St. Aloysius College (Autonomous), Jabalpur

Department of Zoology

M.Sc. ZOOLOGY - III Semester

Choice Based Credit System (CBCS)

Scheme of Examination (w.e.f. Session 2023-24)

Course No.	Course Title	Credits	Marks	
			Max. Marks	Min. Marks For Passing
CORE COURSES				
ZC -301.	Comparative Anatomy of Vertebrates	4	40	14
ZC -302.	Limnology	4	40	14
ZC -303	Ecotoxicology	4	40	14
ZC -304	Aquaculture	4	40	14
ELECTIVE COURSE – (Any 01)				
ZE-305	• Sericulture • Animal Biotechnology	4	40	14
INTERNAL ASSESSMENT				
ZI -306	CCE-Written test (Based on core and elective Courses ZC- 301, 302 ,303, 304 & ZE-305) (Each test of 10 marks)	0	50	20 (04 in each Test)
ZI -307	Project/ Seminar	1	25	09
PRACTICALS				
ZP -308	Practical- I Based on Course ZC -301. & ZC -302.	2	50	18
ZP -309	Practical- II Based on Course ZC -303,ZC -304 & ZE-305.	2	50	18
SKILL BASED COURSE				
ZS-310	Skill Based Course	1	10	4
Total Credits & Total Marks		**26**	**385**	**139**

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CORE COURSE

Paper I- Comparative Anatomy of Vertebrates

Max.M-40

Unit-1	1. Origin of Chordata : Concept of Protochordata 2. Development, structure and functions of integument and its derivatives (glands, scales, feathers and hairs) in Vertebrates. 3. Respiratory system: Characters of respiratory tissue, External and Internal Respiration. 4. Comparative account of Respiratory Organs.
Unit-2	1. 1. Evolution of heart. in vertebrates (Fishes, Amphibia, Reptile, Bird and Mammal). 2. Evolution of aortic arches and portal systems (Renal and hepatic). 3. Blood circulation in various vertebrates groups. 4. Comparative account of Jaw Suspensorium in Vertebrates. 5. Vertebral column of Fishes, Amphibia, Reptile, Bird and Mammal.
Unit-3	1.Evolution of urinogenital system in vertebrates (Fishes, Amphibia, Reptile, Bird and Mammal). 2.Comparative account of organs of olfaction and taste (Fishes, Amphibia, Reptile, Bird and Mammal). 3.Comparative anatomy of brain and spinal cord (CNS) (Fishes, Amphibia, Reptile, Bird and Mammal). 4. Comparative account of peripheral and autonomous nervous system in mammal.
Unit-4	1. Comparative account of lateral line system. 2. Comparative account of electroreception. 3. Flight adaptations in vertebrates. 4. Aquatic adaptations in birds and mammals.
Unit-5	1. Origin, evolution general organization and affinities of Ostracoderm. 2. General organization, specialized, generalized and degenerated characters of Cyclostomes. 3. Origin, evolution general organization of early Gnathostomes. 4. General account of Elasmobranchi, Holocephali, Dipnoi and Crossopterygii.

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SUGGESTED READINGS:

1. Carter,G.S.Structure and habit in vertebrate evolution–Sedgwick and Jackson,London.
2. Kingsley,J.S.Outlines of Comparative Autonomy of Vertebrates,Central Book Depot. Allahabad,
3. Kent,C.G.Comparative anatomy of vertebrates
4. MalcomJollie,Chordata morphology.East–WestPresPvt.Ltd.,NewDelhi.
5. MiltonIlildergr and.Analysis of vertebrate structure.IV.Ed.JohnWiley and SonsInc.,NewYork.
6. Smith,H.S.Evolution of Chordata structure.Hold Rinchart andWinstoin Inc. NewYork.
7. Sedgwick, A. A. Students : TextBook of Zoology,Vol.II.
8. Walter,H.E. and Sayles, L.D.Biology of vertebrates,MacMillan & Co.New York.
9. Romer,A.S.Vertebrate Body,IIIrdEd.W.B.SaundersCo.,Philadelphia
10. YoungJ.Z.life of vertebrates.The oxfordUniversityPress,London
11. Parker&Haswell to IIIRev.by Marshall willians latestedMacmillanCo.ltd.
12. YoungJ.Z.Life of mammals.TheOxfordUniversityPress,London
13. Weichert,C.K.andPresch,W.Elements of chordate anatomy,4th Edn. McGrawHall Book Co.,NewYork.

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CORE COURSE

Paper II-Limnology

Max.M-40

Unit-1	1. Limnology–Definition, historical development and scope of Limnology. 2. Types of fresh water habitats and their Ecosystem- (a) Ponds, Streams and rivers. (b)Lakes–Origin and classification. 3. Morphometry–Use of various morphometric parameters and Zonation.
Unit-2	Physico–Chemical Characteristics- 1. Light and Temperature- (a) Light as an ecological parameter in freshwater. (b) Temperature-Radiation, Stratification and Heat Budget. 2. (a) Dissolved Solids–Carbonate, Bicarbonates, Phosphate and Nitrate. (b) Physico–Chemical characteristics of fresh water with special reference to different parameters-Turbidity, dissolved gases (Oxygen, Carbondioxide, Hydrogen Sulphide), seasonal changes in dissolved gases and pH.
Unit-3	1. Study of Biota- (a) Phytoplankton, Zooplankton and their inter-relationship. (b) Aquatic insects, birds and their environmental significance. 2. Ecological classification of aquatic fauna. 3. Higher aquatic plants and their significance.
Unit-4	1. Methods of water quality testing BOD and COD. 2. Sewage– Definition, composition and its treatment. 3. Bioindicators - Aquatic flora and fauna in relation to water quality in an aquatic environment.

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Unit-5	1. Causes of pollution of aquatic resources, their management and conservation. 2. Resource Conservation–Aquatic pollution & its control, 3. Legislation and regulation on discharge of industrial effluents and domestic wastes in rivers and reservoirs. 3. Use and misuse of inland waters.

Suggested Readings:

Anathakrishnan	:	Bioresources Ecology
Goldman	:	Limnology
Odum	:	Ecology
Pawlosuske	:	Physico-chemical methods for water
Wetzal	:	Limnology
Trivedi&Goyal	:	Chemical and biological methods for water pollution studies
Welch	:	Limnology Vols.I-II
Perkins	:	Ecology
Arora	:	Fundamentals of environmental biology
Ghoshe	:	Toxicology
Sood	:	Toxicology

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CORE COURSE

Paper III - Ecotoxicology

Max M-40

Unit-1	1. General principles of Environmental Biology with emphasis on ecosystems. 2. Abiotic and biotic factors of ecosystems. 3. Communities of the environment, their structure &significance. 4. Energy flow in environment: Ecological energetics.
Unit-2	1. Productivity, Production and analysis. 2. Recycling and reuse technologies for solid and liquid wastes and their role in environmental conservation. 3. Remote Sensing–basic concepts and applications of remote sensing techniques in environmental conservation. 4. Environmental indicators and their role in environmental balance.
Unit-3	1. Air and Water pollution and their control methods. 2. Radioactive compounds and their impact on the environment. 3. Vehicular exhaust pollution, causes and remedies. 4. Noise pollution.
Unit-4	1. Toxicology-Basic concepts, toxicological methods. 2. Toxicity testing principles, hazards, risks and their control methods. 3. Food toxicants and their control methods. 4. Public Health Hazards due to environmental disasters.
Unit- 5	1.Pesticides, types, nature and their effects on environment. 2.Agrochemical use and misuse, alternatives. 3.Important heavy metals and their role in environment. 4..Occupational Health Hazards and their Control.

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SUGGESTEDREADINGS:

1.Clark	:	Elements of ecology
2.Odum	:	Fundamentals of Ecology
3.SouthWoods	:	Ecological methods
4.Trivedi and Goel	:	Chemical and biological methods for water pollution studies
5 Ghoshe	:	Toxicology
6 Sood	:	Toxicology

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CORE COURSE
Paper IV – Aquaculture

Max M: 40

Unit-1	1. Aquaculture: history, definition, scope & importance. 2. Inland Fisheries resources of MP- wsr Narmada 3. Riverine fisheries- Ecology and Fishes of Major River Systems wsr Ganga, Brahmaputra, East coast river system, Godavari and Cauvery river system. 4. Cold water fisheries in India. 5. Coastal fisheries in India. 6. General ecological characteristics of reservoirs of India.
Unit-2	1. Fish culture wsr Mono and Poly/ Mixed/ Composite Fish culture. 2. Fresh Water Prawn Culture and its prospects in India. 3. Culture of Oysters 4. Pearl culture and Pearl industry. 4. Frog culture.
Unit-3	1. Overview of Integrated fish culture 2. Paddy cum fish culture 3. Sewage fed fish culture. 4. Brackish water culture. 5 Cage Culture
Unit-4	1. Fresh water fish farm Engineering: Selection of site, soil chemistry of fish farm, designing of fish farm, Layout & construction of fish farm. 2. Types of fish ponds. 3. Setting and management of fresh water aquarium wsr feeding and Nitrogen cycle 4. Aquarium fishes –Types and characteristics, Breeding of aquarium fishes. 5. Different types of crafts and gears in fisheries
Unit-5	1. Water pollution, its effects on fisheries and methods of its abatement. 2. Common fish diseases & their control. 3. Biochemical composition and nutritional value of fishes. 4. Nutrigenomics and immune function in fishes.

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Suggested Readings:

1. C.B.L.Shrivastava	:	Fishes of India
2. Jhingaran	:	Fish and fisheries of India
3. S.S.Khanna	:	An Introduction to fishes
4. R.S.Rath	:	Fresh waterAquaculture
5. Gopalji Shrivastava	:	Fishes of U.P.& Bihar
6. H.D.Kumar	:	Sustanibility & Management of Aquaculture
Fisheries		
7. A.J.K.Mainan	:	Identification of fishes
8. R.Sanatam	:	A Manual of freshwater Aquaculture
9. S.K.Gupta	:	Fish & Fisheries
10.P.D.Pandey	:	Fish & Fisheries
11.K.P.Vishwas	:	Fish & Fisheries

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ELECTIVE COURSE
Sericulture

Unit-1	Introduction and Moriculture: **Max M : 40** 1. Historical background of sericulture, Scope of sericulture & Entrepreneurship in silk industry 2. Silk Producing organisms and types of silk. 3. Classification of races of *Bombyx mori.* 4. Life cycle of *Bombyx mori* 5. Propagation of Mulberry plant. 6. Process of Sericulture
Unit-2	Plant Pathology, silkworm diseases and Biology of Bombyx mori wsr: 1. Diseases of mulberry plant. 2. Diseases of silkworms wsr Pebrine (Protozoan disease), Bacterial, Fungal and Viral diseases 3. Silk gland of *Bombyx mori.* 4. Structure & chemical composition of silk.
Unit-3	Rearing facilities and operation wsr: 1. Rearing house and appliances for rearing of silk worms. 2. Disinfection operation before rearing of silk worms 3. Maintenance of optimum conditions for rearing. 4. Feeding, Bed cleaning and spacing
Unit-4	Moulting and Mounting wsr: 1. Moultanism . 2. Care during Moulting of silk worm. 3. Characteristic features of ripe silk worm 4. Process of mounting of silk worm. 5. Process of spinning & harvesting of cocoons
Unit-5	Cocoon Marketing, Silk Reeling and Non-Mulberry Silk Worm wsr: 1. Cocoon Quality. 2. Testing and grading of cocoon. 3. Silk reeling operation. 4. Non-Mulberry Silk Worm culture wsr Tasar culture, Eri culture and Muga culture.

List of books for Sericulture:

1. Hand book of Silk Worm rearing by Masanori, Shimiza,D. Agri.
2. Sericulture Manual -2
3. Sericulture Manual -3 by S. Kishanaswamy
4. Introduction to Sericulture by Dr. (Mrs.) G. Ganga Dr. (Mrs.) J. Sulochanachetty
5. Principles of Sericulture by HisaoAruga
6. A Manual of non-mulberry Silks Sericulture Vol.-1 by Dr. M.S. Jolly.*et al*
7. Sericulture and Silk Industries by TripurariSharan
8. Sericulture Manual -1 Mulberry cultivation by Dr. G. Rang swami
9. Sericulture Manual -2 Silkworm rearing by Dr. S. Krishnaswami
10. Sericulture Manual -3 Silk reeling by Dr. S. Krishnaswami
11. Mulberry cultivation by Zheng, Ting-Zing
12. Silkworm rearing by Pva Pang- Chesan
13. Silk worm training manual by ScoHotim.

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ELECTIVE COURSE
Animal Biotechnology

Max M : 40

nit-1	1. Structure and organization of animal cell 2. Elementary idea of equipments and materials for animal cell culture technology. 3. Primary and established cell line cultures. 4. Brief account of balanced salt solution and chemical, physical and metabolic functions of different constituents of commonly used culture mediums. 5. Role of carbon dioxide, serum and supplements in animal cell culture.
Unit-2	1. Serum and protein free defined media and their application, 2. Measurement of viability and cytotoxicity; 3. Biology and characterization of the cultured cells, 4. Measuring parameters of growth. 5. Basic techniques of mammalian cell culture in vitro.
Unit-3	1. Disaggregation of tissue and primary culture. 2. Maintenance of cell culture. 3. Scaling up of animal cell culture 4. Cell separation 5. Cell synchronization 6. Cell cloning and micromanipulation 7. Cell transformation.
Unit-4	1. Embryonic stem cells and their culture. 2. Epithelial stem cells culture. 3. Application of animal cell cultures. 4. Cell culture-based vaccines. 5. Somatic cell genetics. 6. Introduction of assisted reproductive technologies for genetic improvement of farm animals.
Unit-5	1. Organ and Histotypic culture. 2. Elementary idea of Cell Senescence and apoptosis 3. Measurement of cell death. 4. Brief account of three-dimensional culture and tissue engineering. 5. Culture collection centers for animal cell lines.

Recommended Books

1.Culture of Animal Cells (3 rd Edition), R. lan Freshmney.- Wiley Liss.
2.Animal Cell Culture -Practical Approach, (Ed) John R.W. Masters, Oxford.
3.Cell Growth and Division' A Practical Approach. (Ed.) R. Basega, IRL Press.
4.Cell Culture Lab Fax. (Eds). M. Buller & M. Dawson, Bios Scientific Publication Ltd. Oxford.
5 Animal Cell Culture Techniques. (Ed.) Martin Clynes, Springer.
6.Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P.
7.Mather and David Barnes, Academic Press

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Practical I: Related to I & II Theory Papers

1. Study of Specimens, slides and bones Wsr Vertebrates .
2. Major Dissection- General anatomy of cranial nerves of Labeo and Wallago.
3. Minor Dissection of Weberian ossicles (Labeo/Wallago)
4. Estimation of DO, Chloride, BOD, COD, Hardness, pH and Alkalinity of water.
5. Detection of presence of bacteria in soil
6. Study of freshwater ecosystem (Pond/Aquarium).
7. Study of Bioindicators.

Scheme for Practical Examination M.M.50

1.	Major Dissection	10 Marks
2.	Minor Dissection	04 Marks
3.	Spotting	12 Marks
4.	Limnological exercise	10 Marks
5.	Comment upon bioindicators	04 Marks
6.	Practical Record	05 Marks
7.	VivaVoce	05 Marks
	Total	**50 Marks**

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practical II: Related to III & IV and Elective Course Theory Papers

1. Study of plankton.
2. Preparation and Maintenance of Aquarium.
3. Study of common weeds of fish ponds.
4. Methods of culture related to theory papers.
5. Study of abiotic factors of water related to fish life (Turbidity, Conductivity)
6. Determination of different toxic chemicals in samples of soil, water and air.
7. Toxicological testing methods, General tests, acute toxicity test and LD50 test.
8. Identification and comments on Aquaculture animals:

   Coral-Acropora millipora, Prawn , Crab, Pila, Unio, Labeo,Catla, Wallago, Cirrhina reba, Rana tigrina .

Elective Paper (Sericulture)

8. Preparation of Map showing extension of sericulture in India
9. Identification of Major Silk worm pest
10. Life cycle of *Bombyx mori.*

Elective Paper (Animal Biotechnology)

11. MTT assay
12. In vitro Cell viability test
13. Cell separation using HiSep