

Faculty: Science and Technology

Programme: M.Sc. (Zoology)

POs:

The post graduate course of Zoology will provide theoretical as well as experimental knowledge as per the courses included under the syllabi by which build up creativity in students will lead towards thorough learning and development of ideas of research work and will become ready to face recent challenges. Students can attain the employability skills through the experiences based on their practical knowledge.

After completion of MSc in Zoology successfully, the students would be able to:

1. demonstrate the significance of the topics of syllabi and evaluate its relevance. Think creatively for its gravity and develop ideas.
2. Interpret scientific ideas and its analysis. Create experiments independently and draw inferences by sharing it with others.
3. Derive information from various digital sources. Develop skills for scientific writing and present the data and analyse it scientifically.
4. Articulate scientific ideas lay down a hypothesis, design the pathway to develop research ideas.
5. Acquaint skills in handling the instruments and different techniques through the practicals and developing the scientific temperaments for research.
6. Develop competence through healthy atmosphere and a quality intercommunication with different groups.
7. Understand environmental and sustainability issues and its sensitivity and regional relevance.
8. get the facility of different training and internship programs through job-oriented curriculum
9. Utilize the sources confidently and independently and develop self-sustenance.

PSOs:

Upon completion of the programme successfully, students would be able to

1. Learn to Prepare the checklist and inventories through the identification of the fauna in local areas being Melghat Tiger Reserve and Pohra Forest are very nearer to survey.
2. Gain comprehensive knowledge about different animals and develop confidence to handle them during research work.
3. Interpret metabolic pathways, their correlation in concern with prokaryote and eukaryotes.
4. Compare genetic aspects, genetic traits, diseases and their specific causes.
5. Survey and analyse data of the various kinds of diseases in the locality.
6. Understand the various strategies and phenomena related to animal reproduction and their development.
7. Get acquainted with conservation strategies and environmental threats to reduce and save energy through Wildlife Week Celebration.
8. Compare the different developmental events during embryogenesis of different animals.

Employability Potential of the Programme:

Zoology deals with the structure, embryology, evolution, classification, habits, and distribution of all animals, both living and extinct. If you are interested in making a career in Zoology then you need to deal with both the existing, dead and quite possible the extinct species of the animal kingdom. MSc Zoology Programme scope is very rewarding owing to the relevancy of the course. Employability can be found in both the private and public sectors.

A zoologist might even get to travel because the nature of his / her job. Channels like **National Geographic, Animal Planet, Discovery Channel** are in constant need of Zoologists for research and documentaries. Zoologists are also hired for zoos, wildlife services, botanical gardens, conservation organizations, national parks, nature reserves, universities, laboratories, aquariums, animal clinics, fisheries and aquaculture, museums, research, pharmaceutical Companies, veterinary hospitals, etc.

There are various sectors of employment in the field of Zoology. Here's the list of job profiles:

Jobs are available with a wide range of organisations in the public, private and not-for-profit sectors. Typical employers include:

- Zoos or wildlife parks and environmental protection agencies
- Government agencies and research institutions

- Medical research establishments and the National Health Service
- Environmental and animal charities
- Schools, colleges, science centres, libraries and museums
- Universities and research institutes
- Environmental consultancies
- Chemical, pharmaceutical and petroleum companies
- Aquaculture and animal nutrition companies.
- **Wildlife Biologist:** In the current scenario of global warming, mankind needs to pay attention to conserving the wildlife. Main concern of wildlife biologist are conservation and propagation of wildlife.
- **Community development organizations:** Ideal places to apply theoretical knowledge in real life settings. You can also join a number of organizations to pursue career in community development like:
 - Zoo Outreach Organization
 - Dr. Salim Ali School of Ecology
 - Indian Tiger Welfare Society
 - Wildlife Trust of India
 - Bombay Natural History Society (BNHS)
 - Protection Society of India
 - Ashoka Trust for Research in Ecology and the environment (ATREE) etc.
 - Central Zoo Authority (CZA)
 - Regional Resource Centers of Ministry of Environment and Forest Wildlife
 - Wildlife Information Liaison Development
 - Center for Science and Environment (CSE)
- **Indian Forest Services (IFoS):** A candidate can take IFoS exam conducted by Union Public Services Commission (UPSC). The upper age limit is relaxable up to 5 years for the candidates belonging to categories: Scheduled Caste/ Scheduled Tribe (SC /ST).
- **Research work:** If student is keen in research then he/she can apply for IISc., IISER, TIFR, NCBS, JNCASR, etc. for an Integrated MSc-PhD program or pursue advanced degree in wildlife biology or ecological sciences in various institutes.
- **Freelance consultant:** Student may also work as a freelance consultant in various research and development organizations.

This is a great **career** interest for students, who are fascinated with nature and would not mind spending time understanding it. There are several specializations that the students pursuing the field can venture into.

Many research agencies recruit expert people for various research projects for environmental research, animal biodiversity research, conservation of wildlife, environmental management research and monitoring of ecosystems etc.

Zoology Student has ample opportunities as Zoology teacher, Lab Assistant, Conservationist, Wildlife biologist, Marine Biologist, Museum Curator, Taxonomist, forensic expert, Eco-toxicologist, Biomedical Scientist, Animal Care taker, Animal and wildlife Educator, Zoo Curator, Environmental Consultant, Zoo Educator, wildlife Rehabilitator, Medical Representative, Sustainability officer.

Apart from the above, private business enterprise is also one of employability potential such as, Agro Business Industry (Fish, Farming, Sericulture, Apiculture, Prawn culture, pearl Culture, Lac Culture, etc.) Clinical Business Associate, Veterinary based small scale Industry (Goat farming, poultry), Nutrition specialist.

Some top organizations also employ students such as Wildlife Institute of India (NII), Zoological Survey of India (ZSI), National Institute of Oceanography (NIO),

State Forest Department, Centre Marine Fisheries Research Institute (CMFRI), Central Inland Fisheries Research Institute (CIFRI), Ministry of Environment and forest, Medical Laboratories, Agricultural firms Pharmaceutical Companies, etc.

Being Zoology is a basic Science, the demand of Zoology is increasing day by day. It provides a good career option to students. It provides wide horizon of knowledge with preview of employability potential. P.G. in Zoology provides services in various sectors like, Biological Medical, Agriculture as Zoologist, Assistant Professor, Ecologist, Entomologist, Herpetologist, Department of Fishery Zoo Keeper, Zoo Officer, Marine Scientist etc.

- The student can also work in forest department by qualifying Indian Forest Service examination. They can work in sample investigator for those derived from animals in different poaching and forest crime cases. They have opportunities like Wildlife Conservationist, Forest Ranger, Zoologist, Wildlife Educator, Naturalist, Field Officer, Biomedical Scientist, Toxicologist, Marine Scientist, Medical Coder etc.

They can opt to do research-based programs or study for competitive examinations like civil services besides doing a job in a zoology-related field. They can develop entrepreneurship in the different fields like Apiculture, Sericulture, Lac culture, Pisciculture, Aquaculture, Vermiculture, etc. They can contribute as a consultant in Environment impact assessment in different projects of Dam/Road/Rail track constructions etc.

Other than this they can opt post PG Studies M.Phil or Ph.D or can qualify competitive exam like NET/SET/GATE to join as a Assistant Professor or as a Researcher.

A Scholar Student can join services at Bhabha Atomic Research Centre (BARC), NCBS/TIFR, NIO/ZSI etc. as a scientist.

Syllabus Prescribed for First Year 2022-23

PG Programme: MSc Zoology Semester I

S. N.	Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
1.	1ZOO1	Animal Structure and Function (Non-Chordata)	60
2.	1ZOO2	Animal Structure and Function (Chordata)	60
3.	1ZOO3	Gamete Biology	60
4.	1ZOO4	Genes and Differentiation	60
5.	1ZOO5	Lab I	60

COs (1ZOO1: Animal Structure and Function (Non-Chordata):

Upon completion of this course successfully, Students would be able to

1. Find out the taxonomic characters of the different animals and apply for forming the zoological names of the animals in biosystematics.
2. Classify invertebrates by using different methods and can develop different cladogram and phylogram
3. Compare different systems in all phyla of nonchordates and compare it with evolutionary significance of it. They know about the transition occurred with time scale. They can explain digestive, respiratory, circulatory, excretory, reproductive and nervous system from Protozoa to Hemichordata.
4. find out distinguished mechanism of the different system function and the change in their mode of function if any throughout the invertebrate series
5. Identify various larval forms of invertebrates like of Porifera, coelenterate, helminthes, Annelida and Crustacea.

Unit	Content
Unit I	1.1 Definition and basic concepts of biosystematics taxonomy and classification, <ul style="list-style-type: none"> 1.1.1 History of Classification, 1.1.2. Trends in biosystematics: Chemotaxonomy, cytotaxonomy and molecular taxonomy, 1.1.3 Taxonomic characters- different kinds 1.2 Dimensions of specification and taxonomic characters. 1.3 Species concepts: species category, different species concepts, subspecies and other infra- specific categories. 1.4 Parsimony method of classification, cladistic method of classification, phylogram and cladogram
Unit II	2.1. Feeding and Digestion: <ul style="list-style-type: none"> 2.1.1 Nutrition in protozoa – 2.2 Types and mode of feeding. <ul style="list-style-type: none"> 2.2.1 Feeding diversity in insects, 2.2.2 Functional mechanism of Filter feeding in Mollusca 2.2.3 Feeding & digestion in Bryozoans and Echinodermata 2.3 Movements: <ul style="list-style-type: none"> 2.3.1 Micro morphology and mechanism of Movements of cilia and flagella 2.3.2 Hydrostatic movements in Ctenophores and annelida. 2.3.3 Insect flight mechanism
UNIT III	3.1. Organs of Respiration: <ul style="list-style-type: none"> 3.1.1 Body surface, 3.1.2 Gills, 3.1.3 Book-lungs 3.1.4 Tracheal system. 3.2 Respiratory pigments in invertebrates. <ul style="list-style-type: none"> 3.2.1 Mechanisms of gill respiration in Mollusca 3.2.2 Tracheal respiration in Arthropoda (Insecta). 3.2.3 Excretory organs and excretion: 3.2.4 Excretion in Protozoa. 3.2.5 Excretory structures and functions in Helminthes, 3.2.6 Excretory structures and functions in Annelids 3.2.7 Malpighian tubules structure and functions in Insects
UNIT IV	4.1. General organization of Nervous system <ul style="list-style-type: none"> 4.1.1 Coelenterata 4.1.2 Annelida, 4.1.3 Arthropoda (Crustaceans and Insects), 4.1.4 Mollusca (Cephalopod) 4.1.4 Echinodermata.

	<p>4.2 Sense organs:</p> <p>4.2.1 Chemical senses & animal orientations in Nonchordates</p> <p>4.2.2 Mechanoreceptor in Nonchordates,</p> <p>4.2.3 Chemoreception & chemotaxis in insects</p> <p>4.2.4 Photoreception and photosensitivity in non-chordate forms,</p> <p>4.2.5 Functional Morphology of compound eye in Insects</p>
UNIT V	<p>5.1. Reproductive mechanisms in Nonchordates.</p> <p>5.1.1. Asexual, Sexual. Parthenogenesis, Hermaphroditism,</p> <p>5.2 Functional variations of reproductive structures in nonchordate:</p> <p>5.2.1 Porifera, Coelenterate and Echinodermata</p> <p>5.3 Invertebrate hormones of reproduction:</p> <p>5.3.1 Annelids,</p> <p>5.3.2 Mollusca,</p> <p>5.3.3 Arthropods</p> <p>5.4 Larval forms in Porifera, Coelenterata, helminthes, Annelida, Crustaceans.</p> <p>5.5 Metamorphosis and molting in insects & its hormonal control</p>

Suggested Literature:

- Hyman, L.H. The invertebrates. Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
- Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
- Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
- Hyman, L.H. The invertebrates. Vol.2. Mc Graw Hill Co., New York.
- Hyman, L.H. The invertebrates Vol.8. McGraw Hill Co., N.Y. and London.
- Barnes, R.D. Invertebrate Zoology, III edition. W.B. Saunders Co., Philadelphia
- Russel-Hunter, W.D. A biology of higher invertebrates, the Macmillan Co. Ltd., London.
- Hyman, L.H. The invertebrate's smaller coelomate groups, Vol. V. McGraw Hill Co., New York.
- Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
- Sedgwick, A. A. Student text book of Zoology. Vol, I, II and III. Central Book Depot, Allahabad.
- Parker, T.J. Haswell, W.A. Text Book of Zoology, Macmillan Co., London.
- Borradaile, L.A. and F.A. Potts: The Invertebrates: Asia Publishing
- House, Bombay, London Nigam: Biology of non-chordata, S. Nagin Chand.
- Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2 nd ed. Oxford University Press.
- Ruppert, E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: A Functional Evolutionary Approach. 7 th ed. Brooks Cole.
- Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd ed. ELBS & Nelson. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4 th ed. Sinauer Associates.
- Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press. Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill.

Weblink to Equivalent MOOC on SWAYAM if relevant:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

Weblink to Equivalent Virtual Lab if relevant:

<https://www.youtube.com/watch?v=QBLqgrElk>

<https://www.youtube.com/watch?v=OM6x4qaovrU>

<https://youtu.be/CmZ2aFJcJQQ>

Cos (1ZOO2) Animal Structure and Function (Chordata):

After learning this course, students would be able to.....

- Describe different types of taxonomic characters and rules and operative principles of International Code of Zoological Nomenclature and designate zoological names.
- Distinguish the endoskeletal system of Protochordates and Chordates and replacement of the cartilaginous structure by bones.
- Study different systems throughout the vertebrate series as per their adaptations in different habitat and their successive modifications.
- Explain structure and functioning of sense organs of mammals.
- Learn migration avenues of Fishes and Birds, their types, benefits, routes, threats etc.

Paper- II: Animal Structure and Function (Chordata)

Unit	Contents
Unit-I :	<p>1.1 Origin of reproductive isolation.</p> <p>1.2 Biological mechanisms of genetic incompatibility.</p>

	<p>1.3 Taxonomic procedures:</p> <p>1.3.1 Taxonomic collections preservation curation,</p> <p>1.3.2 Process of identification.</p> <p>1.4 Taxonomic keys, different types of keys, their merits and demerits.</p> <p>1.5 International code of Zoological Nomenclature(ICZN):</p> <p>1.5.1 Operative principles, interpretation and application of important rules.</p> <p>1.6 Formation of Scientific names of various Taxa.</p> <p>1.7 Taxonomic categories</p>
Unit-II	<p>2.1. Integument in vertebrates.</p> <p>2.1.1 Derivatives of skin.</p> <p>2.1.2 Functions of skin.</p> <p>2.2 Endoskeleton structures:</p> <p>2.2.1 Endoskeleton in Protochordata.</p> <p>2.2.2 Visceral skeleton in Fishes.</p> <p>2.2.3 Jaw suspensorium in vertebrates.</p> <p>2.3 Structure of tooth and dentition and dental formula in Mammalia.</p> <p>2.4 Structural and functional organization of digestive system in Protochordata.</p> <p>2.5 Structural and functional organization of alimentary canal and digestive glands in vertebrates, with reference to Mammalian type.</p>
Unit III	<p>3.1 Characteristics of respiratory surface.</p> <p>3.2 Gills in fishes and mechanisms of gill-respiration.</p> <p>3.3 Accessory respiratory organs in fishes.</p> <p>3.4 Functional organization of Mammalian lungs.</p> <p>3.4.1 Exchange of gases.</p> <p>3.4.2 Aerodynamics of lungs.</p> <p>3.5 Larynx.</p> <p>3.6 Composition and functions of blood.</p> <p>3.7 Lymph and lymphatic system</p>
Unit IV	<p>4.1 Excretion:</p> <p>4.1.1 Excretory products</p> <p>4.1.2 Kidney structure in relation to Osmoregulation.</p> <p>4.1.3 Archinephros, Pronephros, Mesonephros and Metanephros.</p> <p>4.1.4 External salt excretion.</p> <p>4.1.5 Osmoregulation in freshwater and marine water fishes.</p> <p>4.2 Functional organization of vertebrate nervous system:</p> <p>4.2.1 Brain and spinal cord.</p> <p>4.3 Sense organs:</p> <p>4.3.1 Organs of olfaction and taste.</p> <p>4.3.2 Organs of hearing and balance.</p>
Unit V	<p>5.1 Echolocation:</p> <p>5.1.1 Morphological adaptation for echolocation.</p> <p>5.1.2 Echolocation in bats.</p> <p>5.2 Lateral-line system in fishes.</p> <p>5.3 Electroreception.</p> <p>5.4 Flight adaptations in mammals.</p> <p>5.5 Aquatic adaptations in mammals.</p> <p>5.6 Adaptive radiation in mammals.</p> <p>5.7 Migration in birds and fishes.</p>

Suggested Literature:

1. Carter, G.S. Structure and habit in vertebrate evolution-Sedgwick and Jackson, London.
2. Eccles, J.C. The understanding of the brain. Mc Graw Hill co., New York and London.
3. Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates. Central Book Depot, Allahabad.
4. Kent, C.G. Comparative Anatomy of Vertebrates.
5. Malcom Jollie, Chordata morphology. East-West Press Pvt. Ltd. New Delhi.
6. Milton Hilderbrand. Analysis of vertebrate structure. IVEd. John Wiley and Sons Inc., New York.
7. Monielli, A.R. The chordates, Cambridge University Press, London.
8. Smith, H.S. Evolution of chordata structure. Hold rinehart and Winstoin Inc., New York.
9. Sedgwick, a.A. Students Text Book of Zoology, Vol.II.
10. Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London.
11. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York and London.
12. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.

13. Wolstenholmf, E.W. and Knight, J.(Ed). Taste and smell in vertebrates, J & A Churchill, London.
14. Romer, A.S., Vertebrate Body, IIIrd Ed. W.B.Saunders co., Philadelphia.
15. Young, J.Z. Life of vertebrates. The Oxford University Press, London.
16. Young, J.Z. Life of mammals, Oxford University Press, London.
17. Colbert, E.H.Evolution of the vertebrates, John Wiley and Sons Inc., New York.
18. Romer, A.S. Vertebrate Paleontology, 3rd Edn. University of Chicago Press, Chicago.
19. Clark, W.E. History of the Primates IV Edn. University of Chicago Press, Chicago.
20. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hill Book Co, New York.
21. Messers, H.M. An introduction of vertebrates anatomy
22. Montagna, W. Comparative anatomy. Hohn. Wiley and Sons Inc.
23. de Deer, S.G. Embryos and Ancestors. Clarendon Press, Oxford.
24. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.
25. Waterman. A.J. chordata structure and function. Macmillan co., New York.
26. Bhamrah and Juneja, Chordate Zoology, Anmol Publishers, N.Delhi Bhamarah and Juneja, Invertebrate Zoology, Anmol Publishers, N.Delhi.
27. Barbiur, T. Reptiles and Amphibians: Their habits and adaptations. Hongton Miffin Co., New York.
28. Kingsley Noble, g. The biology of the Amphibia. Dover Publications, New York.
29. Smyth. Amphibia and their ways. The McMillan co., New York.
30. Andrevos, S.M., Miles, R..S. and Walker, A.D. Problems in vertebrate evolution. Academic Press, New York.
31. Boolotian and Stiles: College Zoology (Macmillan)
32. Campbell: Biology (Benjamin)
33. Marshall and Williams: Text Book of Zoology
34. Wolfe: Biology the Foundations (Wadsworth)
35. Wilson. Biodiversity, Academic Press, Washington.
36. G.G. Simpson. Principle of animal taxonomy, Oxford IBHPublishing Company
37. E. Mayer. Elements of Taxonomy.
38. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
39. Tripathi, R. S. Biosystematics and taxonomy
40. Hildebrand, M. (1995). Analysis of Vertebrate Structure. John Wiley & Sons.
41. Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
42. Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9 th ed. Mc Graw Hill.

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- <https://www.youtube.com/watch?v=PfWVMq4RDNw>
- <https://www.youtube.com/watch?v=cCWHeq8H4TY>
- <https://youtu.be/uK6TAPBaBq0>
- <https://www.youtube.com/watch?v=B4lyIDOXH3A>

Cos 1ZOO3: Gamete Biology:

After learning this course, students would be able to.....

1. Study spermatogenesis and oogenesis in eukaryotes.
2. Determine different events and their mechanisms during fertilization and its consequent changes.
3. Learn assisted reproduction techniques to overcome infertility.
4. Understand *Ex vivo* and *In vivo* gene therapy etc.
5. Learn about contraception and methods

Unit	
Unit I	1.1 Heterogamy in eukaryotes. 1.2 Leydig cells: 1.2.1 Morphology. 1.2.2 Differentiation. 1.2.3 Functions and their regulation. 1.3 Spermatogenesis: 1.3.1 Morphological basis.

	<p>1.3.2 Hormonal regulation.</p> <p>1.4 Biochemistry of Semen:</p> <p>1.4.1 Formation of semen and its composition.</p> <p>1.4.2 Assessment of sperm functions.</p>
Unit II	<p>2.1 Ovarian follicular growth and differentiation:</p> <p>2.1.1 Morphology.</p> <p>2.1.2 Endocrinology.</p> <p>2.1.3 Molecular Biology.</p> <p>2.2 Vitellogenesis.</p> <p>2.3 Ovulation and its regulation.</p> <p>2.4 Fertilization:</p> <p>2.4.1 Cell surface molecules in sperm-egg recognition in animals.</p> <p>2.4.2 Reaction of sperm (Sperm motility, Capacitation, Chemotaxis, acrosome reaction, Fusion of sperm and egg plasmalemma).</p> <p>2.4.3 Reaction of egg (formation of fertilization cone, Prevention of polyspermy).</p> <p>2.4.4 Amphimixis.</p>
Unit III	<p>3.1 Creating multicellularity:</p> <p>3.1.1 Characteristics of cleavage divisions</p> <p>3.1.2 Cleavage types.</p> <p>3.1.4 Gastrulation & formation of germ layers in animals.</p> <p>3.1.4 Embryogenesis.</p> <p>3.2. Genomic imprinting.</p>
Unit IV	<p>4.0 Assisted reproductive techniques:</p> <p>4.1 <i>In vitro</i> fertilization.</p> <p>4.2 Multiple ovulation/superovulation.</p> <p>4.3 Collection and cryopreservation of gametes.</p> <p>4.4 <i>In vitro</i> gamete maturation.</p> <p>4.5 Screening of genetic disorders.</p> <p>4.6. ICSI and GIFT.</p> <p>4.6 Cloning of animals by nuclear transfer.</p> <p>4.7 Disadvantages of ART.</p>
Unit V	<p>5.1 Transgenic animals:</p> <p>5.1.1. Procedure.</p> <p>5.1.2. Applications.</p> <p>5.2 Gene Knockout technology:</p> <p>5.2.1. Procedure</p> <p>5.2.2. Applications</p> <p>5.3 <i>Ex Vivo</i> and <i>In Vivo</i> gene therapy</p> <p>5.4 Contraception:</p> <p>5.4.1. Surgical methods.</p> <p>5.4.2. Hormonal methods.</p> <p>5.4.3. Emergency contraceptives.</p> <p>5.4.4. Physical barriers.</p> <p>5.4.5. Intrauterine contraceptive devices (IUCDs).</p>

Suggested Literature:

1. The Physiology of Reproduction, second edition, Vol 1 and 2, edited by Ernst Knobil and Jimmy D. Neil. Raven Press, 2014.
2. Male Reproductive Function, edited by Christina Wang. Kluwer Academic Publishers, 1999.
3. The ovary, edited by Solly Zuckerman Baron Zuckerman, Barbara J. Weir, T. G. Baker. Academic Press.
4. The ovary, edited by Peter C.K. Leung and Eli Y. Adashi, Elsevier (Academic Press), 2004.
5. Cell and Molecular Biology of Testis, edited by Claude Desjardins and Larry L. Ewing. Oxford University Press US.
6. Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management, edited by
7. Samuel S. C. Yen, Robert B. Jaffe, Robert L. Barbieri. Saunders publisher.
8. Long J.A. Evan H.M. 1922 : the oestrous cycle in the Rat and its associated phenomenon.
9. Nalbandou. A.C. – Reproductive physiology
10. Prakash A.S. 1965-66 Marshall's, Physiology Reproduction(3 Vol.)
11. Ethan Bier, the cold Spring. The cold spring Harbor laboratory Press, New York.
12. Balinsky B.I. Introduction to Embryology sanders, Phliedelphia.
13. Berril N.J. and Karp. G. Development Biology. McGraw Hill New York.
14. Davidson, E.H. Gene Activity during Early Development. Academic Press, New York.
15. Wolpert Principles of Development-
16. Slack Essential Developmental Biology- .

Weblink to Equivalent MOOC on SWAYAM if relevant:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

- Weblink to Equivalent Virtual Lab if relevant:

<https://youtu.be/4YKvVeVMmEE>

<https://youtu.be/-c9sbz7-mwg>

https://youtu.be/W_Pn3bJnArM

<https://youtu.be/CW49Vwj6B8o>

<https://youtu.be/cnPIExqb964>

<https://youtu.be/jOYpjrr22X0>

1ZOO4: Genes and Differentiation:

After learning this course, students would be able to.....

1. Describe cell specification and differentiation in whole vertebrate series.
2. Study different body axis formation in *Drosophila*, Amphibia and Chick etc.
3. Learn about Human Aging and Senescence and factors affecting it.
4. Describe Biology of sex determination.
5. Study stem cells, their properties, types markers and disorders etc.

<p>Unit I</p>	<p>1.1 Cell specification and Differentiation:</p> <p>1.1.1 Types of Cell specification. 1.1.2 Cell commitment. 1.1.3 Characteristics of cell differentiation. 1.1.4 Cell differentiation.</p> <p>1.2 Germ cell determination in nematodes, insects and amphibians. 1.3 Germ cell migration in amphibians, reptiles, birds and mammals. 1.4 Concept of organizer.</p>
<p>Unit II</p>	<p>2.1 Body axes formation:</p> <p>2.1.1 Axes formation in <i>Drosophila</i>, amphibia, chick, nematodes, fishes and mammals. 2.2 Proximate tissue interactions. 2.3 Homeobox concept in different phylogenetic groups.</p>
<p>Unit III</p>	<p>3.1 Development and Environment:</p> <p>3.1.1 Polyphenic life cycles. 3.1.2 Developmental symbiosis. 3.1.3 Malformations. 3.1.4 Endocrine disruptors. 3.1.5 Changing evolution through developmental modularity. 3.1.6 Developmental constraints.</p>
<p>Unit IV</p>	<p>4.1 Biology of sex determination:</p> <p>4.1.1 Genetic basis of sex determination in mammals and <i>Drosophila</i>. 4.1.2 Differentiation of gonads in mammals. 4.1.3 Secondary sex determination in mammals. 4.1.4 Environmental sex determination. 4.2 Regeneration.</p>
<p>Unit V</p>	<p>5.0 Stem cells:</p> <p>5.1 Embryonic stem cells. 5.2 Adult stem cells. 5.3 Hematopoietic stem cells. 5.4 Cord-blood stem cells and stem cell banking. 5.5 Stem cell markers. 5.6 Stem cell disorders: Aplastic anemia, Fanconi anemia, paroxysmal nocturnal hemoglobinuria,</p>

	Congenital cytopenia, Hirschsprung's disease 5.7 Stem cells and diabetes. 5.8 Rebuilding the nervous System with stem cells.
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Suggested Literature:

1. Gilbert, S.F. Developmental Biology, Sinauer Associated Inc. Massachusetts.
2. Slack: Essential Developmental Biology- .
3. Principles of Development, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.
4. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher – Thomas Asia Pvt. Ltd
5. Developmental Biology, (2001), R. M. Twyman, Publisher - Bios Scientific Publishers LTD.
6. Concepts of Genetics, 9th edition (2008), William S. Klug, Michael
7. R. Cummings, Charlotte Spencer, and Michael A. Palladino, Publisher-Benjamin Cummings
8. Genes IX, 9th edition (2008), Benjamin Lewin, Publisher-Jones and Barlett Publishers Inc.
9. Principles of Genetics, 4th edition, (2006), Snustad D. Peter and Simmons J. Micheal, Publisher -John Wiley and Sons. Inc.
10. Genetics, (1999), Daniel J. Fairbanks, W. Ralph Andersen Publisher-Brooks/Cole Pub Co.
11. Principles of Genetics, 8th edition (1991), Eldon J. Gardner, D.P. Snustad, M.J. Simmons, and D. Peter Snustad Publisher-John Wiley and Sons. Inc.
12. Microbial Genetics, (1987), David Freifelder, Publisher-Jones & Bartlett
13. General Genetics, (1985), Leon A. Snyder, David Freifelder, Daniel L. Hartl Publisher- Jones and Bartlett.
14. Genetics, 3rd edition, Monroe W. Strickberger, (1968), Publisher - Macmillan Publishing Co.

Weblink to Equivalent MOOC on SWAYAM if relevant:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

- Weblink to Equivalent Virtual Lab if relevant:

<https://youtu.be/n1HZsixeEQU>

<https://youtu.be/PEBW49vxVSA>

<https://youtu.be/ISMip-68Fio>

<https://youtu.be/zyEovPuKhIY>

https://youtu.be/_z6HD2XWCd4

Syllabus Prescribed for 2022-23 Year UG/PG Programme

Programme: MSc Zoology

Semester I:

Code of the Course/Subject	Title of the Course/Subject	No. of Periods/Week
1ZOO5	Lab I: Practical based on 1ZOO1 and 1ZOO2	8 Periods/Week
1ZOO6	Lab II: Practical based on 1ZOO3 and 1ZOO4	8 Periods/Week

Cos:

Upon completion of the course successfully, students would be able to

CO	Description
CO1	Understand comprehensive anatomy of different systems of animals with available resources like C.D./chart/ models/ Video

	clippings/ PPT/ Preserved dissected specimens etc.
CO2	Prepare permanent mountings of various material
CO3	Collect photographs of the fauna of the local region or selected field
CO4	Classify the specimen by the salient features they carry
CO5	Compare the bones throughout the vertebrate series

* List of Practical/Laboratory Experiments/Activities etc.

Practical-1 : (Based on 1ZOO1 AND 1ZOO2

A) Anatomy of Different Systems by demonstration and labelling with available resources like C.D./chart/ models/ Video clippings/ PPT/ Preserved dissected specimens etc.

Earth worm/ Cockroach/Prawn, / a major carp fish/ Rat/mouse /rabbit or similar non-chordate and chordate available animals.

B) Mounting / Stained permanent preparations:-

- i. Conjugation and binary fission in *Paramecium*
- ii. *Vorticella*, *Euglena*
- iii. Rotifers from fresh water
- iv. Setae, Nephridium, Ovary and spermatheca of Earthworm.
- v. Mouth parts and internal organs of mosquito- honey bee, house fly or any pest /vector insect.
- vi. Wings of small insects (Mosquito, *Drosophila*, house fly)
- vii. Halteres and Leg showing pulvillus in insects.
- viii. Fish scales from major carps.

C) Photographic collection and Comments on campus/local faunal diversity with reference to their ecology.

1. Earthworms used in vermiculture (any three species)
2. Any three species of Cockroaches.
3. Any 5 butterfly species
4. Any 5 moth species
5. Any five dragonfly species
6. Any five beetle/bug species
7. Local Freshwater fish species any 10 with fin formulae
8. Any three amphibians.
9. Any five snake species
10. Ten common Birds
11. Any five migratory birds

D. i. Qualitative and Quantitative estimation of Zooplankton communities.

ii. Identification of genera & sex, of local mosquitoes, house flies, cockroach.

iii. Measurement and camera Lucida drawings of microscopic objects.

iv. Hair impressions: cat, dog, rabbit, buffalo, human beings etc.

E) Museum Study:-

Taxonomy of animal specimens/charts / photographs/ models/ video clipping available in the laboratory representing major orders of Nonchordata, Protochordata, and vertebrata, other than studied in previous courses.

F) Study of available Permanent stained slides/ ICT based sources:

Whole mount of Larval forms: Planula, Redia, Cercaria, Cysticercus, bladder worm, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Antilon, Veliger, Bipinnaria, Ophio and Echinopluteus, Auricularia, Tornaria.

Mammalian Histology: Skin, bone, regions of alimentary canal, digestive glands, trachea, lung, kidney. Spinal cord, gonads, Endocrine glands.

G) Comparative Osteology (Excluding loose bones of skull):

Amphibia, Reptilia; Aves, mammals. (with available skeleton or ICT based alternatives).

H) Culture/rearing of earthworm/ cockroach/silkworm/drosophila/any crop pests.

Note : Study tour/frequent field visits for observations of animals in their natural habitat should be arranged. Candidates shall be required to produce at the practical examination the Followings-

1. Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.
2. 10 permanent stained micro- preparations prepared by the examinee.
3. A report of study tour/field visit duly signed by Teacher-In-Charge.

The duration of the practical examination will be of six hours and the distribution of marks are as follows.

Q.1 Hands on experiments

i. Diagrammatic representation of the anatomy of the given system of Non-chordate / Chordate.	10 marks
ii. Practical based on part D	15 marks
iii Stained permanent preparations based on part B	10 marks
Q.2 Identification and comments on 10 spots. two marks each (Specimens, slides, bones,)	20 marks
Q. 3 Identification and Comments on the given Campus/local fauna based on part C (any two)	10 marks
Q.4 Submission of stained permanent preparations	10 marks
Q. 5. Submission of the report of study tour/field visits	05 marks
Q.6 Practical record	10 marks
Q.7 <i>Viva Voce</i>	10 marks

Total 100 marks

Reference Books: As per list of the books provided under Theory papers.

Cos of 1ZOO6:

Upon completion of the course successfully, students would be able to

COs	Description
CO1	realize the importance of animal ethics in laboratories
CO2	Compare the structural differences of the reproductive organs of male and female animals.
CO3	Analyze the events of oogenesis and spermatogenesis through histological preparations
CO4	Distinguish between the developmental/metamorphic events in the life cycle of frog, Chick and <i>Limnea</i> .
CO5	Count the sperms and analyse semen for fructose contents

Practical-2, based on 1ZOO3 and 1ZOO4 :

- Elementary idea of animal ethics in laboratories.
- Morphology and histology of non-chordate and chordate ovary and testis (Insects, snails, frog and rat) / alternative available resources.
- Oogenesis and spermatogenesis through gonad histological preparation (A major carp Fish, Poultry, Goat/Sheep).
- Study of different types of eggs on the basis of their yolk content.
- Observation of frog and toad spawn embryos and larvae up to metamorphosis and study of stages of development
- Study of cleavages in *Limnea* in laboratory.
- Mounting of larvae of *Limnea/Bellamia*.
- Study of development of *Amphioxus*, Frog, Chick and pig through available slides of whole mounts/ available ICT based alternatives.
- Morphogenesis and growth study of chick development.
- Normal Sperm count.
- Abnormal sperm count.
- Semen analysis (Fructose Estimation).
- Study of different types of cells present in bone marrow.
- Estimation of ascorbic acid from ovary of any available source of vertebrates.
- Study of Oestrous Cycle by using vaginal smear of rat.
- Types and Histology of Placenta.

The examinee shall be required to produce at the practical examination the following: Practical record book duly signed by Teacher-In-Charge and certified by the Head of the Department as a bonafide work of the examinees.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Distribution of Marks: The practical shall be of six hours duration & distribution of marks will be as follows:

- Mounting: Chick embryo / Molluscan larvae or Developmental stages : 15 marks
- Identification of spots : 20 marks
- Estimation / histological preparation/ Bioassay. : 20 marks

4. Sperm count / slide of bone marrow : 20 marks
 5. Practical record : 10 marks
 6. Viva voce : 15 marks

Total 100 marks

Syllabus Prescribed for 2022-23 Year UG/PG Programme

Programme: MSc Zoology

Semester I: 2ZOO5

Code of the Course/Subject	Title of the Course/Subject	No. of Periods/Week
2ZOO5	Lab III: Practical based on 2ZOO1 and 2ZOO2	8 Periods/Week
2ZOO6	Lab IV: Practical based on 2ZOO3 and 2ZOO4	8 Periods/Week

Cos:

Upon completion of the course successfully, students would be able to

CO	Description
CO1	separate and determine molecular weights of protein by gel electrophoresis.
CO2	Prepare histochemical demonstration of lysosomes by acid phosphatase activity
CO3	Prepare histochemical demonstration of DNA by Fuelgen technique and DNA/RNA by MGPY Technique
CO4	Prepare histochemical demonstration of carbohydrate by PAS reaction
CO5	Separate Amino acid by Paper chromatography.
CO6	Investigate bacterial growth and different microbial preparations

* List of Practical/Laboratory Experiments/Activities etc.

2ZOO5: Practical based on 2ZOO1 and 2ZOO2

1. Organelle separation by centrifugation
2. Electrophoretic separation and Determination of molecular weights of proteins by SDS-PAGE.
3. Light microscopic demonstration of Plasma membrane. (Oil red O, Sudan black B)
4. Demonstration of mitochondria by vital staining.
5. Histochemical demonstration of extracellular matrix. (glycoproteins- Alcian blue pH 1,2.5, PAS)
6. Histochemical demonstration of Lysosomes by demonstrating acid phosphatase activity.
7. Histochemical demonstration of DNA by Feulgen technique.
8. Histochemical demonstration of DNA & RNA by MGPY technique.
9. Histochemical demonstration of Carbohydrates by PAS reaction
10. Preparation of different cell types.
11. Media preparation for prokaryotic cell culture.
12. Different methods of sterilization (Dry, wet and UV sterilization)

13. *E. coli* culturing.
14. Gram staining of micro-organisms
15. Cell viability testing.
16. Preparation of tissue sections & light microscopic examination.
17. Uses of different microscopes.
18. Absorption spectrum of any coloured solution of a substance.
19. Separation of Amino Acids by paper chromatography.

Candidates shall be required to produce at the practical examination, the following : Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Distribution of Marks for 2ZOO5: The practical shall be of duration of 6 hours and distribution of marks will be done as below-

- | | |
|---|------------|
| 1. Histochemical/Cytological demonstration. | : 25 marks |
| 2. Absorption Spectrum of any coloured solution/
Microbiological Preparation | : 25 marks |
| 3. Chromatography/electrophoresis | : 25 marks |
| 4. Class record | : 10 marks |
| 5. <i>Viva voce</i> | : 15 marks |

Total: 100 marks

2ZOO6: Practicals based on 2ZOO3 and 2ZOO4

Cos:

Upon completion of the course successfully, students would be able to

CO	Description
CO1	study human hormonal disorders.
CO2	Analyse parameters of different soil samples
CO3	Analyse parameters of different water samples
CO4	Calculate Diversity indices (Shannon, Simpson)
CO5	Determine RQ
CO6	Identify Freshwater Plankton from water samples
CO7	Perform Qualitative analysis of Pollution indicators

1. Chart/ Photographic based study of human hormonal disorders.
2. Anatomy and Histology of:
 - a. vertebrate (Poultry/sheep/major carp) endocrine glands.
 - b. Insect Pests /Vector neuroendocrine structures .
3. Water analysis of different samples (Pond/Pool water, Canal/River water, Sewage water);
 - i. total hardness
 - ii. Nitrate contents.
 - iii. Sulphate contents.
 - iv. Fluoride contents o different samples of water.
 - v. Total Alkalinity
 - vi. DO
 - vii. Free CO₂
4. Soil analysis of Different samples (Clay soil, Sandy soil, Garden soil / Red soil)
 - i. Soil Moisture ,
 - ii. Chlorides,
 - iii. Sulphates.
 - iv. Nitrates,
 - v. Total Phosphates ,
 - vi. Total organic matter,
 - vii. Humus
5. Instrumentation AAS/ HPLC for residue analyses of toxicant (demonstration)
6. Biodiversity Inventories/Surveys and Field Techniques, Pitfall traps, transact line etc.
7. Calculation of Diversity indices (Similarity, Shannon, Simpson)
8. Biological responses of animals to various osmotic concentrations and their effects.

- a. Change in weight of Earthworm in mild heteroosmotic media.
 - b. Active uptake of Na⁺ and Cl⁻ of aquarium fish from the environmental water and change in salinity.
9. Rate of oxygen consumption by aquatic/terrestrial animals under various Environmental stresses.
 10. Determination of respiratory quotient of an air breathing animal at different Temperatures.
 11. Measurement of frequency, density and diversity of invertebrates in college campus
 12. Identification of Freshwater Plankton from the slides.
 13. Qualitative analysis of organisms (Pollution indicator) such as diatoms / algae, flagellates, ciliates, Rotifers and larvae of insects.
 14. Research work based study of;
 - a. Effect (microphotograph) of environmental toxicants on histoarchitecture of mammalian
 - i. Kidneys.
 - ii. Liver,
 - iii. Gonads
 - iv. Endocrine glands.
 - b. Effect of environmental toxicants on various blood and tissue biochemical in mammals.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Candidates shall be required to produce at the practical examination, the Following-

Practical Record Book duly signed by the teacher in-charge and certified By the Head of the Department as the bonafide work of the candidate.

The practical shall be six hours duration and distribution of Marks will be as follows:

1. Histological preparation	25 marks
2. Water Analysis	15 marks
3. Soil Analysis	20 marks
4. Plankton analysis/comments on research based environmental toxicity /two hormonal disorders/biodiversity study	15 marks
5. Class record	10 marks
6. <i>viva voce</i>	15 mark

Total 100 marks

Programme: MSc Zoology

Semester II

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
2ZOO1	Molecular Cell Biology	60
2ZOO2	Tools and Techniques in Biology	60
2ZOO3	Endocrinology	60
2ZOO4	Environment and Ecology	60
2ZOO5	Lab III	60
2ZOO6	Lab IV	60

COs 2ZOO1: Molecular Cell Biology:

After learning this course, students would be able to.....

1. Understand and Compare Biomembranes and extracellular matrix.
2. Compare various type cell surface and intracellular receptors.
3. Analyse types of Cell Signalling pathways and Cell cycle control.
4. Describe cytoskeleton in the form of microfilaments and microtubules.
5. Determine secretory pathways in eukaryotic cells

Unit	Contents
Unit I	<p>1.1 Biomembranes:</p> <p>1.1.1 Biochemical Composition of biomembranes</p> <p>1.1.2 Transport across cell membrane & transporters.</p> <p>1.1.3 Transporters</p> <p>1.1.4 Transport across epithelia.</p> <p>1.1.5 .Membrane potential.</p> <p>1.2 Extracellular matrix:</p> <p>1.2.1 Basement membrane(basal lamina) structural and cross-linking Components.</p> <p>1.2.2 Collagens & other proteins of extracellular matrix.</p> <p>1.2.3 Cell-cell adhesion molecules.</p> <p>1.2.4 Cell-matrix adhesion.</p> <p>1.2.5 Gap junctions and connexins</p>
Unit II	<p>2.0 Cell Surface Receptors.</p> <p>2.1 Modes of cell signaling (autocrine, juxtacrine, paracrine and endocrine)</p> <p>2.2 Signaling molecules.</p> <p>2.3 Properties of cell surfacereceptors.</p> <p>2.4 G protein-coupled receptors that activate or inhibit adenylyl cyclase.</p> <p>2.5 G protein-coupled receptors that regulate ion channels.</p> <p>2.6 G protein-coupled receptors that activate phospholipase C.</p> <p>2.7 Receptor protein-Tyrosine kinases</p> <p>2.8 Receptor protein-Tyrosine phosphatases</p> <p>2.9 Receptor protein-guanylyl cyclases</p> <p>2.10 Receptor protein-serine/threonine kinase</p> <p>2.11 Cytokine receptors</p>
Unit III	<p>3.0. Cell Signaling:</p> <p>3.1 Pathways of Intracellular signal transduction:</p> <p>3.1.1 Features of signal transducing systems,</p> <p>3.1.2 Second messengers,</p> <p>3.1.3 Ion channels and electrical signaling,</p> <p>3.1.4 Signal transduction by GProtein-coupled receptors,</p> <p>3.1.5 Signal transduction by receptor enzymes,</p> <p>3.1.6 JAK-STAT pathway,</p> <p>3.1.7 Smad pathway, Wnt pathway, Hedgehog pathway,</p> <p>3.1.8 Signal Transduction in vision, Gustation and Olfaction,</p>
Unit IV	<p>4.1 Cell cycle control</p> <p>4.1.1. Cyclins & cyclin dependent kinases (CDKs), Role of MPF</p> <p>4.1.2 DNA replication block & its removal.</p> <p>4.1.3 Cell cycle checkpoints & feedback control.</p> <p>4.1.4 Regulation of CDK-CyclinActivity</p> <p>4.1.5 Programmed cell death (Apoptosis) - Definition, mechanism (Intrinsic and Extrinsic) & significance</p> <p>4.2 Cytoskeleton</p> <p>4.2.1 Microfilaments & microtubules-structure and dynamics</p> <p>4.2.2 Microfilaments membrane binding proteins & their function.</p>

	4.2.3 Intermediate filaments & their functions 4.2.4 Role of microtubules in mitosis.
Unit V	5.0 Synthetic and Secretory pathways: 5.1.1. Protein synthesis in eukaryotes 5.1.2. Protein Uptake into ER 5.1.3. Co- & Post translational modifications in ER 5.1.4. Protein sorting in Golgi apparatus 5.1.5. Vesicle transport 5.1.6. Transport of proteins across nuclear membrane 5.1.7 Lysosomal assembly & functions

Suggested Literature:

1. Molecular cell Biology, J. Darnell , H. Lodish & D. Baltimore , Scientific American Book , Inc. USA.
2. Molecular cell Biology of the cell , B Alberts , D Bray , J. Lewis , M. Raff , K. Roberts and J. D. Watson . Garland Publishing Inc. New York.
3. The cell a molecular approach: Cooper
4. Molecular cell biology: Gerald Karp
5. Animal Cell Culture – A practical approach, Ed. John R.W. Masters. IRL Press.
6. Genetics- A Conceptual Approach by Benjamin & Pierce 2nd Ed.
7. Principles and Techniques of Biochemistry and Molecular Biology 7th Edition by Keith Wilson and John Walker.

Weblink to Equivalent MOOC on SWAYAM if relevant:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

- Weblink to Equivalent Virtual Lab if relevant:

<https://www.youtube.com/watch?v=qOTsa5xDd88>

<https://www.youtube.com/watch?v=hSTeawTvoIU>

https://www.youtube.com/watch?v=SUyMRfuPQ_w

COs 2ZOO2: Tools and Techniques in Biology

After learning this course, students would be able to.....

1. Apply principles and uses of techniques in Biology.
2. Find principles and applications of advanced microscopes and compare their uses.
3. Adopt different microbiological techniques.
4. Know cryotechniques and cryopreservation of cells, tissues and organisms.
5. Study Radioisotope and mass isotope techniques in biology.

Unit	Contents
Unit I	1.0 Principles instrumentation, working and uses of 1.1 Colorimeter 1.2 Spectrophotometer, 1.3 Spectrofluorometer, 1.4 Atomic absorption spectrophotometer, 1.5 ESR and NMR spectrometers, 1.6 X-Ray Crystallography 1.7 Radioactivity counters
Unit II	2.1. Principles instrumentation, working and application of Microscope : 2.1.1 Light, phase contrast, fluorescence, 2.1.2 Scanning and transmission electron microscopy, 2.1.3 Atomic Force microscopy 2.2 Microbiological techniques 2.2.1 Media preparation and sterilization 2.2.2 Inoculation and growth monitoring. 2.2.3 Use of fermenters. 2.2.4 Biochemical mutants and their use. 2.2.5 Microbial assays.
Unit III	3.1. Organelle separation by centrifugation 3.2 Cell separation by density gradient centrifugation, 3.3 Design and functioning of tissue culture laboratory. 3.4 Cell culture techniques- Monolayer and Poly-layer

	3.5 Cell proliferation measurements. 3.6 Cell viability testing. 3.7 Culture media preparation and cell harvesting methods. 3.8 Tissue engineering
Unit IV	4.1. Cryotechniques; 4.1.1 Cryopreservation for cells, tissue and organs. 4.1.2 Cryotechniques for microscopy. 4.1.3 Freeze-drying for physiologically active substances. 4.2. Molecular Separation techniques. 4.2.1 Thin layer chromatography, 4.2.2 Gas chromatography, 4.2.3 High pressure liquid chromatography, 4.2.4 Ion exchange and affinity chromatography, 4.2.5. Electrophoresis
Unit V	5.0 Radioisotope and mass isotope techniques in biology. 5.1 Sample preparation for radioactive counting. 5.2 Autoradiography. 5.3 Metabolic labeling. 5.4 Magnetic Resonance Imaging. 5.5 Liquid scintillation spectrophotometry 5.6 Radiation dosimetry 5.7 Radioactive isotopes and half life of isotopes

Suggested Literature:

1. A Biologists Guide to Principles and Techniques of Practical Biochemistry. K. Wilson & K.H. Goulding, ELBS Edn.
2. Foundation in microbiology : Talaro
3. Microbiology: Pelczar
4. Biology of micro- organisms : Madigan, Martinko and Parker.
5. Biophysical chemistry- Principles and technique: Upadhyay, Nath

Weblink to Equivalent MOOC on SWAYAM if relevant:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>
- Weblink to Equivalent Virtual Lab if relevant:
- <https://youtu.be/jRAqhFdw20>
- <https://youtu.be/4j-LojofifM>
- <https://youtu.be/Sv0g4U4kUMw>
- <https://youtu.be/JB6xboOZX0A>

CO's 2ZOO3 Endocrinology

Upon completion of the course successfully, students would be able to

1. Study histology and histophysiology of different endocrine glands.
2. Study classification of hormones and their actions at cellular as well as genetic level.
3. Study regulation of the processes in organism by hormones.
4. Describe synthesis, transport and metabolism of steroid and nonsteroid hormones.
5. Study hormones of different endocrine glands and relative diseases.
6. Study hormone replacement therapy and neuroendocrine mechanisms in different animal.

Unit	Contents
Unit I	1.1 Histology, hormones and diseases of vertebrate endocrine glands: Pituitary, Thyroid, Parathyroid, Adrenal gland, Islets of Langerhans of Pancreas 1.2 Histophysiology of Pineal and Thymus gland 1.3 Histophysiology of endocrine placenta, testis and ovary in vertebrates 1.4 Structure and functions of Islets of Langerhans 1.5 Histophysiology of Urohypophysis and Corpuscles of Staninus in fishes

Unit II	2.1 Classification of Hormones (Peptides, Steroids and amino acid derived) 2.2 Hormone action at cellular level 2.3 Hormone action at genetic level 2.4 Hormones in biological clock 2.5 Role of hormones in digestion 2.6 Hormonal regulation of carbohydrate, Lipid and Protein metabolism 2.7 Hormonal regulation of Growth and Reproduction
Unit III	3.1 Synthesis, transport (release) and metabolism of steroid hormones 3.2 Synthesis, transport and metabolism of T3, T4 and epinephrine 3.3 Synthesis transport and metabolism of insulin 3.4 Prostaglandins 3.5 Ectohormones in insects and mammals
Unit IV	4.1 Thyroid hormones and disorders 4.2 Parathyroid hormones and disorders 4.3 Pituitary hormones and major Disorders 4.4 Adrenal Gland hormones and Disorders 4.5 Diabetes: Diabetes Type I, Diabetes Type II, Gestational Diabetes, Autoimmune Diabetes Retinopathy, Neuropathy, Diabetic Kidney Problems.
Unit V	5.1 Hormone replacement therapy 5.2 Risks and benefits of Hormone replacement therapy 5.3 Other hormones: Rennin, angiotensin, cytokines, ANF, Erythropoietin 5.4 Evolution of hormones 5.5 Neuroendocrine mechanism in insects and crustacean metamorphosis 5.6 Neuroendocrine mechanism in Amphibian metamorphosis

Suggested Books:

1. Animal Physiology, mechanism & Adaptation - Eckert, Marshall
2. Animal Physiology, Principal & Adaptation- Garden M. S.
3. Human Physiology- C. C. Chatterji Vol. I and II
4. Comparative Vertebrate Endocrinology, Bentley: Cambridge University Press, 1998
5. Fundamentals of Comparative Endocrinology, Chester-Jones et al.: Plenum Press, New York, London, 1987.
6. Comparative Endocrinology, Gorbman et al.: John Wiley & Sons, New York, 1983
7. Vertebrate Endocrinology, Norris: (2nd ed.), Lea & Febiger, 1997.
8. Vertebrate Endocrinology Schreiber & Pang: Vol. I-IV, Fundamentals & Biomedical Implications, Academic Press, 1985 & onwards
9. Endocrinology, Hadley: Prentice hall. International Edition. 2000
10. Essentials of Endocrinology, Brooks and Marshall Blackwell Science. 1995
11. General Endocrinology, Turner and Bagnara: W. B. Saunders Company Philadelphia. 1984
12. Text Book of Endocrinology, 10th edition Larson: Williams. W. B. Saunders Company, Philadelphia. 2002.
13. William's text book of Endocrinology. (XI edition) H. M. Kronenberg S. Melmed, K.S. Polonsky and P. R. Larsen. Publisher - Saunders, Elsevier Inc. (2009).
14. Concise Histology, Leslie P. Gartner, James L. Hiatt, Saunders Elsevier Publication.
15. Essentials of Medical Physiology 6th Ed. –K. Sembulingam and Prema Sembulingam
16. Medical Physiology 11th Ed. Guyton and Hall, Saunders Elsevier Publication

Weblink to Equivalent MOOC on SWAYAM if relevant:

<https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

Weblink to Equivalent Virtual Lab if relevant:

https://youtu.be/OjXhaZr6B_0

https://youtu.be/_eDsgLq7zyo

<https://youtu.be/SA0DWlf8rL4>

<https://youtu.be/3i47VFjbaDY>

COs 2ZOO4: Environment and Ecology:

Upon completion of the course successfully, students would be able to

1. Study environment and their biotic and abiotic interactions.
2. Describe population ecology in terms of diversity indices along with growth curves, demes and dispersal.

3. Study community ecology, ecological succession, ecosystems.
4. Describe environmental pollution and effects on nature, global warming global dimming.
5. Study conservation biology through sanctuaries, National parks, Project Tiger and Biosphere reserves.
6. Study toxicological effects of pesticides and remedial aspects of it.
7. Study Inter-Government Policy/Protocol for Climate change, Intellectual Property Rights and Environment Impact Assessment Processes.

Unit	Contents
Unit I	1.1. The Environment: <ol style="list-style-type: none"> 1.1.1 Physical environment; 1.1.2 Biotic environment; 1.1.3 Biotic and abiotic interactions. 1.2 Habitat and niche: <ol style="list-style-type: none"> 1.2.1 Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. 1.3 Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and k selection); concept of metapopulation, demes and dispersal, interdemec extinctions, Diversity Index: Simpson's index, Shannon's index 1.4 Species interactions: Types of interactions
Unit II	2.1. Community ecology: <ol style="list-style-type: none"> 2.1.1 Nature of communities; community structure and attributes; 2.1.2 Levels of species diversity and its measurements; 2.1.3 Edges and ecotones. 2.2 Ecological succession: Types; mechanisms; changes involved in succession; concept of climax. 2.3 Ecosystem: <ol style="list-style-type: none"> 2.3.1 Structure and function; energy flow and mineral cycling (CNP); 2.3.2 Primary production and decomposition; 2.3.3 Structure and function of some Indian ecosystems; <ol style="list-style-type: none"> 2.3.3.1 Terrestrial (forest, grassland). 2.3.3.2 Aquatic (fresh water, marine, estuarine). 2.4 Biogeography: <ol style="list-style-type: none"> 2.4.1 Major terrestrial biomes; 2.4.2 Theory of island biogeography; 2.4.3 Elementary idea of biogeographical zones of India.
Unit III	3.1 Environmental Pollution <ol style="list-style-type: none"> 3.1.1 Sources nature and effects of Air Pollution 3.1.2. Sources nature and effects of Water pollution 3.1.3 Biodegradation and bioremediation 3.1.4 Biotechnological methods for Management of pollution 3.2. Global climate change; Global warming, Global dimming, 3.3 Biodiversity-statuses; <ol style="list-style-type: none"> 3.3.1 Monitoring and documentation; 3.3.2 Major drivers of biodiversity change; 3.3.3 Biodiversity management approaches, 3.3.4 Economics of Biodiversity
Unit IV	4 .1 Conservation biology: <ol style="list-style-type: none"> 4.1.1 Principles of conservation; major approaches to management, Indian case studies on conservation/management strategy; 4.1.2 Sanctuaries and National Parks, 4.1.3 Project Tiger, 4.1.4 Biosphere reserves 4.2 Toxicology <ol style="list-style-type: none"> 4.2.1 Metabolism & effects of Organochlorine, organophosphate and carbamate pesticides 4.2.2 Metabolism & effects of alkaloids, barbiturates, alcohol & cyanides. 4.2.3 Metabolism & effects of heavy metal salts. 4.2.4 Formation & effects of free radicals. 4.2.5 Biochemistry of Detoxification – Phase I & phase II reactions.
Unit V	5.1 Environmental Monitoring: <ol style="list-style-type: none"> 5.1.1- IGPC (Inter Government Policy/ Protocol for Climate change) 5.1.2- EPA (Environmental Protection Agency) 5.1.3- Laws, legislation pertaining to environment 5.1.4- Control, monitoring & surveillance of environment. 5.1.5- IPR (Intellectual Property Rights) ; Patents need, how to obtain in India & abroad, patent offices in India. 5.2 Environmental Impact Assessment Processes: <ol style="list-style-type: none"> 5.2.1 EIA of reservoirs and Coal mines, thermal Power stations

Suggested Books:

1. Toxicology - A Sood , Sarup & Sons, New Delhi.
2. Biodegradation of pesticides - G. N. Vankhede , Bajaj Publication
3. Environmental biodegradation, Ramkumar, Sarup & Sons , New Delhi
4. Toxicology by Parikh.
5. Poisoning by drugs & chemicals - Cooper
6. Analytical toxicology of inorganic poisons - Jacob M.B
7. Environmental management of toxic and hazardous chemical - Madhuraj
8. Environmental Biology - J. L. Blish
9. Fundamental Ecology - Odum
10. Environmental Physiology - Philips G.
11. Toxicology mechanism & analytical methods - Stewarts & Stratman
12. Environmental Impact Assessment: G .N. Vankhede Biotech Publishers, Delhi
13. Ecology and Biogeography of India, Mani, M.S. : 1974. Junk. Publ. The Hague.

Weblink to Equivalent MOOC on SWAYAM if relevant:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA>

- Weblink to Equivalent Virtual Lab if relevant:

<https://youtu.be/EDohGfEfOis>

<https://youtu.be/L6GguK6s3vw>

<https://youtu.be/-Xm1TMRR9yI>

https://youtube.com/playlist?list=PL7rkRU_uK7LnRnI4p_UXbZUatIC4pzvaD

Syllabus Prescribed for 2022-23 Year UG/PG Programme

Programme: MSc Zoology

Semester II: 2ZO05

Code of the Course/Subject	Title of the Course/Subject	No. of Periods/Week
2ZO05	Lab III: Practical based on 2ZO01 and 2ZO02	8 Periods/Week
2ZO06	Lab IV: Practical based on 2ZO03 and 2ZO04	8 Periods/Week

Cos:

Upon completion of the course successfully, students would be able to

CO	Description
CO1	separate and determine molecular weights of protein by gel electrophoresis.
CO2	Prepare histochemical demonstration of lysosomes by acid phosphatase activity
CO3	Prepare histochemical demonstration of DNA by Fuelgen technique and DNA/RNA by MGPY Technique
CO4	Prepare histochemical demonstration of carbohydrate by PAS reaction
CO5	Separate Amino acid by Paper chromatography.
CO6	Investigate bacterial growth and different microbial preparations

* List of Practical/Laboratory Experiments/Activities etc.

2ZO05: Practical based on 2ZO01 and 2ZO02

1. Organelle separation by centrifugation
2. Electrophoretic separation and Determination of molecular weights of proteins by SDS-PAGE.
3. Light microscopic demonstration of Plasma membrane. (Oil red O, Sudan black B)
4. Demonstration of mitochondria by vital staining.
5. Histochemical demonstration of extracellular matrix. (glycoproteins- Alcian blue pH 1,2.5, PAS)
6. Histochemical demonstration of Lysosomes by demonstrating acid phosphatase activity.
7. Histochemical demonstration of DNA by Feulgen technique.
8. Histochemical demonstration of DNA & RNA by MGPY technique.
9. Histochemical demonstration of Carbohydrates by PAS reaction
10. Preparation of different cell types.
11. Media preparation for prokaryotic cell culture.
12. Different methods of sterilization (Dry, wet and UV sterilization)
13. *E. coli* culturing.
14. Gram staining of micro-organisms

15. Cell viability testing.
16. Preparation of tissue sections & light microscopic examination.
17. Uses of different microscopes.
18. Absorption spectrum of any coloured solution of a substance.
19. Separation of Amino Acids by paper chromatography.

Candidates shall be required to produce at the practical examination, the following : Practical Record Book duly signed by the teacher in-charge and certified by the Head of the Department as the bonafide work of the candidate.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Distribution of Marks for 2ZOO5: The practical shall be of duration of 6 hours and distribution of marks will be done as below-

- | | |
|---|------------|
| 1. Histochemical/Cytological demonstration. | : 25 marks |
| 2. Absorption Spectrum of any coloured solution/
Microbiological Preparation | : 25 marks |
| 3. Chromatography/electrophoresis | : 25 marks |
| 4. Class record | : 10 marks |
| 5. <i>Viva voce</i> | : 15 marks |

Total: 100 marks

2ZOO6: Practicals based on 2ZOO3 and 2ZOO4

Cos:

Upon completion of the course successfully, students would be able to

CO	Description
CO1	study human hormonal disorders.
CO2	Analyse parameters of different soil samples
CO3	Analyse parameters of different water samples
CO4	Calculate Diversity indices (Shannon, Simpson)
CO5	Determine RQ
CO6	Identify Freshwater Plankton from water samples
CO7	Perform Qualitative analysis of Pollution indicators

1. Chart/ Photographic based study of human hormonal disorders.
2. Anatomy and Histology of:
 - a. vertebrate (Poultry/sheep/major carp) endocrine glands.
 - b. Insect Pests /Vector neuroendocrine structures .
3. Water analysis of different samples (Pond/Pool water, Canal/River water, Sewage water);
 - viii. total hardness
 - ix. Nitrate contents.
 - x. Sulphate contents.
 - xi. Fluoride contents o different samples of water.
 - xii. Total Alkalinity
 - xiii. DO
 - xiv. Free CO₂
4. Soil analysis of Different samples (Clay soil, Sandy soil, Garden soil / Red soil)
 - viii. Soil Moisture ,
 - ix. Chlorides,
 - x. Sulphates.
 - xi. Nitrates,
 - xii. Total Phosphates ,
 - xiii. Total organic matter,
 - xiv. Humus
5. Instrumentation AAS/ HPLC for residue analyses of toxicant (demonstration)
6. Biodiversity Inventories/Surveys and Field Techniques, Pitfall traps, transect line etc
7. Calculation of Diversity indices (Similarity, Shannon, Simpson)

8. Biological responses of animals to various osmotic concentrations and their effects.
 - a. Change in weight of Earthworm in mild heteroosmotic media.
 - b. Active uptake of Na⁺ and Cl⁻ of aquarium fish from the environmental water and change in salinity.
9. Rate of oxygen consumption by aquatic/terrestrial animals under various Environmental stresses.
10. Determination of respiratory quotient of an air breathing animal at different Temperatures.
11. Measurement of frequency, density and diversity of invertebrates in college campus
12. Identification of Freshwater Plankton from the slides.
13. Qualitative analysis of organisms (Pollution indicator) such as diatoms / algae, flagellates, ciliates, Rotifers and larvae of insects.
14. Research work based study of;
 - a. Effect (microphotograph) of environmental toxicants on histoarchitecture of mammalian
 - v. Kidneys.
 - vi. Liver,
 - vii. Gonads
 - viii. Endocrine glands.
 - b. Effect of environmental toxicants on various blood and tissue biochemical in mammals.

Note: Besides these any other additional experiment relevant to the syllabi depending on resources

Candidates shall be required to produce at the practical examination, the Following-

Practical Record Book duly signed by the teacher in-charge and certified By the Head of the Department as the bonafide work of the candidate.

The practical shall be six hours duration and distribution of Marks will be as follows:

1. Histological preparation	25 marks
2. Water Analysis	15 marks
3. Soil Analysis	20 marks
4. Plankton analysis/comments on research based environmental toxicity	
/two hormonal disorders/biodiversity study	15 marks
5. Class record	10 marks
6. <i>viva voce</i>	15 mark

Total 100 marks

General Model Scheme

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course-C.B.C.S)

(M.Sc. Part-I) (Semester- I) , Subject : Zoology

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks				Minimum Passing		
			L	T	P	Total	Theory	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	Core – Paper -I	1Z1	04	--	--	04	04	--	04	03	75	25	--	--	100	40	P	
2	Core – Paper - II	1Z2	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
3	Core – Paper - III	1Z3	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
4	Core – Paper - IV	1Z4	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
5	Lab- I (Paper I & Paper II)	1Z5			08	08	-	04	04	06	-	-	25	75	100	50	p	
6	Lab-II (Paper III & Paper IV)	1Z6			08	08	-	04	04	06	-	-	25	75	100	50	p	
	Total		16		16	32	16		08	24	-	300	100	50	150	600		

- Rows as many required
- L: Lecture, T: Tutorial, P: Practical
For Theory 1 Credit is = 01 hour.
For Practical 1 Credit is = 02 hours.

General Model Scheme

Sant Gadge Baba Amravati University Amravati

Scheme of teaching, learning & Examination leading to the Degree Master of Science (Choice Based Credit System) (Two Years ... Four Semesters Degree Course-C.B.C.S)

(M.Sc. Part-I) (Semester- II), Subject : Zoology

Sr. No	Subjects	Subject Code	Teaching & Learning Scheme								Duration of Exams Hrs.	Examination & Evaluation Scheme						
			Teaching Period Per week				Credits					Maximum Marks				Minimum Passing		
			L	T	P	Total	Theory	Internal Ass.	Practical	Total		Theory + M.C.Q External	Theory Internal	Practical		Total Marks	Marks	Grade
														Internal	External			
1	Core – Paper - V	2Z1	04	--	--	04	04	--	04	03	75	25	--	--	100	40	P	
2	Core – Paper - VI	2Z2	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
3	Core – Paper - VII	2Z3	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
4	Core – Paper - VIII	2Z4	04	--	--	04	04	--	04	03	75	25	--	--	100	40	p	
5	Lab- I (Paper V & Paper VI)	2Z5			08	08	-	04	04	06	-	-	25	75	100	50	p	
6	Lab-II (Paper VII & Paper VIII)	2Z6			08	08	-	04	04	06	-	-	25	75	100	50	p	
	Total		16		16	32	16		08	24	-	300	100	50	150	600		

- L: Lecture, T: Tutorial, P: Practical
For Theory 1 Credit is = 01 hour.
For Practical 1 Credit is = 02 hours.

