescott, John P.Harley and Donald A. Klein. Microbiology Mc Graw Hill(1999):
3. Patel, A.H. - Industrial Microbiology (2001). MacMillan India Limited.
4. Powar and Dagainwala: General Microbiology - Vol II Microbiology-fourth edition.
5. Ronald, M. Atlas, Principles of Microbiology (1997)
6. Sharma. P.D, Microbiology- A text book for university students.
7. Benjamin Lewin Gene VII (2000) Oxford University press.
8. Desmond S.T. Nicholl- An introduction to Genetic Engineering (1996) – CambridgeUniversity press.
9. Purohit-Biotechnology.
10. Schlegel- Genetic Engineering.
11. R.W. Old and S.B. Primrose Principles of Gene Manipulation. (1994). V-Edition Blackwell Science.

E – Learning Resources:

1. <https://www.encyclopedia.com/science/encyclopedias-almanacs-transcripts-and-maps/microbial-taxonomy>
2. <https://www.ncbi.nlm.nih.gov/books/NBK20370/>
3. <https://microbenotes.com/microbial-interaction-and-its-types-with-examples/>
4. <https://www.slideshare.net/HiwrHastear/food-microbiology-60301420>
5. <https://www.slideshare.net/anjushasuki/industrial-microbiology-149068423>
6. <https://www.ncbi.nlm.nih.gov/books/NBK27092/>

Question Paper Pattern – Microbiology & Immunology

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	1	-
II	2	-	1	-	1	-
III	2	-	2	-	1	-
IV	3	-	2	-	2	-
V	2	-	1	-	1	-
TOTAL	12	-	8	-	6	-

GENETIC ENGINEERING

Subject Code:	Elective Paper: 2/Theory	Marks: 100
Semester: II	Credits: 4	Total Hours: 45

COURSE FRAMEWORK:

To understand the Principles and methods in genetic engineering and the role of Protein engineering.

COURSE OUTCOME:

1. To acquire theoretical knowledge in the techniques, tools, application of restriction enzymes in genetic engineering.
2. To get the detailed knowledge on vectors and its significant role in genetic engineering.
3. To understand the basic steps of gene cloning and the role of enzymes and gene transfer methods for identifying suitable hosts in cloning which responsible for gene manipulation, transformation and genetic engineering.
4. To describe the analysis of recombinant DNA through various techniques such as PCR, Nucleic acid hybridization, Southern and Northern blotting etc.,
5. To discuss the protein engineering and applications of genetic engineering in agriculture, health and industry include gene therapy.

UNIT-I

10 Hours

Principles and methods in genetic engineering: Host cell restriction; Restriction modification; Restriction enzymes: Types and applications; Restriction mapping; DNA finger printing; RFLP, RAPD and AFLP techniques; Nucleases, Ribonucleases, DNA ligases, Taq Polymerases, Methylases, Topoisomerases, Gyrase and Reverse Transcriptases.

UNIT- II:

10 Hours

Vectors: plasmid vectors: pSC101, pBR322, pUC series and Ti plasmids based vectors; Bacteriophage vectors: Lambda phage based vectors, phagemids, cosmids, and M13 based vectors; Viral vectors: Vaccinia, Retroviral, SV40 and Baculoviral system; Bacterial artificial chromosome and yeast artificial chromosome. Expression vectors, Insect vectors.

UNIT III:

10 Hours

Cloning techniques: Genomic DNA and cDNA library Construction; Screening methods; Cloning in *E. coli*, *Bacillus*, *Pseudomonas*, *Streptomyces* and yeast; Expression systems; Gene fusion and Reporter genes; Gene targeting; Methods of gene transfer - Transformation, Transfection; Electroporation, microinjection and biolistic.

UNIT IV:

5 Hours

Analysis of Recombinant DNA: Polymerase chain reaction; Principles and techniques of nucleic acid hybridization and cot curves; Southern, Northern blotting techniques; Dot and Slot blotting.

UNIT V:**10 Hours**

DNA and protein sequencing; Protein engineering; Protoplast fusion; Hybridoma Technology, cell & tissue culture in plants & animals. Transgenic animals & plants; Applications of genetic engineering in agriculture, health and industry including gene therapy.

TEXT BOOK:

1. Dubey R.C. (2008) A text Book of Biotechnology. S. Chand and Company, New Delhi
2. Satyanarayana. U. (2005) Biotechnology. Books and Allied P. Ltd. Kolkata.

REFERENCE BOOKS:

1. Brown, C.M., Campbell, I. and Priest, F.G. (1988), Introduction to Biotechnology, Blackwell Scientific Publications, UK.
2. Primrose, S.B. (2000), Modern Biotechnology, Blackwell Scientific Publications, Oxford, London.
3. Keshav Trehan (1996), Biotechnology, New Age International Pvt. Ltd. Publishers, New Delhi.
4. Watson et.al. (1999) Recombinant DNA. Freeman and Company, New York
5. Ignacimuthu, S. (1998), Basic Biotechnology, Tata McGraw Hill Publishing Co., New Delhi.
6. Kumar, H.D. (1998), Modern Concepts of Biotechnology, Vikas Publishing House Pvt. Ltd., New Delhi.

E- Learning Resources:

1. <https://www.youtube.com/watch?v=7onjVBsQwQ8>
2. <https://www.youtube.com/watch?v=Bz02Qlsu4XI>
3. <https://www.youtube.com/watch?v=FjBgLIE7514>
4. <https://www.youtube.com/watch?v=a5jmdh9AnS4>
5. <https://www.youtube.com/watch?v=CNPwxbeP7B8>

Question Paper Pattern – Genetic Engineering

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	1	-
II	3	-	2	-	1	-
III	2	-	2	-	2	-
IV	2	-	1	-	1	-
V	2	-	1	-	1	-
TOTAL	12	-	8	-	6	-

SEMESTER-III
DEVELOPMENTAL BIOLOGY AND ENVIRONMENTAL BIOLOGY

Subject Code:	Core Paper: 8/ Theory	Marks: 100
Semester: III	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

Developmental biology helps to understand the ontogeny of animals. To study the interaction between living organism and the environment.

COURSE OUTCOME:

1. To describe the basic concepts of development, Gametogenesis and differentiation.
2. To analyze the chemical nature of inducing substances in embryonic induction, regeneration in animals and gene regulation of ageing.
3. To discuss the formation of various germ layers in animals and the gene activity during gastrulation.
4. To study the general components of environment and biogeochemical cycles.
5. To explain the importance of biodiversity, conservation and effects of pollution in the environment.

UNIT-I

15 Hours

Basic concepts of development: Potency, commitment, specification, competence, determination; cell fate and cell lineages;

Gametogenesis – Spermatogenesis – Biochemistry of semen, Sperm physiology – Oogenesis – Superovulation, ICSI, GIFT – Embryo cloning. Fertilization – *In Vitro* fertilization – vitellogenesis. Morphogenetic gradients in egg-double gradient theory. Embryonic fields and their properties.

Differentiation: Concept and nature of differentiation-selective action of genes in differentiation in *Drosophila* development, recognition of gene to signal molecules – time factor in progressive differentiation.

UNIT-II

15 Hours

Embryonic induction-concepts-organizers-classical experiments on organizers-analysis of the nature of primary organizer-chemical nature of inducing substances – mechanism of induction competence of organizer. Influence of hormones on growth and metamorphosis of insects and amphibians. Regenerative ability in *Planaria* and Salamander-blastema formation – Factors affecting regeneration. Aging and alterations in development – Gene regulation of aging.

UNIT-III

10 Hours

Fertilization and early development: Cell surface molecules in sperm-egg recognition in animals; embryo sac development and zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals. embryonic adaptation and the development of mammals. Gene activity during Gastrulation-Involvement of paternalthe core genes in the development.

UNIT-IV

10 Hours

General components of Environment:

Stability and complexity - Primary Production and secondary production - Biogeochemical cycles-nitrogen and carbon. Population dynamics- growth curve. Trends in human population –urbanization. Natural resources – Renewable (food, water and forest) and non-renewable (land,energy and mineral) resources. Conservation of natural resources and biota-soil conservation.

UNIT-V

10 Hours

Biodiversity –basic concepts, types, values, threats, methods of conservation-sustainable development and biodiversity indices. Wildlife conservation-Wildlife sanctuaries and NationalParks-Biosphere Reserves - Habitat Ecology- lake, marine, rocky, muddy and sandy shore,estuary, terrestrial grassland, forest, desert.

Pollution – sources, effects, and control of air, water, organic pollutants, BOD, COD, pesticides, heavy metals, thermal, radiation, oil, land and noise pollution – indicator organisms

-bioaccumulation – biomagnification and biomonitoring of pollutants. Environmental impact assessment (EIA) – definition, steps in EIA, method of EIA, problems involved in EIA,reporting (EIS).

TEXT BOOK:

1. Balinsky B.I., An introduction to Embryology. (1981) Saunders, Philadelphia.
2. Anantha krishnan, T.N., Bioresources Ecology. (1982) Oxford-IBHPublishing Co, New Delhi.

REFERENCE BOOKS:

1. M.J. Berrill–Developmental Biology. (1986) Tata Mc Graw Hill, publications Ltd.
2. Raven: An outline of developmental physiology. Porgaman press.
3. Robert S.Rugh: The frog Reproduction. (1951) Tata Mc Graw Hill publications Ltd.
4. P.K. Gupa, Biotechnology and genomics.
5. Began M. J. L. Harper and C. R. Town Send (1990), Ecology, individuals, populations and communities. Blackwell Scientific Publication, London.
6. Clarke, G. L., Elements of Ecology (1954), John Wiley, New York.
7. Odum. E.P. Fundamentals of Ecology (1971) 3rd Edition, W.B. Saunder Co, Philadelphia.
8. Elton,C. Animal Ecology, (1971), Metheun company.
9. Rastogi, V.B. and Jayaraj, M. S., Animal ecology and distribution of animals.

E- Learning Resources:

1. <https://www.youtube.com/watch?v=0-PE3ve3w2w>
2. <https://www.youtube.com/watch?v=n4crvs-KTBw>
3. <https://www.youtube.com/watch?v=GciJ9X3tJtl>
4. <https://www.youtube.com/watch?v=W6Vwojq5b98>
5. <https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/fertilization>
6. <https://www.nature.com/scitable/topicpage/genetic-control-of-aging-and-life-span-847/>

Question Paper Pattern – Developmental biology and Environmental biology

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	1	-
II	2	-	2	-	2	-
III	2	-	1	-	1	-
IV	2	-	1	-	1	-
V	3	-	2	-	1	-
TOTAL	12	-	8	-	6	-

ECONOMIC ENTOMOLOGY AND PEST MANAGEMENT

Subject Code:	Core Paper: 9/Theory	Marks: 100
Semester: III	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To study about the insects, their habitats and physiology; to acquire the knowledge on the economic importance of insects.

COURSE OUTCOME:

1. To study the biology of an insect with reference to nutrition, development, reproduction and Endocrinology.
2. To analyze and list out beneficial and harmful insects with reference to stored pests, pest of vegetables and fruits.
3. To discuss the injuries and loss caused by pest and the impact of insect in human and domestic animals.
4. To list out the different control methods of pest and their mode of action.
5. To describe the insecticide formulations in pest control and its impact on environment.

UNIT I

10 Hours

Brief account of morphology, classification (Major orders) and development (Metamorphosis) of insects. Biology of an insect with special reference to the following: Nutrition, Development, Reproduction and Endocrinology. Insects and their interrelationships with environments (Interspecific and Intraspecific).

UNIT II

10 Hours

Beneficial and harmful insects. Economic importance of honeybees, silkworm and lac insect – parasitic and predatory insects. Damages to plants, animals and man by insects. Brief account of any three pests of 1. Rice, Cholam and Pulses 2. Sugarcane 3. Cotton 4. Groundnut, Gingely and Coconut 5. Brinjal, Tomato and Lady's finger 6. Cardamom, Chillies, tea and Coffee 7. Mango and Citrus.

UNIT III

15 Hours

Insects as crop pests: Types of injuries and loss caused to plants in general factors governing the outbreak of pests – Insect vectors of plants, animals and man – Other insects affecting the health of man domestic animals.

UNIT IV

10 Hours

Insect pest control methods (Physical, mechanical, biological and chemical) – Classification of pesticides and their modes of action. Traditional methods – Poison bait, Stomach Poison, Light Trap, Attractants, Repellents, and Antifeedants.

UNIT V

15 Hours

Pesticide – basic principles of insecticide formulations and their application in pest control. Classification of Insecticides- Inorganic, organic and synthetic organic compounds. Plant protection appliances- Dusters and Sprayers, Aircraft and Other equipments. Pesticides and environmental pollution – precautions in handling pesticides.

TEXT BOOK:

- David, B.V. and T. Kumarasamy, 1984. Elements of Economic Entomology, PopularBook Depot, Madras, 536 pp.

REFERENCES:

- The Science of Entomology. William S. Romoser and John G.Stoffolano. Wm. C. Brown Publishers, England.1994.
- The Silkwonn. An important laboratory tool. By Yataro Tazima,Kodarsha, Scientific Book Ltd., Japan.1978.
- Sericulture Manual: FAD, Agril, Service Bulletin, Rome.
- Applied Entomology: P. G. Fenemore, Allaprkash, Wiley Eastern Ltd., Delhi.1992.
- Park, J. E and K. Park. Textbook of social and preventive medicine.Publ. Mis. Banarasides Bharol. Jabalpur.
- Nayar, K. K, Ananthakrishnan, T. Nand B. V. David. General and Applied Entomology. Tata McGraw Hill Publ., New Delhi.1989.
- Entomology and Pest Management. Larry, P. Pedigo Prentice Hall, New Jersey.1989.

E- Learning Resources:

- https://en.wikipedia.org/wiki/Insect_morphology
- <https://www.pinterest.com/pin/423197696217649698/>
- <https://agrihunt.com/articles/pesticide-industry/introduction-to-crop-pest/>
- https://www.researchgate.net/figure/Mechanisms-of-insect-control-methods-in-respect-of-insect-movement-behaviours_tbl1_332287125
- <https://byjus.com/chemistry/pesticides/>

Question Paper Pattern – Economic entomology and Pest Management

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	2	-
II	3	-	2	-	1	-
III	2	-	1	-	1	-
IV	2	-	1	-	1	-
V	2	-	2	-	1	-
TOTAL	12	-	8	-	6	-

BIOPHYSICS AND BIOSTATISTICS

Subject Code:	Elective Paper – 3/ Theory & Problems	Marks: 100
Semester: III	Credits: 4	Total Hours: 45

COURSE FRAMEWORK:

To highlight the statistical applications in biological sciences and to enhance the principles of physics in biology.

COURSE OUTCOME:

1. To apply the methods of histochemistry in tissue processing
2. To demonstrate and apply the different types of Chromatography, Electrophoresis and Spectroscopic techniques in biological investigations.
3. To explain the phenomenon of radioactivity and the biological applications of radioisotopes.
4. To compile, classify and design statistical data into different diagrammatic and graphical forms.
5. To compute, analyze, correlate and interpret the statistical data for the measures of dispersion and for the measures of central tendencies.

UNIT-I

5 Hours

Principles of Light Microscopy, Electron Microscopy and their applications; Principles and methods of Histology and Histochemistry, Freeze-drying, Freezing Microtome and Cryostat.

UNIT-II

10 Hours

Electronic configuration of an atom: Vander Waal's forces – Hydrophobic and hydrophilic interactions; Principles and different types of Chromatography and Electrophoresis; Principles and applications of Colorimetry, Spectroscopy, Ultra violet and Infrared Spectroscopy in Biological investigations.

UNIT-III

10 Hours

Phenomenon of Radioactivity: Isotopes and their use in biological investigations. Biological effects of radiation- Determination and measurement of radio activity- Geiger Muller and scintillation counter- Biological applications of radio isotopes and autoradiography.

UNIT-IV

5 Hours

Collection of data-primary and secondary, Methods of Classification and tabulation of data. Variables -Qualitative and Quantitative, Discrete and Continuous. Types of classification-Qualitative and Quantitative. Qualitative - chronological, geographical etc., Quantitative –Frequency distribution, Discrete and Continuous frequency distribution.

UNIT- V**15 Hours**

Measures of central tendency: Arithmetic Mean, Median and Mode. Definition and computation for different types of data (ungrouped, discrete and continuous frequency distribution). Measures of Dispersion: Mean deviation-coefficient of variation-variance- Standard deviation and standard error. Regression analysis. Correlation- Definition and Types, Scatter diagram, Computations of Karl Pearson's coefficient of correlation, Regression analysis. Students "t" test and Chi square analysis.

TEXT BOOKS:

1. Dr. S. P. Gupta, Statistical Methods. (1984) Sultan Chand and Sons, New Delhi.
2. M.A Subramanian, Biophysics Principles and Techniques (2005), MJP Publishers.

REFERENCE BOOKS:

1. Pillai, R.S.N. and Bagawathi. V Statistical Theory and practice (1989).
2. Sokal, R.R and Roulf, F.J - Biometry. The Principles and Practice of Statistics in Biological Research. (1969).

E – Learning Resources:

1. <https://microbenotes.com/electron-microscope-principle-types-components-applications-advantages-limitations/>
2. <https://chemistry.stackexchange.com/questions/10210/whats-the-relationship-between-van-der-waals-forces-and-hydrophobic-interaction>
3. <https://www.slideshare.net/arundeepra/radioactive-isotopes-72515767>
4. <https://egyankosh.ac.in/bitstream/123456789/20420/1/Unit-13.pdf>
5. <https://rajneeshrajaoria.weebly.com/uploads/4/9/0/6/49069889/statistics.pdf>

Question Paper Pattern – Biophysics and Biostatistics

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	2	-	1	-
II	2	-	1	-	2	-
III	3	-	1	-	1	-
IV	2	-	2	-	1	-
V	1	2	1	1	-	1
TOTAL	10	2	7	1	5	1

AQUACULTURE

Subject Code:	Elective Paper: 4 / Theory	Marks: 100
Semester: III	Credits: 3	Total Hours: 45

COURSE FRAMEWORK:

This paper is focused mainly on the site selection for Aquafarm designing, construction and different types of farming practices.

COURSE OUTCOME:

1. To explain the classification of various environments such as marine, brackish, estuarine, mangroves, lagoons and coral reefs.
2. To acquire the knowledge on methods of collection of live food organisms, identification, isolation and maintenance of phytoplankton, mass culture of phytoplankton and zooplankton.
3. To describe the types of culture systems like Cage, Pen, raft, rack and raceways; construction, repairing and maintenance of fish farming systems, build hatchery for producing finfish and shellfish.
4. To identify the emerging diseases and its management in aquaculture industry.
5. To develop technology for freshwater and marine aquaria; to study the role of women in ornamental fish culture

UNIT I: Ocean – General:

5 Hours

Classification of coastal environment – marine, brackish, estuarine, mangroves, lagoons and coral reefs – their physicochemical features. East and West coast fisheries in India. Activities of CMFRI, CIFE, CIBA, MPEDA, INCOIS and FIRMA. Aquaculture Authority Act-Coastal Regulation and EEZ.

UNIT II: Live feed & Plankton

10 Hours

Methods of collection of live food organisms, identification, isolation and maintenance of phytoplankton, mass culture of phytoplankton and zooplankton (Brachionus, Copepods and Moina), culture of Artemia, production of cyst and their utilization. Classification of plankton, methods of collection, preservation, analysis and biomass of phytoplankton and zooplankton.

UNIT III: Fish Farming Management

10 Hours

Water supply to fish farm – controlling devices of flow, pump types – aerating equipments and filtration systems. Open sea – farming – site selection, Constraints and prospects of open sea farming – Culture in Cages, Pens, rafts rack and raceways: design, construction, repairing and maintenance.

UNIT IV: Diseases – Finfishes & Shell fishes**10 Hours**

Disease development factors involved, abiotic and biotic. Detailed study on diseases of finfish (food fishes) – viral, bacterial, fungal, parasitic (protozoan & metazoan), environmental and nutritional diseases. Environmental and nutritional diseases. Larval health monitoring with special reference to shrimps and fishes. Modern techniques employed in diagnosis of diseases in cultivable organisms with special reference to shrimps, WSSV sample collection and preparation for different techniques (microbiology, immune studies).

UNIT V: Aquarium Fishes**10 Hours**

Freshwater and marine aquaria – global status of aquarium fish keeping – advantages and benefits of fish keeping – criteria of choosing aquarium fishes – common aquarium fishes – collection techniques. Air pumps – air operated filters – biofilters – Heating devices – aquarium thermostats – water quality maintenance – lighting methods. Tropical marine set up – aqua scaping – base covering – adding decorative materials – plants. Role of women in ornamental fish culture.

TEXT BOOKS:

1. Iversen, E.S., 1996. Living Marine Resources. Chapman and Hall, New York, 403 pp.
2. Castro, P. and M.E. Huber, 1997. Marine Biology, Second Edition. McGraw Hill Company, New York, 450 pp.

REFERENCE BOOKS:

1. Kenneth Sherman, 1998. Large marine ecosystems of the Indian Ocean, Blackwell science-USA, 394pp.
2. Satyanarayana, U., 1999. Biochemistry, Books and Allied (p) Ltd, New Delhi, 695pp.
3. Joachim W. Bertram and Felicitas Piedad – Pascal, 2000. Hand Book on Ingredients for Aquaculture Feeds. Kluwer Academic Publishers, London.
4. Robert R. Stickney, 2000. Encyclopedia of Aquaculture. John Wiley & Sons, Inc., New York, 1063 pp.
5. Holmer, M., 2008. Aquaculture in the ecosystem, Springer, New York, 326 pp.

E- Learning Resources:

1. <https://www.youtube.com/watch?v=6Cgs2SdzETc>
2. <https://www.youtube.com/watch?v=abZ7PWO97DA>
3. <https://www.youtube.com/watch?v=njARpXT2jD4>
4. <https://www.youtube.com/watch?v=YXdmhNoW-k8>
5. https://www.youtube.com/watch?v=W_mD6P_UPfA

Question Paper Pattern - Aquaculture

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	1	-	1	-
II	2	-	2	-	1	-
III	2	-	2	-	1	-
IV	3	-	2	-	1	-
V	2	-	1	-	2	-
TOTAL	12	-	8	-	6	-

**PRACTICAL-III: DEVELOPMENTAL BIOLOGY, ENVIRONMENTAL BIOLOGY
AND ENTOMOLOGY**

Subject Code:	Core–Practical - II	Marks: 100
Semester: III & IV	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To describe the different developmental stages in prawn, fish, drosophila and frog. To analyze different water samples for its hydro biological parameters and about insect pest and its control methods.

COURSE OUTCOME:

1. To describe the different developmental stages in prawn, fish, drosophila and frog.
2. To analyze different water samples for its hydro biological parameters.
3. To Study earthworm population and termitarium.
4. To discuss insect physiology, classification and its control measures.
5. To explain medical entomology, storage entomology and plant protection appliances.

DEVELOPMENTAL BIOLOGY

1. Oogenesis and Spermatogenesis– Histological studies in mammals.
2. Study of life cycle of *Drosophila melanogaster* and record its developmental stages(Egg, larvae, pupal and adult stages).
3. Different stage in Development of Prawn (Egg, Nauplius, Metanuplius, Zoea, Mysis)
4. Different stage in Development of frog (Egg, Tadpole, Young adult with tail and adultstages)
5. Mounting of Chick embryo (24 Hrs, 48 Hrs, 72 Hrs, and 96 Hrs)
6. Slide showing C.S of Heart, Kidney, Eye lens and Limb of Frog.
7. Development of Invertebrates. Eggs, Cleavage, Gastrula, study of larval forms.
8. Development stages of Fish.

ENVIRONMENTAL BIOLOGY

1. Identification of freshwater and marine planktons.
2. Study of rocky, sandy and muddy shore fauna and their adaptations.
3. Determination of the following water quality parameters:
 - a) pH
 - b) Salinity
 - c) Free-Carbon dioxide
 - d) Dissolved Oxygen
 - e) Chemical Oxygen Demand
 - f) Calcium
 - g) Carbonate
 - h) Bi-carbonate
 - i) Ammonia
 - j) Nitrate

4. Analysis of macro and microorganisms in soil and soil litter.
5. Animal associations- parasitism, mutualism and commensalism
6. Earthworm population estimation.
7. Analysis of industrial effluent for TDS, TSS and BOD (Demonstration).
8. Study of fauna in their natural habitats by visiting places of Zoological Parks and Biosphere Reserves.

ENTOMOLOGY

1. **Taxonomy:** Identification and Displaying of Insects.
2. Identification of different types of Mouth parts in insects.
3. Distinguishing characters of mosquitoes by using key characters.
4. Life cycle of Mosquitoes.
5. Life cycle of Silk moth.
6. Study of Termitarium.
7. **Medical Entomology:** Medical importance of Rat Flea and House fly.
8. **Control:** Insecticide formulations and mixtures, common natural enemies of crop pests; Light Trap, Poison Bait.
9. **Storage Entomology:** Collection, identification and familiarization with the stored grains/seed insect pests and nature of damage caused by them.
10. **Plant protection appliances:** Dusters and sprayers.

PRACTICAL – IV
BIOPHYSICS, BIOSTATISTICS, BIOCHEMISTRY AND BIOINFORMATICS

Subject Code:	Core Practical –12	Marks: 100
Semester: III & IV	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To understand the principle and application of bioinstruments, estimate the amount of organic compounds in fish tissues and to analyze the gene sequences using tools in bioinformatics.

COURSE OUTCOME:

1. To demonstrate the principle and applications of electrophoresis and spectrophotometer.
2. To analyze the problems related to mean, median, mode, and chi-square.
3. To demonstrate the amount of carbohydrates, protein and lipids present in the fish tissue samples and to estimate the bleeding, clotting time and hemoglobin in the human blood samples.
4. To describe the human genome project and gene sequencing.
5. To explain the methodology for DNA sequencing, genome mapping and determining the Functions of Individual Genes

BIOPHYSICS

Demonstration:

1. Spectrophotometry: Principle and application
2. Electrophoresis: Description and applications.

BIOSTATISTICS

1. Problems relating to mean, mode and median.
2. Problems relating to standard deviation.
3. Problems relating to standard error.
4. Problems relating to Chi- square method for testing genetic ratios.

BIOCHEMISTRY

1. Estimation of protein by Lowry's method from fish tissues.
2. Estimation of carbohydrates by Anthrone method from fish tissues.
3. Estimation of lipids by Zak's method from fish tissues.
4. Amino acid detection by TLC method.
5. Blood: Clotting time and bleeding time.
6. Estimation of hemoglobin.
7. Erythrocyte Sedimentation Rate (ESR) – Chick.

BIOINFORMATICS

1. Human Genome Project,
2. Anatomy of the Eukaryotic and Prokaryotic Genome,
3. Repetitive DNA Content of Genomes.
4. Gene-protein relations, Mutational sites Complementation.
5. Genome Mapping – Mapping Genomes, Genetic and Physical Maps, Sequencing Genomes.
6. Methodology for DNA Sequencing
7. Assembly of a Contiguous DNA Sequence, understanding a Genome Sequence, Locating the Genes in a Genome Sequence, Determining the Functions of Individual Genes

STUDY TOUR

Report on the physiological and ecological adaptations of animals through field visit.

SEMESTER-IV
BIOCHEMISTRY AND BIOINFORMATICS

Subject Code:	Core Paper: 12/Theory	Marks: 100
Semester: IV	Credits: 4	Total Hours: 60

COURSE FRAMEWORK:

To train the students to apply the principles for a better understanding of biological phenomena and to impart knowledge. To understand the genome architecture with gene function and regulation. To provide students with the skills of genomic data analysis.

COURSE OUTCOME:

1. To explain the action of enzymes and enzyme kinetics
2. To describe the biochemical pathways in the biosynthesis of lipids, aminoacids and purines and pyrimidines.
3. To discuss the metabolic pathways in carbohydrate catabolism, protein metabolism and lipid metabolism.
4. To demonstrate the tools involved in gene sequencing analysis, similarity sequence search and about transcriptomics.
5. To analyze and interpret the structure function alignment, DNA Microarrays, Next Generation Sequencing, algorithms and tools for NGS.

UNIT I

10 Hours

Nature of living matter- Biomolecules, pH, Buffers. Enzymes –Mechanism of enzyme action, coenzymes, classification and functions of Isoenzymes, Apoenzymes, Holoenzymes
–Enzyme kinetics.

UNIT II

10 Hours

Bio chemical pathways of energy use – Photosynthetic fixation of CO₂ – Biosynthesis of peptidoglycan – Biosynthesis of lipids – Biosynthesis of amino acids -proline, arginine, aspartic acid, histidine- Interconversions-threonine, isoleucine and methionine; isoleucine, valine and leucine; serine and lysine; Aspartate and pyruvate. Bio synthesis of purines and pyrimidines.

UNIT III

20 Hours

Carbohydrate catabolism – Pentose phosphate pathway – ED pathway –Energy yield in Glycolysis and aerobic respiration – Anaerobic respiration – Lactic acid fermentation – Alcohol fermentation. Protein metabolism- Amino acid metabolism- Oxidative Deamination, Transamination, Decarboxylation, Demethylation Reaction. Lipids- Lipid metabolism-Metabolism of fatty acids and glycerol.

UNIT IV

10 Hours

Overview of bioinformatics- database types. Genomics and human genome project. Computertools for sequence analysis; finding and retrieving tools similarity searching. Transcriptomics: Introduction and Importance, Data collection and processing. Applications and Candidate genes. Significance of Transcriptomics. Different types of RNA transcripts and, Single-cell transcriptomics.

UNIT V

10 Hours

Pair wise and multiple sequence alignment. Structure function relationships. DNA micro array. Next Generation Sequencing - traditional sequencing/Microarrays. Various NGS technologies/platforms. Experiment types and applications. Workflows for various NGS experiments (variant discovery and expression profiling). Algorithms and tools for NGS read alignment, SNP calling. Various file formats - SAM, VCF, BED, WIG, and PILEUP. DNA sequence genetic variations. Whole genome sequencing. Target sequencing. Sequencing Map ability. Refined alignment. Base quality Recalibration. Variants identification. Four different workflows for mutation discovery (Cross Bow, Bowtie, BWA, MAQ).

TEXT BOOK:

1. Ambika Shanmugam: Fundamentals of Biochemistry for Medical Students.
2. Brown, T.A. 2002 Genome. John Wiley Press, US.
3. Campbell, A.M. & Heyer, L.J. 2002 Discovering Genomics, Proteomics and Bioinformatics. Benjamin/Cummings.

REFERENCE BOOKS:

1. J.L. Jain: Fundamentals of biochemistry (1983).
2. Lehninger, A. L. (1970): Biochemistry, worth publishing co., N.Y.
3. Lubert stryer: Biochemistry- (1975) Freeman and co.
4. D.W. Martin, P.A.Mayer and V.W.Redwell:Harper"sReview of biochemistry 19th edition (1983). Maruyen Asian Edition.
5. Primrose and Twyman 2003 Principles of GenomeAnalysis & Genomics. Blackwell.
6. Pasternak 2000 An Introduction to Molecular HumanGenetics. Fitzgerald.

E- Learning Resources:

1. <https://www.youtube.com/watch?v=CHJsaq2INjU>
2. <https://www.youtube.com/watch?v=4eLjRcHnMCk>
3. <https://www.youtube.com/watch?v=w-uk- TOgR0>
4. <https://sapac.illumina.com/science/technology/next-generation-sequencing.html>
5. <https://www.youtube.com/watch?v=XWHsLm6pF6k>

BIOCHEMISTRY AND BIOINFORMATICS**Question Paper Pattern**

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	3	-	2	-	1	-
III	2	-	2	-	2	-
IV	2	-	1	-	1	-
V	3	-	2	-	1	-
TOTAL	12		8		6	

RESEARCH METHODOLOGY

Subject Code:	Core Paper: 13/Theory	Marks: 100
Semester: IV	Credits: 4	Total Hours: 45

COURSE FRAMEWORK:

To acquire the knowledge on research and use of various tools and techniques in research.

COURSE OUTCOME:

1. To explain the fundamentals of research and characteristics of scientific methods such as data collection; processing and analysis of data; sampling fundamentals; testing of hypothesis.
2. To discuss the gene knock out in bacterial and eukaryotic organisms; methods for analysis of gene expression at RNA and protein level; isolation separation and analysis of carbohydrate and lipid molecules; radio labeling techniques.
3. To analyze the histochemical and immunotechniques: flowcytometry and immune fluorescence microscopy.
4. To get exposure in components of research report, journals, impact factor, plagiarism and ethical issues in research.
5. To identify different software's for paper formatting, reference management and for detection of Plagiarism, biopiracy.

Unit-I

5 Hours

Research Methodology - An Introduction: Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Importance of knowing how research is done, Research Process, Criteria of good research. Defining the Research Problem; Research Design; Sampling Design; Methods of Data Collection; Processing and Analysis of Data; Sampling Fundamentals; Testing of Hypothesis.

Unit-II

10 Hours

Molecular biology methods: *In vitro* mutagenesis and deletion techniques, Gene knock out in bacterial and eukaryotic organisms; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation separation and analysis of carbohydrate and lipid molecules.

Radiolabeling techniques: Properties of different types of radioisotopes normally used in biology, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

Unit-III**10 Hours**

Histochemical and immunotechniques: Flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH. Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Unit-IV**10 Hours**

Writing the Research Report (Thesis and publications): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography, Impact factor of Journals, When and where to publish and Research ethics: Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook. UGC care listed journals, Scopus index, Web of science and H – index.

Unit-V**10 Hours**

Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism Biopiracy.

TEXT BOOK:

1. Gurumani: A text Book of Research Methodology.

REFERENCE BOOKS:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R. Kothari
4. Select references from the Internet

E- Learning Resources:

1. <https://www.youtube.com/watch?v=GSeeyJVD0JU>
2. <https://www.youtube.com/watch?v=UYvx0O8itMA>
3. <https://www.youtube.com/watch?v=zO70nrWcAyk>
4. <https://www.youtube.com/watch?v=bvrqAgFBMBY>
5. <https://www.youtube.com/watch?v=n-c55CEfTdQ>

Question Paper Pattern – Research Methodology

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	2	-	1	-	1	-
II	3	-	2	-	1	-
III	2	-	2	-	1	-
IV	3	-	2	-	1	-
V	2	-	1	-	2	-
TOTAL	12	-	8	-	6	-

APPLIED ZOOLOGY

Subject Code:	Elective Paper: 5 / Theory	Marks: 100
Semester: IV	Credits: 4	Total Hours: 45

COURSE FRAMEWORK:

To encourage young learners to take up the small scale industries; generate motivation for Self-Employment; disseminate information on economic aspects of Zoology; inculcate knowledge on useful animals to Mankind; satisfy the learners with modern techniques of Animal culture.

COURSE OUTCOME:

1. To describe the lifecycle of silkworm, silkworm rearing and silkworm pests and diseases.
2. To discuss the selection of bee species for apiculture, methods of extraction and byproducts of honeybee.
3. To perform vermicomposting and economic importance of vermiculture.
4. To explain the principles of poultry farming and poultry diseases.
5. To study the importance of dairy farming and its management.

UNIT – I

5 Hours

Sericulture:

Life cycle of *Bombyx mori*, Structure of silk gland and secretion of silk Silkworm rearing technology. Spinning, harvesting and storage of cocoons. Silk worm Pests and Diseases: Uzi fly; Protozoan, Viral, Fungal and Bacterial; Control and prevention. Prospects of Sericulture in India.

UNIT – II

10 Hours

Apiculture:

Selection of Bee Species for Apiculture. Bee Keeping Equipment. Methods of Extraction of Honey (Indigenous and Modern). Bee Diseases and Enemies. Products of Apiculture Industry and its Uses (Honey, Bees Wax).

UNIT – III

10 Hours

Vermiculture:

Introduction of Vermiculture and Vermicomposting. Vermiculture techniques. Bedding, Essential parameters for Vermiculture and Management Methods of Harvesting (Manual & Mechanical). Economic Importance of Vermiculture.

UNIT – IV

10 Hours

Poultry Farming:

Classification of Fowls based on their use – Broilers and Commercial layers. Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs. Poultry diseases - Viral, Bacterial, Fungal, Protozoan Management of a modern Poultry Farm, progressive plans to promote Poultry as a Self-Employment venture.

UNIT – V

10 Hours

Dairy farm and its management:

Animal Husbandry – Genetic Improvement for best breeds - Preservation of semen, artificial insemination of cattle, Induction of early puberty and synchronization of estrus in cattle. Economic importance of Dairy, Leather, Wool, Fur and Pharmaceutical Industries in India - Transgenic Animal Technology.

TEXT BOOKS:

1. Jawaaid Ahsan and Subhas Prasad Sinha, 2000 A Handbook on Economic Zoology-ISBN-81-219-0876-O. S. Chand & Co., Ltd., New Delhi.
2. Ashok Kumar and Prem mohan Nigam, 1991, Economic and Applied Entomology Emkay Publications, New Delhi.
3. Banerjee, G.C. 1992, Poultry – III- Edition – ISBN-81-204-008-4. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Kaushish, S.K., 2001, Trends in Livestock Research – ISBN-81-7754-112-9. Agrobios (India), Jodhpur – India.

REFERENCE BOOKS:

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB, Bangalore
3. Ranganathan L.S, Vermicomposting technology- soil health to human health
4. Keith Wilson, N.D.P., 2005. A Handbook of Poultry Practice – ISBN-81-7754-O-69-6 Agrobios (India), Jodhpur – India.
5. Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher.

E- Learning Resources:

1. https://www.researchgate.net/publication/302320291_The_Silkworm_Bombyx_mori
2. <https://byjus.com/biology/apiculture-beekeeping/>
3. <https://www.agrifarming.in/vermiculture-process-techniques-worm-farming>
4. https://en.wikipedia.org/wiki/Poultry_farming
5. https://www-pub.iaea.org/MTCD/Publications/PDF/te_1533_web.pdf

Question Paper Pattern – Applied Zoology

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	1	-	1	-
II	2	-	2	-	1	-
III	2	-	2	-	1	-
IV	3	-	1	-	2	-
V	2	-	2	-	1	-
TOTAL	12		8		6	

WILD LIFE MANAGEMENT

Subject Code:	Extra Disciplinary: 1	Marks: 100
Semester: II	Credits: 3	Total Hours: 45

COURSE FRAMEWORK:

To acquire the knowledge conservation of biosphere reserve and its fauna and flora.

COURSE OUTCOME:

1. To demonstrate knowledge of the main components of wildlife habitat ecology and be able to give examples.
2. To describe the conservation management of Himalayan salamander, Olive ridley turtles, Great Indian bustard, Himalayan musk deer, Greater one-horned rhinoceros, Fishing cat, Ganges river dolphin.
3. To acquire the knowledge on basic concept of wildlife biology and also to protect the endangered, vulnerable and rare species.
4. To understand the problems and prospects of sanctuaries and national parks.
5. To describe the types of wildlife sampling such as random sampling, systematic sampling, stratified sampling and cluster sampling.

UNIT-I

10 Hours

Wildlife habitat ecology: Biomes of the world – an overview; biome types of India: alpine tundra, grassland, forest, desert, aquatic and wetlands (unique features, distribution, vegetation, faunal make up and adaptations). Forest types of India.

Protected area concept: Protected area network in India; Design and management of nature reserve; concept of corridor; joint forest management.

UNIT-II

10 Hours

Conservation biology of important wild animals: Conservation status, habit & habitat, behavioral biology, threats and conservation management of the following animals. Himalayan salamander / Olive ridley turtles / Great Indian bustard / Himalayan musk deer / Greater one-horned rhinoceros / Fishing cat / Ganges river dolphin.

UNIT-III

10 Hours

Basic Concept of Wildlife Biology: Definition and importance of wildlife; Wildlife wealth of India; Threatened wildlife and IUCN status - Concept of Extinct, Critically Endangered, Endangered, Vulnerable and rare species; Red data book.

Wildlife conservation Indian perspective: Aims & Objectives of wildlife conservation. A brief idea about Indian wildlife, causes for depletion of Indian wildlife; wildlife conservation in India- through age, post-independence initiatives. Different approaches for conservation – *in situ* and *ex situ*, Conservation breeding; Threats to wildlife conservation in India.

UNIT-IV

10 Hours

Protected Area Concept: In situ conservation- problems and prospects; Sanctuaries, National parks, Community Reserves and Conservation Reserves; Biosphere Reserve, Case studies - Sundarbans Biosphere Reserve.

Wildlife Habitat Ecology: Concept of Biome, Biome types of India –a general account. Case studies: Tropical rain forest – characteristics, faunal make up and animal adaptations.

UNIT-V

5 Hours

Wildlife sampling: random sampling, systematic sampling, stratified sampling, cluster sampling. Population estimation using Mark-recapture method, Transects; GPS use. Introduction to radio telemetry, Larger mammal population estimation techniques. Remote sensing – aerial photography – satellite images – thermal, infra – red, radar images, ecological applications.

Peoples' participation in wildlife activities: Community participation in conservation; JFM.

TEXT BOOKS:

1. Simmons, I.G. (1981). The Ecology of Natural Resources (II Edn), Edward Arnold Publishers. Ltd., Bedford Square, London.
2. Kapoor, V.C. (1995). Theory and Practice of Animal Taxonomy (III Edn) Oxford and IBHPublishing Co., New Delhi

REFERENCE BOOKS:

1. Global Biodiversity strategy (1992). Report by World Resources Institute (WRI). TheWork Conservation Union, and United Nations Environment Programme (UNEP).
2. Sinha, R.K. (1996) Biodiversity (Global Concerns), Commonwealth Publishers, NewDelhi.
3. Solbrig, O.T., Van Emden, H.M., and Van Oort, P.G.W.J. (1995). Biodiversity andGlobal change. CAB International, Wallingford, U.K.

E – Learning Resources:

1. <https://www.nature.com/scitable/knowledge/library/conservation-biology-16089256/>
2. https://www.youtube.com/watch?v=b6Ua_zWDH6U
3. <https://www.youtube.com/watch?v=6zUXScqzWd4>
4. <https://www.youtube.com/watch?v=0-PE3ve3w2w&t=109s>
5. <https://www.wildlifebiology.org/>
6. https://www.youtube.com/watch?v=o_AfNcjlOgU

Question Paper Pattern – Wildlife Management

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	1	-
II	3	-	2	-	1	-
III	2	-	1	-	2	-
IV	2	-	2	-	1	-
V	2	-	1	-	1	-
TOTAL	12	-	8	-	6	-

PUBLIC HEALTH AND HYGIENE

Subject Code:	Extra Disciplinary: 2 / Theory	Marks: 100
Semester: III	Credits: 3	Total Hours:45

COURSE FRAMEWORK:

To enlighten the students about the general knowledge on their health and hygiene. To create general health awareness, the hazardous impacts and remedy.

COURSE OUTCOME:

1. To provide knowledge on different health indicators and classification of foods.
2. To create awareness on environmental degradation through Air, Water, Land and Noise Pollution.
3. To enrich knowledge on communicable diseases and their preventive and control measures.
4. To aware the student on the importance of non-communicable diseases and their control.
5. To impart knowledge on different health care programmes taken up by India

UNIT I

5 Hours

Scope of Public health and Hygiene – nutrition and health – classification of foods – Nutritional deficiency diseases- Vitamin deficiency diseases.

UNIT II

10 Hours

Environment and Health hazards: Environmental degradation – Pollution – Air, Water, Land and Noise-associated health hazards.

UNIT III

10 Hours

Communicable diseases and their preventive and control measures. Measles, Malaria, Hepatitis, Cholera, Filariasis, HIV /AIDS.

UNIT IV

10 Hours

Non-Communicable diseases and their preventive measures. Genetic diseases, Cancer, Cardio vascular diseases, Chronic respiratory disease, Diabetes, Epilepsy.

UNIT V

10 Hours

Health Education in India – WHO Programmes – Government and Voluntary Organizations and their health services – Precautions, First Aid and awareness on epidemic, endemic, Pandemic and sporadic diseases.

TEXT BOOKS:

1. Park and Park, 1995: Text Book of Preventive and Social Medicine – Banarsidas Bhanot Publ. Jodhpur – India.

REFERENCE BOOKS:

1. Verma, S. 1998: Medical Zoology, Rastogi publ. – Meerut – India
2. Singh, H.S. and Rastogi, P. 2009: Parasitology, Rastogi Publ. India.
3. Dubey, R.C and Maheswari, D.K. 2007: Text Book of Microbiology- S. Chand & Co. Publ.New Delhi – India.

E – Learning Resources:

1. <https://www.youtube.com/watch?v=ZqN1ctb-XHU>
2. <https://acphd.org/communicable-disease/>
3. <https://www.mayoclinic.org/diseases-conditions/vitamin-deficiency-anemia/symptoms-causes/syc-20355025>
4. https://www.youtube.com/watch?v=vP3pbh_-pu8
5. <https://www.youtube.com/watch?v=BWolWB3tSEU>

Question Paper Pattern – Public health and Hygiene

Section	Question Component	Numbers	Marks	Total
A	Answer any 10 out of 12 questions (Each in 50 words)	1 - 12	3	30
B	Answer any 5 out of 8 questions (Each in 300 words)	13 - 20	6	30
C	Answer any 4 out of 6 questions (Each in 1200 words)	21 - 26	10	40
TOTAL MARKS				100

Break up of questions

UNITS	SECTION – A		SECTION - B		SECTION - C	
	THEORY	PROBLEM	THEORY	PROBLEM	THEORY	PROBLEM
I	3	-	2	-	1	-
II	3	-	2	-	1	-
III	2	-	1	-	2	-
IV	2	-	2	-	1	-
V	2	-	1	-	1	-
TOTAL	12	-	8	-	6	-