

**Shikshan Haach Dharma  
S. A. P. D. Jain Pathashala's  
(Jain Minority Institute)**

# **Walchand College of Arts & Science, Solapur** **Autonomous College**

**(Affiliated to P.A.H. Solapur University, Solapur)**



Name of Faculty: Science & Technology

Choice Based Credit System

**M.Sc.-Part-II**

**Subject: Zoology**

**with effect from: 2022 -23**

M. Sc. –II (Sem. III and IV) Syllabus Structure-Zoology - w. e. f. 2022-23

Semester	Code	Title of the Paper	Semester Examination			L	T	P	Credits
			ESE	IE	Total				
<b>Semester –III</b>									
<b>Sem-III</b>		<b>Hard Core</b>							
	<b>HCT3.1</b>	Molecular Cytogenetics	80	20	100	4	--	--	4
	<b>HCT3.2</b>	Biochemistry	80	20	100	4	--	--	4
		<b>Soft Core (Any one)</b>							
	<b>SCT3.1</b>	Comparative Animal Physiology	<b>80</b>	<b>20</b>	<b>100</b>	4			4
	<b>SCT3.2</b>	Economic Entomology	80	20	100	4	--	--	4
		<b>Open elective(Any one)</b>							
	<b>OET3.1</b>	Wildlife Conservation and Management	80	20	100	4	--	--	4
	<b>OET3.2</b>	Ecology and Ethology	<b>80</b>	<b>20</b>	<b>100</b>	<b>4</b>	--	--	<b>4</b>
		<b>Seminar/Tutorial/ Industrial Visit/ Field Tour</b>	---	25	25	--	1	--	1
	<b>HCP3.1</b>	Practical Course HCP 3.1	40	10	50	--	--	03	2
	<b>HCP3.2</b>	Practical Course HCP 3.2	40	10	50	--	--	03	2
	<b>SCP 3.1/3.2</b>	Practical Course SCP 3.1/3.2	40	10	50	--	--	03	2
	<b>OEP3.1/3.2</b>	Practical Course OEP 3.1/3.2	40	10	50	--	--	03	2
		<b>(Add-on /-self learning)- MOOC/SWAYAM/Skill based -certificate course –institute or university /internship/ apprenticeship</b>							<b>4</b>
<b>Total for Semester-III</b>			<b>480</b>	<b>145</b>	<b>625</b>	--	--	--	<b>29</b>
<b>SEMESTER IV</b>									
<b>Sem-IV</b>		<b>Hard Core</b>							
	<b>HCT4.1</b>	Animal Biotechnology	80	20	100	4	--	--	4
	<b>HCT4.2</b>	Applied Zoology	80	20	100	4	--	--	4
	<b>HCT4.3</b>	Environmental Biology and Toxicology	80	20	100	4	--	--	4
		<b>Soft Core (Any one)</b>							
	<b>SCT4.1</b>	Zoo-keeping and Animal House Management	80	20	100	4	--	--	4
	<b>SCT4.2</b>	Fishery Science	80	20	100	4	--	--	4
		<b>Seminar/Tutorial/ Industrial Visit/ Field Tour</b>	---	25	25	--	1	--	1
	<b>MP4.1</b>	Project work	140	60	200	--	--	03	08
<b>Total for Semester-IV</b>			<b>480</b>	<b>145</b>	<b>625</b>	--	--	--	<b>25</b>

L = Lecture T = Tutorials P = Practical IE=Internal Evaluation ESE= End Semester Examination-4 Credits of Theory = 4 Hours of teaching per week 2 Credits of Practical = 4 hours per week HCT = Hard core theory SCT = Soft core theory OET = Open elective theory; HCP = Hard core practical SCP = Soft core practical OEP = Open elective practical MP = Major project

**Walchand College of Arts and Science (Autonomous) Solapur**  
**M. Sc. ZOOLOGY- Part - II Syllabus w. e. f. from – 2022-23**  
**Semester- III- Theory**

**HCT -3.1 Molecular Cytogenetics**  
**Teaching Hours- 60; Total credits- 4**

**About the course**

The course is designed to revise basic concepts of Genetics and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human cytogenetics, etc. will be covered. A strong emphasis will be laid on the modern tools and techniques used in genetics.

<b>Unit No</b>	<b>Title and Chapters</b>	<b>Lectures</b>
<b>Unit-I</b>	<b>Fine Structure of Gene</b>	<b>(12)</b>
1	Prokaryotic and Eukaryotic genome organization, Metaphase chromosome. Structure of chromatin, centromere, Telomere and its maintenance. Heterochromatin and euchromatin. Coding and noncoding sequences, Satellite DNA, Amplification and rearrangement.	
2	Dosage compensation of sex determination in: <i>Caenorhabditis elegans</i> , <i>Drosophila</i> and human Imprinting of genes, chromosomes and genomes.	
<b>Unit-II</b>	<b>Genome Analysis</b>	<b>(12)</b>
1	C value paradox, detailed account of various models of prokaryotic genomes, viral genomes, eukaryotic genomes, organization of genes in organelle genomes.	
2	Molecular analysis of genomic DNA in yeast.	
3	Transposable elements in genetic regulation. Genome analysis-Human, Yeast and microbial genomes.	
<b>Unit-III</b>	<b>Microbial Genetics</b>	<b>(12)</b>
1	Structure and replication of bacterial chromosome(s).	
2	Bacteriophages- types, structure and morphology of T4 phage. Morphogenesis, lysogeny and lytic cycle in bacteriophages.	
3	Host cell restriction, complementation, molecular recombination.	
<b>Unit-IV</b>	<b>Human cytogenetics</b>	<b>(12)</b>
1	Cytogenetic implications and consequence of structural and numerical alterations of chromosome. ,Cytogenetic effects of ionizing and non-ionizing radiation.	
2	Techniques in human chromosome analysis. Molecular cytogenetic approach.	
3	Human karyotype, Q and R banding, nomenclature of chromosomes.	
4	Chromosome based heritable diseases in human: Sickle Cell Anemia, PKU and Thalassemia.	
<b>Unit-V</b>	<b>Molecular Cytogenetic Techniques</b>	<b>(12)</b>
1	Blotting Techniques- Southern, northern and western blotting techniques and applications.	
2	Polymerasechain reaction: Types, In-situ hybridization, FISH and GISH.	

3	Molecular cytogenetic techniques: Automated karyotyping, Chromosome painting, DNA Sequencing.
4	Application of RFLP in forensic Science, disease prognosis , genetic counseling and pedigree analysis.
5	Introduction to genomics, transcriptomics, proteomics, metabolomics

### Reference Book:

1.	<b>Molecular Biology of the Gene, J.D. Watson , N.H. Hopkins, J.W. Roberts et al The Benjamin/Cummings Pub. Co. Inc., California.</b>
2.	Molecular Cell Biology, J. Darnell, H Lodish and D. Baltimore Scientific American Books, Inc, USA.
3.	Molecular Biology of the Cell B. Alberts, D. Bray. J. Lewis, J.D. Watson. Garland Publishing Inc. New York.
4.	Molecular Biology and Biotechnology: A comparative desk reference. R. A. Meyers (ED) VCH Publishers, Inc New York.
5.	Genes VI/VII Benjamin Lewin Oxford University Press UK.
6.	Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley and Sons Ltd., New York.
7.	Cell Physiology and Molecular Dynamics, Henry Tedeschi (2003). Running text book available on Wen link only.
8.	Essentials of Human Genetics (1990). Orient Longmans Ltd. Bomb .

### Learning outcomes:

After successfully completing this course, the students will be able to:

- Understand how DNA encodes genetic information and the function of mRNA
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Relate the conventional and molecular methods for gene manipulation.
- Discuss and analyze the epigenetic modifications and imprinting.

## HCT 3.2 Biochemistry

Teaching Hours-60; Total credits -4

### About course

The course deals with various aspects related with Biochemistry w. r. t. major bio organic molecules, bioenergetics, metabolic pathways and enzymes.

Unit No.	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Bioenergetics</b>	<b>(12)</b>
1	Laws of Thermodynamics, Concept of free energy, Coupled reaction.	
2	Energy rich bonds, Hydrogen bonding, Redox potential, Oxidative phosphorylation.	
3	Concept of Metabolism, Coordinated control of metabolism, metabolic regulation during hypoxia.	
<b>Unit-II</b>	<b>Biomolecules</b>	<b>(12)</b>
1	Structure, properties and role of - Carbohydrates, Lipids, Proteins.	
2	Structure, properties and role of Nucleic Acids: DNA, forms of DNA: A, B- and Z- DNA, RNA: Types of RNAs, Micro-RNA.	
3	Types of vitamins and their role as co-factors in enzymes	
4	Venom as bioactive compounds and their significance (cone snail, spider, puffer fish and sea snake).	
<b>Unit-III</b>	<b>Metabolism of Carbohydrates and Proteins</b>	<b>(12)</b>
1	Carbohydrate Metabolism: Glycogenesis, Glycogenolysis, gluconeogenesis, glycolysis, TCA cycle, pentose phosphate pathway.	
2	Protein metabolism: Amino acid synthesis and breakdown, General reactions of amino acid metabolism, urea cycle.	
<b>Unit-IV</b>	<b>Metabolism of Nucleotides and Lipids</b>	<b>(10)</b>
1	Outline of biosynthesis of purines and pyrimidines.	
2	Biosynthesis of fatty acids, triglycerides, phospholipids and cholesterol.	
3	Breakdown of triglycerides, $\beta$ - Oxidation of fatty acids, Ketone bodies synthesis	
<b>Unit-V</b>	<b>Enzymology</b>	<b>(14)</b>
1	Classification and nomenclature of enzymes. Mechanism of Catalysis.	
2	Factors affecting enzyme activity. Co-enzymes, Enzyme activators and inhibitors, Isoenzymes, allosteric enzymes, Ribozyme, Abenzymes, Regulation of enzyme activity.	
3	Enzyme kinetics: Michaelis-Menten equation, Metabolic engineering, site directed mutagenesis and enzyme engineering. Immobilized enzymes and their applications.	

## Reference Books

1. Lehninger Principles of Biochemistry, 7<sup>th</sup> edition (2017). Dvis L. Nelson, Michael M. Cox. (Publisher-WH\_Freeman).
2. Biochemistry, 9th Edition (2019) Jeremy M. Berg, LubertStryer, John Tymoczko, Gregory Gatto. (Publisher-WH Freeman).
3. Fundamentals of Biochemistry, 5th Edition (2016) Donald Voet, Judith G. Voet, Charlotte W. Pratt(Publisher- John Wiley & Sons, Inc).
4. Biochemistry, 4<sup>th</sup> Edition (2013). Christopher K. Mathews, Kensal E. van Holde, Dean R Apppling and Spencer J. Anthony-Cahill. (Publisher- Pearson).
5. Harper's Illustrated Biochemistry, 31st Edition (2009). Victor W Rodwell, Peter J. Kennelly, Kathleen M. Botham, P. Anthony Weil, David A. Bender (Publisher- McGraw Hill).
6. Basic Separation Techniques in Biochemistry (1998). Okotore R.O. New Age Internationals New Delhi.
7. Fundamental Lab Techniques in Biochemistry and Biotechnology (1998). Ninfa A.J. and Ballou O.P. Fitzgeralf Science Press Bethesba.
8. Modern Experimental Biochemistry Boyer and Rodney (2001) Benjamin Cunnings N.Y.
9. Biochemistry of Plants and Animals Mallette M.E.
10. Cell Physiology and Biochemistry Mcelroy W. D.
11. Nature of Enzymology R.L. Foster.
12. Enzyme Biotechnology Tripathi G.

## Learning Outcomes:

- Students will be imparted complete knowledge about structure and function of different biomolecules found in living cells.
- Students can understand pathways, regulation and importance of metabolic pathways.
- This course provides the knowledge of enzyme, its function, and regulation.
- Understanding of biochemistry w.r.t. pharmacology, clinical and pathology

## SCT 3.1 Comparative Animal Physiology

Teaching Hours- 60; Total credits -4

### About the course

The course deals with various physiological functions in mammals. It also gives an account on the metabolic/ biochemical pathways and the probable impact of environment on them. The course integrates structural and functional aspects.

Unit No.	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Physiology of Digestion</b>	<b>(10)</b>
1	Feeding mechanism and its regulation, food and diet specificity.	
2	Comparative physiology of nutrition and digestion in vertebrates (Fish to mammals).	
<b>Unit- II</b>	<b>Physiology of Respiration, Excretion and Thermoregulation</b>	<b>(14)</b>
1	Physiology of respiratory pigments in different groups, circulation of body fluids and its regulation, regulation of pH of body fluids.	
2.	Pattern of nitrogen excretion among different animal groups, osmoregulation in freshwater and marine fishes, desert adaptation(s) of osmoregulation.	
3	Thermoregulation in Poikilotherms, homeotherms, hibernation.	
<b>Unit-III</b>	<b>Physiology of Vision and Hearing</b>	<b>(10)</b>
1	Physiology of light reception and visual perception, visual impairment.	
2	Physiology of of hearing, hearing impairment, hearing aids, Stato-acoustic organs in chordates.	
<b>Unit-IV</b>	<b>Physiology of Muscle, Heart and Reproduction.</b>	<b>(14)</b>
1	Physiology of contractile elements: voluntary and involuntary muscles- actin, myosin, troponin, tropomyosin; myofilaments; molecular mechanism of muscle contraction; myogenic heart, cardiac muscle physiology; role of isoenzymes (LDH) in cardiac physiology.	
2	Reproduction cycle in mammals and its hormonal control, infertility and surrogacy.	
<b>Unit- V</b>	<b>Physiology of Nervous system</b>	<b>(12)</b>
1	Physiology of nervous system with reference to neurohormone regulation in mammals.	
2	Neurotransmitters- types and roles.	
3	Physiology of bioluminescence.	
4	Physiology of sleep and anesthesia.	

## Reference Books

1. Comparative Animal Physiology. C. L. Prosser. W. B. Saunders and Company.
2. General and comparative physiology. W.S. Hoar.
3. Animal Physiology: Adaptations and Environment. Schmidt- Nielsen Cambridge.
4. Chemical Zoology Academic Press Edited by Florkin and Sheer 7 Volume series.
5. Physiology of Mammals and other vertebrates Marshall and Hughes.
6. Chemical Zoology Ed. Florkin and Sheer B. T. Academic Press Vol. 1-10.
7. Text Book of Medical Physiology: Guyton , Prism Publishers Bangalore 2004 Ed.
8. Comparative Physiology :B. T. Sheer.

## Learning outcomes

After successfully completing this course, the students will be able to:

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Understand the process of vision and hearing.
- Understand the process of muscle contraction
- Learn the determination of hemoglobin content, blood groups and blood pressure.



## SCT 3.2 Economic Entomology

**Teaching Hours- 60: Total credits -4**

### About the course:

To understand diversity and economic importance of insects, their anatomy, physiology, diversity and ecological roles.

Unit No.	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Industrial Entomology</b>	<b>(12)</b>
1	Sericulture- Types of silk worm, life cycle and rearing of mulberry silkworm ( <i>Bombyx mori</i> ) and its economic importance, mechanization in sericulture.	
2	Life cycle and rearing of non-mulberry silkworm (Tassar- <i>Antheraea mylitta</i> ): brief idea of cocoon processing for silk fabric, cocoon boiling, reeling, winding, doubling, twisting and weaving and its economic importance.	
3	Apiculture: types of honey bees. life cycle, bee-hive, apiary, bee products and its economic importance.	
4	Lac culture: Lac insect- <i>Laccifer lacca</i> -Life cycle, lac processing, lac-products and its economic importance.	
<b>Unit-II</b>	<b>Study of Insect pest</b>	<b>(12)</b>
1	Agricultural pests w. r. t. damage caused by- grasshopper, red cotton bug, cotton spotted boll-worm, cotton pink boll-worm, gram pod borer.	
2	House hold pest: cockroach, termite, stored grain pests.	
3	Veterinary pest: ticks, mites, bird lice.	
4	Vegetable pest: red pumpkin beetle- <i>Pieris brassicae</i> , brinjal fruit borer- <i>Leucinodes orbonalis</i>	
<b>Unit-III</b>	<b>Methods of Pest Control</b>	<b>(14)</b>
1	Natural control, applied control, Integrated Pest Management (IPM).	
2	Chemical control: organochlorine, organophosphate, pyrethroids, carbamates- mode of action, merits and demerits.	
3	Biological control: biological agents-predators, parasites, parasitoids; merits and demerits.	
<b>Unit-IV</b>	<b>Diseases Caused by Insect Vectors</b>	<b>(10)</b>
1	Mode of transmission and control- malaria, filaria and dengue.	
2	Mode of transmission and control-Sleeping sickness, Leishmaniasis (Kala azar).	
<b>Unit-V</b>	<b>Animal Association- Parasitism</b>	<b>(12)</b>
1	Types of parasites, types of hosts, interrelationship between host and parasite.	
2	Host responses to parasitic infection, mode of transmission of parasite.	
3	Host specificity and parasitic adaptations.	

## Reference Books:

- 1 A text book of Applied Entomology, vol.2 - K. P.Srivastava, 1996.
- 2 Elements of Entomology- Rajendrasingh.
- 3 A text book of Forest Entomology – T.V. Sathe, 2009.
- 4 Sericulture and Pest Management – T.V. Sathe and A. D. Jadhav, 2001.
- 5 Sericultural crop protection – T.V Sathe, 1998.
- 6 Agricultural Pests of India and South East Asia – A.S. Atwal, 1993.
- 7 Crickets and Household pests – T.V. Sathe and M.R. Awate, 2009.
- 8 Beekeeping in the tropics – G.S. Smit, 1960.
- 9 Beekeeping in India, ICAR, New Delhi, S. Singh, 1975.
- 10 A handbook of practical Sericulture, CSB, UllalandNarsimhanna, 1981
- 11 Lac culture in India farm information unit, DEMOFA, New Delhi S.Krishnaswami
- 12 A text book of applied entomology- K. P. Srivastava.
- 13 Elements of entomology- Rajendra Singh.
- 14 Invertebrate Zoology –Jordan Verma.
- 15 A text book of Entomology – B. D. Pattnaik.
- 16 A text book of Entomology – S. K. Kochhar.
- 17 Economic Zoology –Shukla Upadhaya. Saras Publication.
- 18 Invertebrate Zoology- R. L. Kotpal.

## Learning outcome:

After successfully completing this course, the students will be able to:

- Understand the diversity of insects.
- Understand the mechanism and regulation of pests and parasites.
- Understand how morphology changes in animals due to change in environment.
- Understand the process of feeding in insects
- Medical and forensic entomology
- Agriculturally important insects/pests
- Insects & human diseases
- Economic entomology and economy of insects

## OPEN ELECTIVE (Any one)

### OET 3.1 Wild life and Conservation Biology

Teaching Hours- 60; Total credits -4

#### About the course

The course is an introduction to wildlife management and gives an account of the tools used by wildlife managers. Topics covered are to equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases

Unit No.	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Ecosystem and Community</b>	<b>(10)</b>
1	Ecosystem and community: definition and characteristics of community, classification of communities, composition of community, structure and stratification of community, habit and Niche.	
2	Ecological succession: types of ecological succession, ecotypes, ecotone.	
<b>Unit-II</b>	<b>Ecofactors</b>	<b>(14)</b>
1	Factors affecting ecosystem and community structure: Natural factors: Earthquakes, tsunamis, volcanoes, landslides. Intracommunity factors- Competition, antagonism. Anthropogenic factors- Introduction of exotic species, urbanization, industrialization, Patch formation, breaking of food chain.	
<b>Unit-III</b>	<b>Biodiversity Conservation</b>	<b>(14)</b>
1	Quantifying community diversity: Indices of diversity	
2	Conservation of nature and natural resources: an overview of marine conservation and its management	
3	Traditional conservation practices, agricultural practices, fishing methods.	
4	Modern conservation practices- reserve forests, sanctuaries, national parks, biodiversity hotspots, captive breeding of endangered species.	
<b>Unit-IV</b>	<b>Natural Resources</b>	<b>(12)</b>
1	Renewable resources: Solar, wind, hydro-energy, tidal and biomass energy.	
2	Non-renewable resources: Oil, natural gas, coal, nuclear.	
3	Role of individuals, NGOs and GOs in conservation of natural resources.	
<b>Unit-V</b>	<b>Wildlife and Environmental Protection Acts</b>	<b>(10)</b>
1	Indian Forest Acts-1980, Indian Wildlife Act-1972, Environment (Protection) Act-1986, Red data book.	
2	Earth Summit and Agenda, Environment Impact Assessment (EIA).	

#### Reference Books

- 1 Ecological Methods with particular reference to the study of insect populations: Sothwood T. R. E.
- 2 The Oxford Anthology of Indian Wild life Vol I Hunting and Shooting.
- 3 The Oxford Anthology of Indian Wild life Vol II Watching and Conserving.

- 4 Nair S.M. Endangered Animals in India and Their Conservation.
- 5 English M.A. Animal Kingdoms : Wild Sanctuaries of the World.
- 6 Sanctuary Asia : Bimonthly Journal.
- 7 Biodiversity: E.O. Wilson (1988) National Academies Press.

**Learning outcomes:** After successfully completing this course, the students will be able to:

- Develop an understanding of how animals interact with each other and their natural environment
- Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues
- Develop the ability to work collaboratively on team-based projects
- Demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.
- Develop an ability to analyze, present and interpret wildlife conservation management information.

## OET 3.2 Ecology and Ethology

Teaching Hours- 60; Total credits -4

### About the course:

To understand the basics of ecology and animal behavior. The course integrates study of interactions of organisms with their environment, distribution of species and the factors that regulate them.

Unit No	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Ecosystem</b>	<b>(12)</b>
1	Structure and function of ecosystem.	
2	Energy flow and energy pyramids.	
3	Mineral cycling (Carbon, Nitrogen, Phosphorus).	
4	Primary production and decomposition.	
5	Structure and function of ecosystems: Terrestrial (forest) and Aquatic (fresh water).	
<b>Unit-II</b>	<b>Habitat and Niche</b>	<b>(12)</b>
1	Concept of habitat and niche.	
2	Niche width and overlap.	
3	Fundamental and realized niche; ecological succession: types; mechanisms; changes involved in succession, concept off climax community.	
<b>Unit-III</b>	<b>Species Interactions</b>	<b>(12)</b>
<b>1</b>	Types of interactions - Interspecific: commensalism, mutualism, parasitism, symbiosis, competition.	
2	Intraspecific Interactions with examples.	
3	Community ecology: Nature of communities; community structure and attributes; edges and ecotones.	
<b>Unit-IV</b>	<b>Population Ecology and Ethology</b>	<b>(12)</b>
1	Characteristics of a population	
2	Population growth: Natalty, mortality, survivorship, life-tables	
3	Population regulation: Intraspecific competition, density dependent regulatory factors, concept of carrying capacity, life-history traits ( $r$ and $k$ selected species)	
4	Reproductive behavior: Courtship behavior and its adaptive significance with examples; altruistic behavior-kin selection with suitable examples, Sociobiology and its adaptive nature.	
<b>Unit-V</b>	<b>Applied Ecology</b>	<b>(12)</b>
1	Brief idea of causes, control and prevention of environmental pollution with reference to Air, water, Noise and land pollution.	
2	Biodiversity-Global patterns of biodiversity: Latitudinal and Longitudinal distribution of species.	
3	Application of G.I.S. (Geographical Information Systems), G.P.S	

## Reference Books

- 1 Alcock, John 1975. Animal behaviour—an evolutionary approach. (Sinauer Associates). 547 pages.
- 2 Barnard, C.J. 1983. Animal behaviour. (Croom Helm, London). 340 pages.
- 3 Barnett, S.A. 1981. Modern Ethology.
- 4 McFarland, David. Animal behaviour: Psychology, Ethology & Evolution. (ELBS Publ.).
- 5 Slater, P.J.B. 1999. Essentials of animal behaviour. (Cambridge Univ. Press). 233 pages.
- 6 Wallace, Robert A. 1979. The ecology and evolution of animal behavior. (Goodyear Publ. Co. Inc.).284 pages.
- 7 Agarwal, V.K. Animal Behaviour (Ethology).
- 8 Agarwal, V.K. & Usha Gupta. S. Chand's simplified course in Ecology and Ethology. (S. Chand &Co.).
- 9 Gundevia, H.S. & Hare Govind Singh. A Textbook of Animal Behaviour. (S. Chand & Co.). 280 pages.
- 10 Mathur, Reena, 1998. Animal behaviour. (Rastogi Publ., Meerut). 280 pages.
- 11 Arora, Mohan P. 2000. Animal behaviour. (Himalaya Publ. House). 436 pages.
- 12 Ranga, M.M. (2004). Animal behavior- [Agrobios (India)]. Rs.395.
- 13 Shukla, J.P. Fundamentals of Animal behaviour.
- 14 Ecology Textbook Md. Abdul Ahad.
- 15 Fundamentals of Ecology 2004 by Eugene Odum , Gary Barrett
- 16 Environment and Ecology by R. Rajagopalan.
- 17 Environment and Ecology' by Majid Husain - Access Publishing India Pvt. Ltd.
- 18 Bandhopadhyay j. (ed.), 1985, India's Environment, Crisis and Response.
- 19 Fernandes W. Menon G and Viegas P, 1998, Forests, Environment and Tribal Economy, Deforestation Impoverishment and ' Marginalisation in Orissa, Indian Social Institute, Tribes of India Series 2, New Delhi.
- 20 Goldblatt. D, 1996, Social Theory and Environment, Polity Press, U.K.
- 21 Jeffery Roger and Sundaran Nandini (ed.), 1999, A new moral economy for India's Forests, Sage Publications Private ltd., Delhi.
- 22 Maccully Patrick, 1998, Silenced Rivers, The Ecology and Politics of Large Dams, Orient Longmann,New Delhi.
- 23 Environment and Man- R.H. Wagher.
- 24 Man fresh water ecology- T.T. Macan.
- 25 Biodiversity, academic press Washington- E.O. Wilson.
- 26 Biodiversity Principles and conservation, Kumar and Aseja Agrobios Sidia.
- 27 Biodiversity and Environment Agrawal Tiwari and Dubey.
- 28 Principles of Environmental Biology PKJ Nair Himalaya Pub House Delhi.
- 29 E.O. Wilson: Biodiversity, Academic Press, Washington.

## Learning outcome

At the end of the course, Students will be able to understand

- Ecological relationships among species and their variables
- Species distribution, population, habitats and niche concepts & applied ecology for their study
- Ethological aspects such as causation and evolution of behavior

## M. Sc. part II- Sem III –PRACTICALS

Sr. No.	Title of the practical	Credits
<b>HCP 3.1</b>	<b>Molecular Cytogenetics</b>	<b>(2 credits)</b>
1	Demonstration of Barr body.	
2	Isolation of nuclei and mitochondria using ultracentrifugation.	
3	To study effect of colchicine on metaphasic chromosomes in onion root tip.	
4	Study of polytene chromosomes in <i>Chironomous</i> larva / <i>Drosophila</i> .	
5	Demonstration of Polymerase Chain Reaction (PCR).	
6	Determination of cell size/nucleus using micrometry.	
7	Examples of Mendelian inheritance of human genetically inherited diseases (minimum 5).	
8	Pedigree analysis of human genetical traits & diseases (Four types).	
9	Study of following techniques through photographs/virtual. i) DNA fingerprinting ii) Human genetic diseases: Down, Turner's, Klinefelter's, Cat cry syndrome.	
10	Collection and analysis of demographic data on genetical diseases and cancers from local hospitals.	
<b>HCP 3.2</b>	<b>Biochemistry</b>	<b>(2 credits)</b>
1	Calorimetric estimation of blood urea.	
2	Colorimetric estimation of glucose.	
3	Colorimetric estimation of Protein.	
4	Separation of Isozyme- LDH by electrophoresis.	
5	Estimation of fat soluble vitamins (Vitamin-A).	
6	Estimation of water soluble vitamins (Vitamin-C).	
7	Colorimetric estimation of Lactose in Milk.	
8	Preparation of casein from milk.	
9	Electrophoretic separation of proteins.	
10	Preparation of starch from potato.	
11	Excursion Tour (research centre / instrumentation centre).	



<b>SCP 3.1</b>	<b>Comparative Animal Physiology</b>	<b>(2 credits)</b>
1	To study effect of stress on heart beat in male and female human individuals and perform statistical analysis of data.	
2	To study effect of stress on pulse rate in male and female human individuals and perform statistical analysis of data.	
3	To study effect of stress on blood pressure in male and female human individuals and perform statistical analysis of data.	
4	To perform effect of stress (pH variation) on oxygen consumption of aquatic animal (Guppy fish/ornamental fish) and perform statistical analysis of data.	
5	To study effect of body weight on rate of oxygen consumption using fishes	
6	To perform a comparative analysis of hemoglobin concentration among male and female individuals during a monthly cycle and perform statistical analysis of data (monthly data)	
7	To perform analysis of nitrogenous waste products from different habitats (ammonotelic, uricotelic and ureotelic animals) using ammonia test, uric acid test and urea test	
8	To perform effect of hypotonic, hypertonic and isotonic solutions on RBC morphology in vertebrates differing in their habitats (Fish, birds and mammals)	
9	Estimation of blood sugar in fish/bird/mammal (any two)	
10	To study effect of hypergravity on rate of heart beat of <i>Daphnia</i> and perform statistical analysis of same	
11	To analyze ECG of patients suffering with cardiovascular diseases and draw conclusion accordingly	
12	To investigate effect of yoga and meditation on rate of heart beat, pulse rate, Blood Pressure and on male and female (monthly data)	
13	To estimate blood calcium concentration in male and female and correlate with monthly data.	
<b>SCT 3.2</b>	<b>Economic Entomology</b>	<b>(2 credits)</b>
1	Documentation and identification of stored gains pests.	
2	Documentation and identification of household pests- Cockroach, rat and louse.	
3	Documentation and identification of pests of medical importance: Mosquito, housefly from local area.	
4	Documentation and identification of pests of veterinary importance: Ticks and mites, lice, biting flies, fleas.	
5	Documentation and identification of forest pests: Bark beetle, borers, gypsy moth, leaf beetle, Scarabs etc.	
6	Study of types of silk moths (museum specimens).	
7	Documentation and identification of forensic insects- Blow flies, Flesh fly, Green bottle fly, House fly, Piophilidae, Chrysoma, Phoridae etc.	
8	Documentation and identification of nutritional insects: Grasshoppers,	

	termites, silkworms.
9	Observation and documentation of predator-prey interactions in local agro-ecosystems/botanical garden.
10	Economic evaluation of sericulture from local agro-ecosystem and its statistical analysis
11	Economic entomological survey of use of insect pheromones repellants, attractants and other methods to controls pests from local agro-ecosystems and its statistical analysis
12	Economic entomological survey and data collection on major pests of: Pomegranate, Grapes, Jowar, Onion,
13	Survey of pesticide use in agro-ecosystem from local area & its statistical analysis: Chemical based, biopesticides and other traditional methods.

<b>OEP 3.1</b>	<b>Wild life and Conservation Biology</b>	<b>(2 credits)</b>
1	Community sampling for animals- Sampling methods (line transect, quadrat and point count) to study relative abundance of species.	
2	To prepare casting of pug marks using plaster of Paris for identification wild animals.	
3	Identification of diversity of: insects, butterflies, reptiles, aves and mammals from urban ecosystem/botanical garden	
4	Identification of locally seen wild animal parts: hairs, antlers, teeth(s), skull, bones etc. from nearby habitats	
5	To document, identify and study impact of road kill on animals from local area (to explore impact of habitat fragmentation).	
6	To demonstrate use of basic equipments used in wildlife studies: Binocular, GPS, insect and plankton net, insect spreader etc.	
7	To record indirect evidences of wild animals: Pug marks, calls, songs, scats, scent mark, dust bath etc.	
8	Observation and documentation of rare and endangered species from local area: Great Indian Bustard, Indian Grey Wolf, Lesser Florican, Golden Jackal, harriers etc.	
9	To perform use of Q-GIS for preparation of map of study area.	
10	To geotag observed specimens in the wild or within campus area with the help of mobile GPS.	
<b>OET 3.2</b>	<b>Ecology and Ethology</b>	<b>(2 credits)</b>
1	To observe and document grassland adapted/interior species from local ecosystem.	
2	To determine physical parameters of water- temperature, pH , Turbidity.	
3	To perform estimation of DO/ BOD from various water samples.	
4	To perform estimation of hardness and TDS of water samples.	
5	To perform estimation of nitrates and phosphates from a given water samples.	

6	To analyze biomass of a given ecosystem or patch of habitat
7	To estimate productivity of a given ecosystem (Primary and Secondary) or patch of habitat
8	To gather data on air quality from urban ecosystem from municipality sources and perform statistical analysis and interpretation
9	To record and interpret of courtship behavior in insects, lizards, birds (minimum three) from local gardens/campus
10	To record and interpret community structure of insects and birds within campus/local gardens
11	Visit to any biodiversity centre /National park/Sanctuary and submission of report.

**Learning Outcomes:** at the end of practical course, students will gain knowledge about:

- Molecular aspects of cell and their analysis in biochemistry and cell biology
- Chemistry and physics behind body functions in physiology laboratory
- Biodiversity and ecosystem, natural resources and their measurement and valuation
- Role of agricultural and economic entomology through survey, documentation and importance

## SEMESTER -IV

### HCT4.1 Animal Biotechnology

Teaching Hours- 60; Total credits -4

#### About the course

This course gives an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way. It envisages concepts, mechanisms, biological designs, functions and evolutionary significance of genetic modification or manipulation in special organisms and also discusses the recent advance in recombinant DNA technology.

Unit No.	Title and chapters	Lectures
<b>Unit-I</b>	<b>Cell and Tissue Culture</b>	<b>(15)</b>
1	Primary cultures, cell line, cell clones, somaclonal variations, micropropagation, somatic embryogenesis.	
2	Haploidy, protoplast fusion, and somatic hybridization, cybrids, gene transfer methods, transgenic biology.	
3.	Cell diversification in early embryo, stem cells and stem cell therapy, totipotency and pluripotency, embryonic stem cells; Renewal of stem cells- epidermis, hematopoietic stem cells, blood cell formation, bone marrow transplant, placental (cord) blood.	
<b>Unit- II</b>	<b>Current Issues in Animal Biotechnology</b>	<b>(15)</b>
1	Gene knockout technology and its applications in animal biotechnology	
2	Xenotransplantation- donor animals, immunological rejection with example	
3	Whole animal genomic sequencing and its application in biotechnology (Overview of <i>Drosophila</i> and <i>Homo sapiens</i> ).	
4	Application of animal biotechnology (transgenic carp, transgenic cow) and ethical issues; Crispr-cas9 (gene editing)	
<b>Unit- III</b>	<b>Animal Cloning Techniques</b>	<b>(10)</b>
1	Types of artificial cloning: Reproductive cloning, gene cloning, therapeutic cloning.	
2	Somatic cell nuclear transfer method with suitable example (Dolly the sheep).	

3	Applications of cloning (for therapeutic protein production in the milk, transplantation, genetically modified livestock).	
<b>Unit-IV</b>	<b>Applied Biotechnology</b>	<b>(10)</b>
1	Somatic cell banking, in-vitro cryo-conserved materials (semen, oocytes, embryos, somatic cells), Use of molecular markers for wildlife conservation.	
2	Biotechnology for evaluation of genetic diversity, applications in wildlife forensics.	
3	Transgenic animal technology, methods of captive breeding, artificial insemination.	
4	Biodiversity informatics: Global Biodiversity Information Facility (GBIF) and its applications	
<b>Unit-V</b>	<b>Applications of Animal Biotechnology</b>	<b>(10)</b>
1.	Principles and methods of genetic engineering and gene targeting, application in agriculture, health, medicine and industry.	
2	Ethical issues in human cloning and biotechnology, biosafety regulations	
3	Genetic Engineering and Approval Committee (GEAC) as a regulatory body in India	
4	Bioinformatics: Introduction to biological databases and sequence retrieval	

#### Reference Books:

- 1 Guidelines for Human Embryonic Stem Cell Research National Academies Press (2005).
- 2 Stem Cells and Future Regenerative Medicine (2002) National Academies Press.
- 3 Animal Cell Culture: A Practical Approach Ed, John R.W. Masters IRL Press.
- 4 Cell Culture Handbook -Sigmall. ( Available with the help of Internet Search Sigma Website).
- 5 Concepts of Genetics Klug W.S. Cummings M.R. (2005) Pearson Education , Delhi.
- 6 Campbell A.M. and Heyer L.J. Discovering Genomics, Proteomics and Bioinformatics Pearson Education (2004).
- 7 Selvin J. and Others : Biotechnology Emerging trends, Biotech Books Delhi (2003).
- 8 Cellular Interaction and Immunology (1994). Open University Netherlands University of Greenwich, UK.

**Learning outcomes:** After successfully completing this course, the students will be able to:

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

**HCT 4.2 Applied Zoology**  
**Teaching Hours- 60; Total credits-4**

About Course. The course discusses applied aspects of reproductive technologies, immunology, Hematology and economic zoology

<b>Unit No</b>	<b>Title And Contents</b>	<b>Lectures</b>
<b>Unit-I</b>	<b>Advances in Reproductive Technology</b>	<b>(10)</b>
1	Reproductive technology- Collection and cryopreservation of gametes, semen analysis, induction, of ovulation, sterility and its treatment, Gamete Intrafallopian Transfer (GIFT).	
2	Surrogate pregnancy and gestational carrier, fertility control in male and female, modern trends in contraception. methods of hormonal assay, reproductive tract infections.	
<b>Unit-II</b>	<b>Immunology</b>	<b>(20)</b>
1	History, overview, and scope of immunology.	
2	Antigen- antigenecity, organs of immune system, cells and tissues in immune system, Innate immunity, humoral immunity, B-lymphocytes, Immunoglobulins, organization and expression of immunoglobulin genes.	
3.	Cell mediated immunity- T-lymphocytes, Major Histocompatibility Complex MHC: Class I and II molecules, HLA system in human.	
<b>Unit-III</b>	<b>Vaccines</b>	<b>(10)</b>
1	Development of polyclonal sera, monoclonal antibody production and characterization, applications of monoclonal antibodies.	
2	Vaccines- Conventional and genetically engineered vaccines, Booster dosing of vaccine.	
3	DNA vaccines, RNA vaccines, Immunological tolerance, immunological rejection.	
<b>Unit-IV</b>	<b>Hematology</b>	<b>(10)</b>
1	Blood bank protocols: Blood matching, methods of separation of blood cells, plasma and serum, routine tests of blood in blood bank.	
2	Blood cancer: Types- Leukemia, lymphoma, myeloma (diagnosis, causes and symptoms); Bone marrow transplantation.	
<b>Unit-V</b>	<b>Economic Zoology</b>	<b>(10)</b>
1	Vermitechnology: Importance of vermiculture, vermiwash, Vermicompost, Earthworms as protein source.	
2	Dairy industry: An overview of Indian White Revolution.	
3	Aquaculture: An overview of Indian Blue Revolution.	
4	Apiary: Golden Revolution and National Horticulture Mission with reference to production of honey and horticulture.	

## Reference Books:

- 1 Animal Health at Cross Roads: Preventing Detecting and Diagnosing Animal Diseases (2005).
- 2 IVF Protocol (Wikipedia) The Free Web Encyclopaedia.
- 3 Biotechnology Research in Age of terrorism: National Research Council (2004). National Academies Press.
- 4 Earthworms-Their ecology and Relationship with Soils and Land Use; Lee K. E.
- 5 Modern Immunology :Das Gupta.
- 6 Biology of Earthworms: Edwards C. A. and Lofty J. R.
- 7 Immunology; Roitt I.M. / Brostoff J.

## Learning Outcome: At the end of the course:

- Students with gain knowledge of immunology, vaccines
- Will understand concepts of reproductive tools, hematology and economic zoology
- Students will be able to apply learned knowledge to their future research.

### HCT-4.3 Environmental Biology and Toxicology

Teaching Hours-60 ; Total credits-4

#### About the course

The course aims to provide a broad understanding of ecosystem structure and function and its applied components.

Unit No.	Title and Chapters	Lectures
<b>Unit-I</b>	<b>Ecosystem Structure</b>	<b>(15)</b>
1	Concept, components of ecosystem: primary productivity, gross primary productivity, net primary productivity, secondary production; structure and function of ecosystem; food chain and energy flow, productivity.	
2	Biogeochemical Cycles: Oxygen, Carbon, nitrogen, sulfur, phosphorus; impact of anthropogenic activities on biogeochemical cycles	
3	Biomes: major categories (forests, woodlands, shrublands, grasslands, scrublands, deserts)	
<b>Unit-II</b>	<b>Habitat Ecology</b>	<b>(15)</b>
<b>1</b>	Aquatic communities: Categories (Freshwater lentic, freshwater lotic, estuaries, marine benthic, marine pelagic); Distribution and impact of environmental factors in the marine ecosystems (littoral, abyssal, neritic & oceanic communities); critical habitats in marine ecosystem (sea grass, mangroves, coral reef)	
<b>2</b>	Landscape ecology: definition, heterogeneity concept, ecological characteristics of semi-arid grassland as a landscape; Tropical environments and high biodiversity correlation; Tropical rain forests: distribution, significance and challenges for conservation.	
<b>3</b>	Ecological Restoration of degraded ecosystems: Definition, principles and methodology, case studies of ecologically restored ecosystems in India; Ecology of agriculture (soil erosion and agriculture)	
<b>Unit-III</b>	<b>Natural Resources and Human Ecology</b>	<b>(10)</b>
1	Natural resources and their conservation: Renewable and non-renewable, alternate sources of energy; dams: benefits and	



	problems, impact of dams on tribal community; soil erosion and desertification; Solar energy and International Solar Alliance.	
2	Food Resources: Changes in landuse by agriculture, overgrazing and its impact on land, impact of modern agriculture, water logging and salinity	
3	Human Ecology: Population explosion & its impact on natural resources, green revolution and its impact.	
<b>Unit-IV</b>	<b>Environmental Pollution</b>	<b>(10)</b>
1	Environmental pollution- implications in terms of causes, effects and control of air, water, soil, noise, radiation and thermal pollution.	
2	Case studies: i) Chernobyl and Three Mile Island ii) Minamata disease iii) Methylene Isocyanate poisoning in Bhopal	
3	Issues and challenges of pollution: carbon credits, cultural eutrophication, DDT as biocide, biological indicators of pollution; microplastic, additives and bioaccumulation.	
4	Legislation and Indian standards of pollution levels w.r.t. air, water and soil.	
<b>Unit-V</b>	<b>Toxicology</b>	<b>(10)</b>
1	Toxicology- Classification of toxicants, pesticides, metals, toxic agents in house hold use.	
2	Determination of LC50 along with regression analysis of toxicant.	
3	Carcinogens used in industries, food additives in the form of food colours and preservatives.	
4	Food and Drug Administration (FDA) standards.	

### Reference Books

- 1 **Singh H.R. Introduction to Animal Ecology and Environmental Biology.**
- 2 Lee K.E. Earthworms: Their Ecology and Relationship with soil and land use (1985) Academic Press, New York.
- 3 Matsumura Fumio Toxicology of Insecticides (1985) Plenum Press New York.
- 4 Jakob T. Food Adulteration (1977). Macmillan Comp Delhi.
- 5 Jacob T. Foods, Drugs and Cosmetics (1977) Macmillan Comp Delhi.
- 6 Text Book of Environmental Science Purohit/Shammi/ Agrawal (2005 reprint) Student Edition Jodhpur.
- 7 Environmental Biology : Eric Bharucha UGC Press Hyderabad 2005.
- 8 Environmental Toxicology Satake M, Mido Y and others (2001) Discovery Publishers Delhi.
- 9 Mineral Resources Economic and Environmental Kesler S.E. (1994) Mac-Millan College Publishers London.

- 10 Environmental Medicine Andrew Pope and David Rall (1995) National Academies Press.
- 11 Environmental Challenges in Chemistry in 21st Century Report on Workshop on Environment (2003) National Academies Press.
- 12 Forging a Poison Control System Committee on Poison Control System US (2004).

**Learning outcomes:**

On the completion of the course, the students shall be able to

- Understand the functioning of ecosystems with examples
- Analyze ecological dynamics of various biomes, ecosystems etc.
- Reflect upon various sustainable environmental protection strategies
- Evaluate the implications of legislations, policies for environmental protection

## SCT-4.1 Zoo Keeping and Animal House Management

**Teaching Hours-60 ; Total credits-4**

**About course:** The course delivers *in situ* conservation of animals in the Zoo. This will enable students to contribute in the understanding of needs of animals in captive environment.

Unit No.	Title and Chapters	Lecture
<b>Unit-I</b>	<b>Introduction to Zoo-keeping</b>	
1	Introduction, Scope, captive breeding and zoo management policy of India	<b>(06)</b>
2	Management- Animal behavior in captivity, zoo layout.	
3	Rules for governing zoo in India (Zoo Authority of India).	
4	Role and responsibilities of zoo animal keeper.	
<b>Unit-I</b>	<b>Zoo Keeping-Reptiles</b>	<b>(06)</b>
1	Case study of captive breeding and management of crocodiles in India.	
2	Management of snakes in zoos, antivenom production in India (Haffkin Institute, Mumbai).	
<b>Unit-II</b>	<b>Zoo keeping- Aves</b>	<b>(10)</b>
1	Housing, feeding, behavior of birds in zoo; enclosure design for birds; Nesting material used for zoo birds.	
2	Management of captive birds in enclosures with example of local birds like Great Indian Bustard ( <i>Ardeotis nigriceps</i> )	
3	Food habits of different groups of birds in Zoo.	
4	Case study of captive bred birds in India and their management (Bustard, vulture).	
<b>Unit- III</b>	<b>Zoo keeping- Mammals</b>	<b>(14)</b>
1	Housing, feeding, behavior of common zoo mammals.	
2	Prioritized mammalian species for captive breeding in India (Red Panda, golden langur, muskdeer, hoolock gibbon, rhino, mouse deer, giant squirrel)	
3	Common diseases and its prevention in zoo mammals.	
<b>Unit-IV</b>	<b>Managing Animal Habitat in Zoos</b>	<b>(14)</b>
1	Layout of species specific animal pen or enclosures.	
2	Hygiene and sanitation standards, tools and chemicals for cleaning of enclosures, safety and security measures, waste disposal practices for enclosures.	
3	First aid to animals in cages.	
<b>Unit-V</b>	<b>Animal House Management</b>	<b>(10)</b>
1	Animal house management- Management of rodents- growth, maintenance, housing, feeding, disinfection procedures in animal house.	

2	Guidelines for use of laboratory animals for research in India.	
3	Taxidermy and its applications.	
4	Role of zoos in conservation education and awareness.	

### Reference Books

- 1 **Animal Care and Management at the National Zoo Review Smithsonian Institute's National Zoological Park (2005) National Academies Press.**
- 2 An Introduction to Animal Behavior, (1997) Cambridge, New York.
- 3 Rodents Laboratory Animal Management: National Academies Press 1996.
- 4 Animal care and Management at the National Zoo: Smithsonian Institute's National Zoological Park Interim Report (2004)
- 5 PJC Zoo Animal Technology On line (Free website).
- 6 Taxidermy .net
- 7 Animal Health at the cross roads Preventing Detecting and Diagnosing Animal Diseases(2005) National academies Press.

### Learning outcomes:

On the completion of the course, the students shall be able to

- Understand Animal behavior in captivity learn Zoo architecture.
- Rescue and rehabilitation of animals.
- Animal care and ethics.
- Conservation practices in captivity.
- Education and awareness on biodiversity.
- Career opportunities in zoo and wildlife sectors.

## SCT 4.2 FISHERY SCIENCE

Teaching Hours- 60; Total credits -4

**About course:** The course deals with application of fisheries in food industry, its biology, aquacultural practices, economy and other interesting facts on fishes.

Unit No.	Title and Chapter	Lectures
<b>Unit-I</b>	<b>General Features of Fishes</b>	<b>(10)</b>
1	General characters and classification of fishes.	
2	Identification of larval stages of major carps.	
3	Identification of major carp fishes up to species level.	
<b>Unit-II</b>	<b>Aquatic ecosystems</b>	<b>(10)</b>
1	Characteristics and diversity of -Fresh, brackish and marine waterfishes with examples.	
2	Identification of plankton, nekton and benthos: definition and role as fish food.	
<b>Unit-III</b>	<b>Aquaculture</b>	<b>(14)</b>
1	Culture techniques of major carps.	
2	Breeding techniques, induced breeding, breeding in hapa,	
3	Types of fish culture- Cage culture, monoculture, polyculture.	
4	Types of hatcheries, hatching hapa, Chinese hatchery.	
<b>Unit-IV</b>	<b>Economic importance of fishes</b>	<b>(14)</b>
1	Conventional and non-conventional fishing methods.	
2	Fishing crafts and gears.	
3	Fish products and by-products.	
4	Fish preservation techniques, economic importance of fishes.	
<b>Unit-V</b>	<b>General Topics in Fishes</b>	<b>(12)</b>
1	Coloration in fishes, physiology of coloration.	
2	Types of migration: Catadromous and anadromous with examples; Significance of migration.	
3	Bioluminescence and physiology of light production in fishes.	
4	Electric organ in fishes.	

### References Books

- 1 Prosser & Brown- Comparative Physiology
- 2 Leninger- Principles of Biochemistry
- 3 Harper-. Physiological Chemistry
- 4 Boyd, C.E. -Water Quality Management for Pond Fish Culture. Elsevier Scientific Publishing Company, 1982.
- 5 Jhingran, V. G. -Fish and Fisheries of India. Hindustan Publishing Corporation India, 1982.
- 6 Bardach *et al.*, (1972). Aquaculture-The farming and Husbandry of Freshwater and Marine Organisms. John Wiley and Sons, NY.

- 6 Bardach, *et. al.*, -Aquaculture – The Farming and Husbandry of Freshwater and Marine Organisms. John Wiley & Sons, NY, 1972.
- 7 Chondar, C.L. -Hypophysation of Indian major carps. Satish Book Enterprise, Agra, 1980.
- 8 Santhanam, R. *et. al.* -A Manual of Freshwater Aquaculture. Oxford & IBH Publishing Co. Pvt.Ltd., 1987.
- 9 Cheng, T.C. -The Biology of Animal Parasites. Saunders, Philadelphia, 1964.
- 10 Ribelin, W.E. & G. Miguki- The Pathology of Fishes. The Univ. of Wisconsin Press Ltd., Great Russelst., London, 1975.
- 11 Karunasagar, I. -Aquaculture and Biotechnology. Oxford-IBH Publishers, New Delhi.
- 12 Govindan, T.K. -Fish Processing Technology, Oxford-IBH, 1985.
- 13 Shang, Y. C. -Aquaculture Economic Analysis – An Introduction. 1990
- 14 Nikolsky, G. V. -Ecology of Fishes. Academic Press, NY, 1963
- 15 Nikolsky, G.V. -Ecology of Fishes. Academic Press, NY, 1963
- 16 Day, F. -The fishes of India.

**Learning outcomes:** On the completion of the course, the students shall be able to

- Understand taxonomy and ecology of fishes
- Knowledge on methods of aquaculture industry
- Know-how of recent aquaculture practices and its economical value

**MP4. 1- Project**  
**MP 4.1: PRACTICAL PAPER: PROJECT DISSERTATION AND VIVA- VOCE**  
**(200 Marks, Credits-8)**

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**Students have to begin their projects in 3<sup>rd</sup> Semester and submit the report in 4<sup>th</sup> Semester.**

- Students have to select individual project under the guidance of faculty and carry out projects as an in-house activity or in collaboration with industry/institute with the permission of host institution.
- Projects will be related to **Zoology and allied branch** with applied components.
- Research out-put will be presented in the form of a **dissertation**. At the end of semester IV students have to present their research outcome in the form of oral presentation during practical examination.
- Weightage will be given based on: Introduction, Objectives, Review of literature, Materials & methods, Results and Discussion, Summary & Conclusions, References and overall significance of project outcomes.
- Students will be encouraged to publish their research outcomes in research journals

**Note:**

As per the guidelines of UGC notification number F.14-6/2014(CPP-II) dated 1st August, 2014 it is now essential to make necessary modifications to stop dissection and promote and orient students towards the knowledge component rather than skill development. However, ITC based virtual dissections are promoted. Now, the responsibility to discontinue dissections and use of animals in experiments totally rests on concerned authorities of respective colleges/Institutes. As per the notification it is important to encourage the field trips and observations without disturbing the biodiversity. For laboratory observations existing permanent slides and specimens should be shown. As per the guidelines of UGC, all the Zoology departments should be empowered with infrastructure to adopt Information communication technology (ICT) required for the purpose of virtual dissections for which virtual class room / laboratory to be enriched with few computers (according to the strength of students), internet facility, printer etc.

**Note: The excursion tour may be arranged by abiding the rules of Government of Maharashtra/PAH Solapur university/Parent Institute.**

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## NATURE OF QUESTION PAPERS

Walchand College of Arts and Science (Autonomous), Solapur  
Nature of Theory Question Paper for CBCS Pattern (CHOICE BASED CREDIT SYSTEM)  
Faculty of Science M.Sc.-I and II Zoology

Time: - 3 hrs

Total Marks-80

### Instructions:

- i) Question No. 1 and 2 are compulsory
  - ii) **Attempt any three questions from Q.No. 3 to Q.No.7**
  - iii) Figures to right indicate full marks
  - iv) Draw neat labeled diagram wherever necessary
- 

- Q. 1** A) Choose correct alternative (MCQ) (10)  
B) Fill in the blanks or write true / false (06)
- Q 2. A) Answer the following (16=4x4)**  
A)  
B)  
C)  
D)
- Q.3) Answer the following (10+6 or 8+8)**  
A)  
B)
- Q.4) Answer the following (10+6 or 8+8)**  
A)  
B)
- Q.5) Answer the following (10+6 or 8+8)**  
A)  
B)
- Q.6) Answer the following (10+6 or 8+8)**  
A)  
B)
- Q.7) Answer the following (10+6 or 8+8)**  
A)  
B)



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**PRACTICAL**

**Walchand College of Arts and Science (Autonomous), Solapur  
Nature of Practical Question Paper for CBCS Pattern  
(CHOICE BASED CREDIT SYSTEM)  
Faculty of Science M.Sc.-I Zoology**

**Total Marks: 40**

Q.1.	Major Experiments (Options)	15
Q.2.	Minor Experiments (Options)	10
Q. 3.	Spotting	05
Q.4.	Laboratory Record (Journal)	05
Q. 5:	Viva-Voce	05

(Prof. R. V. Hippargi)  
**Chairman BOS in Zoology**