

Proceedings of the online/offline meeting of Post-Graduate Board of Study

Siddharth University, Kapilvastu, Siddharth Nagar, U.P.

Subject: Zoology

Date: 24/05/2022

An online/Offline meeting of Board of Studies of Zoology subject was held on 24/05/2022 at 11: 00 AM under the chairmanship of Dr. Susmita Srivastav, Convenor BoS to Design the Post-Graduate syllabus (according to new education policy-2020). Following members of the BoS were present in this meeting:

Offline Attendee

1. Dr. Susmita Srivastav (Convenor, BoS)
2. Prof. Vijay Bahadur Upadhyay (External Subject Expert, BoS)
3. Prof. Rajendra Singh (External Subject Expert, BoS)
4. Dr. Sapna Rani (Member, BoS)
5. Mr. Dharmendra Singh (Member, BoS)
6. Dr. Ashish Srivastava (Special Invitee Member, BoS)
7. Dr. Vineeta Rawat (Special Invitee Member, BoS)

Online Attendee

1. Prof. Madhu Tripathi (External Subject Expert, BoS)
2. Prof. Ajay Kumar Srivastav (Special Invitee Member, BoS)
3. Dr. Rajendra Singh (Special Invitee Member of BoS)

The BOS meeting comprehensively discussed the M.Sc.Zoology: 2 Year Semester Course (CBCS) Syllabus and recommended. The BOS submitted it to university for further necessary action.

Enclosure: The final Syllabus of Zoology



(Dr. Susmita Srivastav)

Convenor

Board of Studies (Post -Graduate Zoology)
Siddharth University, Kapilvastu,
Siddharth Nagar, U.P.

SIDDHARTH UNIVERSITY, KAPILVASTU, SIDDHARTH NAGAR



Proposed Syllabus for P.G.

Subject: Zoology

Syllabus Developed/Proposed by				
Sr.No.	Name of Expert/BOS Member	Designation	Department	College/ University
1	Dr. Susmita Srivastav	Convener	Department of Zoology	Shiv Harsh Kisan P.G. College, Basti
2	Dr. Sapna Rani	Member	Department of Zoology	Shiv Harsh Kisan P G. College, Basti
3	Mr. Dharmendra Singh	Member	Department of Zoology	Shiv Harsh Kisan P G College, Basti
Invited Member				
1	Dr. Ashish Srivastava	Invited Member	Department of Zoology	Siddharth University, Kapilvastu, Siddharth Nagar
2	Dr. Vineeta Rawat	Invited Member	Department of Zoology	Siddharth University, Kapilvastu, Siddharth Nagar
External Subject Expert				
1	Prof. Vijay Bahadur Upadhyay	Retd. Professor and Expert	Department of Zoology	DDU University Gorakhpur
2	Prof. Rajendra Singh	Retd. Professor and Expert	Department of Zoology	DDU University Gorakhpur
3	Prof. Madhu Tripathi	Retd. Professor and Expert	Department of Zoology	Lucknow University Lucknow
Special Invitee Subject Expert				
1	Prof. Ajay Kumar Srivastav	Retd. Professor and Expert	Department of Zoology	DDU University Gorakhpur
2	Dr. Rajendra Singh	Subject Expert	Department of Zoology	Bareilly College, Bareilly

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Department of Zoology

M.Sc. I Year (Semester-I)

S.N.	Course Code	Credit/Marks	Name of the Course	Remark
1	MZOC 401	4/100	Non Chordata	Core Paper
2	MZOC 402	4/100	Biostatistics and Computational Biology	Core Paper
3	MZOC 403	4/100	Comparative Animal Physiology	Core Paper
4	MZOC 404	4/100	Biochemistry	Core Paper
5	MZOL 405	4/100	Practical	Practical
6	MZOM 406	4/100	Minor Elective	Minor Elective
7	MZOP 407	4/100	Research Project	Research Project
		28/700		

M.Sc. I Year (Semester-II)

S.N.	Course Code	Credit/Marks	Name of the Course	Remark
1	MZOC 411	4/100	Chordata	Core Paper
2	MZOC 412	4/100	Developmental Biology	Core Paper
3	MZOC 413	4/100	Genetics and Cytogenetics	Core Paper
4	MZOC 414	4/100	Ecological Principles	Core Paper
5	MZOL 415	4/100	Practical	Practical
6	MZOP 416	4/100	Research Project	Research Project
		24/600		

- Minor Elective Paper can be taken either in Semester I or Semester II

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M.Sc. II Year(Semester-III)

S.N.	Course Code	Credit/Marks	Name of the Course	Remark
1	MZOC 501	4/100	Animal Taxonomy, Behaviour and Chronobiology	Core Paper
2	MZOC 502	4/100	Environmental Biology, Wild Life and Economic Zoology	Core Paper
3	MZOE 503 A	4/100	Morphology, Physiology and Development of Fishes	Elective Paper
	MZOE 503 B		Principles of Endocrinology	Elective Paper
	MZOE 503 C		Genome Structure and Replication of DNA	Elective Paper
	MZOE 503 D		Insect Morphology, Physiology and Development Theory	Elective Paper
4	MZOE 504 A	4/100	Taxonomy and Fish Ecology	Elective Paper
	MZOE 504 B		Endocrine Disorder and their diagnostics	Elective Paper
	MZOE 504 C		Expression of Genome	Elective Paper
	MZOE 504 D		Ecology, Evolution and Taxonomy	Elective Paper
5	MZOL 505	4/100	Lab based on 501,502,503&504	Practical
6	MZOP 506	4/100	Research Project	Research Project
		24/600		

- A student has to choose one elective paper from each of the following in Semester III and Semester IV

MZOE 503 Paper III Elective Paper I

- A. Fish Biology I
- B. Endocrinology and Reproductive Physiology I
- C. Molecular Biology I
- D. Entomology I

MZOE 504 Paper IV Elective Paper II

- A. Fish Biology II
- B. Endocrinology and Reproductive Physiology II
- C. Molecular Biology II
- D. Entomology II

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M.Sc. II Year (Semester-IV)

S.N.	Course Code	Credit/Marks	Name of the Course	Remark
1	MZOC 511	4/100	Bioinstrumentation and Bio techniques	Core Paper
2	MZOC 512	4/100	Comparative Anatomy of Vertebrates	Core Paper
3	MZOE 513 A	4/100	Applied Fish and Fisheries	Elective Paper
	MZOE 513 B		Reproductive Endocrinology I	Elective Paper
	MZOE 513 C		Regulation of gene expression	Elective Paper
	MZOE 513 D		Economic Entomology	Elective Paper
4	MZOE 514 A	4/100	Aquaculture Fisheries	Elective Paper
	MZOE 514 B		Reproductive Endocrinology II	Elective Paper
	MZOE 514 C		Applied Molecular Biology	Elective Paper
	MZOE 514 D		Applied Entomology	Elective Paper
5	MZOL 515	4/100	Lab based on 511,512,513 & 514	Practical
6	MZOP 516	4/100	Research Project	Research Project
		24/600		

Subject Pre requisites:

Zoology in UG course as a major subject studied in six Semesters

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M.Sc. I Year (Semester-I)
MZOC 401 Paper I NON-CHORDATA

Course Code: MZOC 401		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Non-Chordata	
Course objectives			
<ul style="list-style-type: none"> • To create in the student an appreciation of non-chordate diversity • To develop in the student an understanding of structural and functional diversity • To develop in the student the understanding of evolutionary relationship amongst non-chordate group 			
Unit	Topics		No. of Lectures
I	Protozoa – Organization, osmoregulation, locomotion, nutrition and reproduction Porifera – Organization and affinities Cnidaria – Origin of metazoa, polymorphism, coral reefs		15
II	Helminthes – General organization and larval forms of trematodes and cestodes, parasitic adaptation Annelida – Adaptive radiation in polychaeta, segmental organs		15
III	Arthropoda – Larval forms in Crustacea, respiratory organs in Arthropods, mouthparts and modes of feeding in insects, economic importance of arthropods		15
IV	Mollusca – Modifications in foot, nervous system and torsion in gastropods Echinodermata – Water vascular system, larval forms and their affinities Minor Phyla – Organization and affinities of Rotifera, Ctenophora and Sipunculoidea		15
Student learning outcomes			
The student at the completion of the course will be able to:			
<ul style="list-style-type: none"> • Structural and functional diversity of non-chordate. • Explain evolutionary relationship and larval forms amongst non-chordate groups. 			

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Books Recommended

1. Barnes: Invertebrate Zoology (Holt-Saunders International, 4th edition, 1980)
2. Barnes: The Invertebrates – A synthesis, 3rd edition, Blackwell, 2001
3. Hunter: Life of Invertebrates, Collier Macmillan Pub. 1979
- 4 Marshall· Parker & Haswell Text Book of Zoology, Vol. I, 7th edition, Macmillan, 1972
5. Moore: An Introduction to the Invertebrates, Cambridge University Press, 2001

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M.Sc. I Year (Semester-I)
MZOC 402 Paper II BIOSTATISTICS AND COMPUTATIONAL
BIOLOGY

Course Code: MZOC 402		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Biostatistics and Computational Biology	
<p>Course objectives</p> <p>The course is so designed that students will learn:</p> <ul style="list-style-type: none"> • Representation of data in the form of Table and Graph • Statistical Analysis • Basics of Computers and Bioinformatics 			
Unit	Topics		No. of Lectures
I	Tabulation and graphical representation of the data: frequency distribution, tabulation, bar diagram, histogram, pie diagram and their significance, measures of central tendencies and variation in data, principle of probability, Probit log analysis		15
II	Test of Significance: t test, analysis of variance, f - test, null hypothesis and chi-square test; distribution. normal, binomial and poisson, correlation and regression		15
III	Basic components of computer-Hardware (CPU, input, output, storage device) and software (operating system); MS Excel: use of worksheet to enter, edit, copy, move data, Use of input statistical function for computation of mean, S.D., Correlation, Regression coefficient and graphical presentation		15
IV	Introduction to bioinformatics: Database: Nucleotide sequence data base (Gene Bank, UCSC, EMBL, DDBJ) and protein sequence data base (Swiss prot, PDB, Blast, Psi-Blast), FASTA, sequence alignment: pairwise and multiple sequence alignment		15
<p>Student learning outcomes</p> <ul style="list-style-type: none"> • Introduction to basic components of computers, Software (operating systems) and application software used in biological and statistical studies. • An overview of databank search data mining, data management and interpretation. <p>An introduction and learning of Probit Log Analysis for interpretation of toxicity data.</p>			

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Books recommended :

1. P N Arora and P.K Malhan. Biostatics, Himalaya publishing house
2. Pagano M. Gauvreau, K (2000). Principles of Biostatistics, Duxbury press, USA
3. I A Khan and A Khanam, Fundamental of Biostatics, Ukaaz publication, Hyderabad
4. Batschelet, E., Introduction to mathematics for life scientists. Springer-Verlag, Berlin.
5. Jorgensen, S.E., Fundamentals of ecological modeling, Elsevier, New York.
6. Swartzman, G.L., and S.P.O. Kaluzny, Ecological simulation primer, Mac millan, New York.
7. Lendren, D., Modelling in behavioral ecology, Chapman & Hal, London, U.K.
8. Sokal, R.R. and F.J. Rohlf, Biometry, Freeman, San Francisco.
9. Snedecor, G.W. and W.G. Cochran, Statistical methods, Affiliated East-West Press, New Delhi (Indian ed).
10. Green, R.H., Sampling design and statistical methods for environmental biologists, John Wiley & Sons, New York.
11. Murray, J.D., Mathematical biology, Springer-Verlag, Berlin.
12. Pielou. E.C., The interpretation of ecological data: A primer on classification and ordination.

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M.Sc. I Year (Semester-I)
MZOC 403 Paper III Comparative Animal Physiology

Course Code: MZOC 403		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Comparative animal Physiology	
Course objectives			
To develop in the student an understanding of:			
<ul style="list-style-type: none"> • functioning of organisms body • the various homeostatic systems of the body • regulation of function in the body 			
Unit	Topics		No. of Lectures
I	Digestion – Digestion and absorption of carbohydrates, proteins, lipids and nucleic acids Excretion – Structure of nephron, urine formation and its regulation, Acid-base balance and homeostasis Thermoregulatory mechanism		15
II	Respiration – Gaseous exchange through respiratory membrane, respiratory pigments, respiratory adaptation to low oxygen tension, mechanism and regulation of respiration Circulation – Blood, haemopoiesis, lymph – composition. haemodynamics, regulation of circulation: cardiac cycle		15
III	Muscular System – Types and ultrastructure of muscle fibres, mechanism of muscular contraction, muscle twitch, summation, tetanus and fatigue		15
IV	Nervous System – Structure and Functions of neurons, mechanism of conduction and transmission of nerve impulse, mechanism of synaptic transmission Major endocrine glands their secretion and functions (pituitary, thyroid, parathyroid, adrenal)		15
Student learning outcomes			
The student at the completion of the course will be able to			
<ul style="list-style-type: none"> • Understand various functional components of an organism body • Analyze the complexities and interconnectedness of these functional components • Identify the mechanism underlying maintenance of homeostasis of the body • Understand the regulatory mechanisms for maintenance of function in the body 			

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Books Recommended

1. Chatterjee C.C. (2016) Human Physiology Volume 1 & 2. 11th edition. CBS Publishers
2. Christopher D. Moyes, Patricia M. Schulte 2016 Principles of Animal Physiology. 3rd Edition, Pearson Education 4. Hill, Richard W , et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, 2004.
3. Ganong' Review of Medical Physiology (21st Ed.), Lang Medical Publications, 2003
4. Guyton, A.C. & Hall, J E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company
5. Keel et al: Samson Wright's Applied Physiology (13th Ed.), Oxford Press, 1989
6. Murray et al: Harper's Illustrated Biochemistry (26th Ed.), Appleton & Lange, 2003
7. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
8. West: Best and Taylor's Physiological Basis of Medical Practice (11th Ed.), Williams and Wilkins, 1981.
9. C. Ladd Procsser. Comparative animal physiology. Wiley Publication
10. William Stewart Hoar. General and Comparative Physiology. Prentice Hall

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M.Sc. I Year (Semester-I)
MZOC 404 Paper IV BIOCHEMISTRY

Course Code: MZOC 404		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Biochemistry	
Course objectives			
To develop			
<ul style="list-style-type: none"> • an understanding of biochemical basis of life • role of stabilizing interaction and biomolecular complexity • biochemical processes as the foundation of all physiological events occurring in animals 			
Unit	Topics		No. of Lectures
I	Thermodynamics – Elementary thermodynamic system, second law and its applications, concept and calculation of free energy change during biological redox reactions Electrolytes – Concepts of Buffers, Handerson-Hasselbach Equation		15
II	Carbohydrates- Glycolysis, Kreb’s cycle, oxidative phosphorylation, gluconeogenesis, glycogenesis, glycogenolysis, hexose monophosphate pathway		15
III	Amino Acids –Biosynthesis of amino acids (Phenyl alanine, tryptophan and aspartate,proline) Proteins –Organization and structure of proteins (α -helix, β -sheet, motifs, folds, domains), Ramachandran plot		15
IV	Lipid – Structure, classification and beta oxidation Nucleic Acids – Structure, types and biosynthesis of nucleotides Enzymes – Kinetics; inhibition; mechanism of action; Michaelis and Menton Equation; Isozyme: allosteric enzymes, ribozymes Vitamins and coenzymes – Structure and functions		15
Student learning outcomes			
<ul style="list-style-type: none"> • The course will lay down the foundation of biochemistry among students where they will develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates and how simple molecules together form complex macromolecules. • They will be able to understand the thermodynamics of enzyme catalyzed reactions and mechanisms of energy production at cellular and molecular levels. 			

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- In addition, the application of Biochemistry in understanding disease and medicine will be appraised

Books recommended :

1. Berg et al.: Biochemistry (5th Ed.), Freeman, 2001
2. David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry (8rd Ed.), W.H. Freeman & Co Ltd; 2021
3. Mathews et al.: Biochemistry (3rd Ed.), Benjamin/Cummings Publuishing, 1990
4. Segal Biochemical calculations (2nd), John Wiley & Sons, 1976
5. Watson et al: Molecular Biology of the Gene (2nd Ed.), Benjamin/Cummings, 1976
6. Zubay et al: Principles in Biochemistry (2nd Ed.), WCB, 1995 7. Rawn: Biochemistry, Neil Patterson, 1989
8. Primrose et al: Principals of gene manipulation (6th Ed.), Blackwell Scientific, 2001
9. Srivastva; Lal; N.Singh Essentials of Biochemistry, Rekha Publications
10. J. Awapra ; Introduction to biochemistry, Printice Hall of INDIA Pvt. LTD
11. Harpur's Illustrated Biochemistry McGraw Hill (Ed 2018)

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MZOL 405 Practical Syllabus

Distribution of Marks:

Time: 6 hours

Exercise	Marks
Physiology Exercise	20
Biochemistry Exercise	20
Biostatistics and computer Exercise	10
Slide preparation	06
Spotting (12 spots)	24
Viva voce	10
Class record	<u>10</u>
	Total Marks <u>100</u>

Nonchordata

General characters and classification of the non- chordates phyla (Protozoa to Echinodermata) with the help of museum specimens and slides.

Protozoa Vital staining and staining preparation of *Paramecium*; Study of cyclosis and trichocysts in *Paramecium*; Permanent preparation of *Ceratium*, *Noctiluca*, *Paramecium*, *Vorticella*.

Study of prepared slides: *Balantidium*, *Nyctotherus*, *Opalina* *Paramecium* - conjugation / binary fission, *Entamoeba histolytica*, *Entamoeba coli*, *Entamoeba gingivalis*, *Monocystis*, *Giardia*, *Trypanosoma*, *Leishmania*, *Trichomonas*, *Trichonympha*, *Plasmodium*.

Porifera: Permanent preparation of gemmules and different kinds of spicules

Study of museum specimens/models; *Lecuosolania*, *Sycon*, *Grantia*, *Euplectella*, *Hyalonema*, *Oscarella*, *Chondrilla*, *Chliona*, *Chalina*, *Spongilla*, *Spongia*, *Hippospongia*.

Cnidaria and Ctenophora: Study of nematocysts of *Hydra*, Permanent preparation of *Hydra*; *Obelia* and other hydrozoan colonies and *Obelia* Medusa

Study of museum specimens/ models : *Tubularia* , *Bougainvillia*, *Pennaria*, *Hydractinia*, *Sertularia*, *Campanularia*, *Millepora*, *Stylaster*, *Physalia*, *Porpita*, *Varella*, *Aurelia*, *Rhizostoma*, *Tubipora*, *Alcyonium*, *Gorgonia*, *Corallium*, *Pennatula*, *Zoanthus*, *Metridium*, *Adamsia*, *Cerianthus*, *Fungia*, *Madrepora*, *Cestum* .



Helminths. Permanent preparation of selected soil and plant nematodes, cestode and trematode parasites of cattle and poultry and different larval stages of liver fluke,

Study of museum specimens/ whole mounts : *Dugesia, Polystoma, Bipalium, Fasciola, Paramphistomum, Schistosoma, Taenia solium, Taenia saginata, Moniezia, Echinococcus, Trichuris, Trichinella, Heterodera, Enterobius, Ascaris, Ancylostoma, Dracunculus, Wuchereria*

Study of prepared slides: Scolex of tape worm, mature and gravid proglottid of tape worm; Study of cysticercus larva, hydatid cyst, larval stage of *Fasciola*

Annelida: Study of museum specimens/models: *Aphrodite, Tomopteris, Glycera, Chaetopterus, Arenicola, Sabella, Amphitrite, Serpula, Tubifex, Branchiobdella, Eisenia, Metaphire, Placobdella, pontobdella Branchellion, Polygordius,*

Study of prepared slides: T.S. of body of leech passing through various places.

Arthropoda. Study of museum specimen: *Limulus, Palamnaeus, Lycosa, Apus, Argulus, Balanus, Sacculina, Mysis, Gmmarus, Squilla, Prawn, Lobster, true crab, hermit crab, Julus, Scolopendra, Scutigera, Lepisma, Mantis, stick insect, grass hopper, termites, Forficula, Pediculus, Ranatra, Dysdercus, Musca.* Lady bird beetle, butterfly, wasp, *Xenopsylla*, life history of honey bee, lac insect and silk moth, spider

Study of prepared slides: Mouth parts of male and female *Anopheles* and *Culex*, house fly, honey bee, butterfly, *Cimex, Daphnia, Cypris, Cyclops, Pediculus,*

Mollusca: Study of museum specimen/models: *Chiton, Dentalium, Pila, Aplysia, Baccinum, Doris, Lymnaea, Mytilus, Patella, Pecten, Limax, pearl oyster, Teredo, Nautilus, Loligo, Sepia, Octopus.*

Study of prepared slide: Radula, T.S of shell of *Unio*, T.S of gill lamina of *Unio*, T.S of body of *Unio* passing through middle region; Larvae of molluscs.

Echinodermata: Study of museums specimen/ models: *Astropecten, Asterias, Ophiothrix, Ophiura, Echinus, Clypeaster, Echinocardium, Thyone, Holothuria, Antedom;*

Study of prepared slides. Larvae of echinoderms: Aristotle's lantern

Minor phyla: Representative specimens of Sipunculida (*Sipunculus*)

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Biostatistics and Computation Biology

- Numerical Based on: Matrices. Mean, median and mode. Mean deviation, variance, standard deviation and standard error.
- Representation of data: Bar diagrams, π -diagrams, Histograms, Frequency polygons
- t-test
- F-test
- Chi square test
- ANOVA
- Demonstration of PubMed in searching scientific literature using authors name, fields, limits etc.
- Demonstration of BLAST in comparing Protein Sequences.
- Use of Sigma Stat/Prism Software for Statistical analysis.
- Use of Search engines and online resources.

Physiology

- Determination of rate of Oxygen consumption of Albino rat
- Study of total count of erythrocyte and leukocytes of rats
- Study of different leukocyte count of rat
- Determination of Rh factor in human blood
- Colorimetric estimation of hemoglobin content of the blood, colour index and mean corpuscular in rat.
- Determination of respiratory rate of rat in relations to size and sex; Respiration rate in fish at different temperatures.

Biochemistry

- Isolation and colorimetric determination of glycogen content of rat liver
- Demonstration of effect of epinephrine on the glycogen yield from the liver
- Estimation of protein content liver in fish and rat
- Quantitative estimation of total free amino acid in tissues of cockroach and paper chromatographic separation of these amino acids
- Kinetic assay of salivary amylase and study of effects of time temperature and pH
- Estimation of total lipid in fat body of cockroach and liver of fish and rat.

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M.Sc. I Year (Semester I) Paper VI

Course Code: MZOP 407	Credit: 4	Project
	Course Title: Research Project	
Each student will do a research project under the guidance of a supervisor. Evaluation of the research project will be done after the second semester.		

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M.Sc. I Year (Semester-II)
MZOC 411 Paper I CHORDATA

Course Code: MZOC 411		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Chordata	
Course objectives			
To create in the student			
<ul style="list-style-type: none"> • an appreciation of chordate diversity • an understanding of structural and functional diversity • the understanding of evolutionary relationship amongst chordate 			
Unit	Topics		No. of Lectures
I	Origin of chordates: pisces – ostracoderm, placoderms and devonian fishes: general organization and affinities of holocephali, crossopterygii and dipnoi		15
II	Origin of tetrapoda: general organization of anura, peculiarities of urodela and apoda, neoteny in amphibia		15
III	Origin and evolution of Reptilia: General organization of Chelonia, Rhynchocephalia, Squamata and Crocodilia		15
IV	Origin and Evolution of Birds: Aerodynamics in Birds: flight Adaptations Origin and Evolution of Mammals: Characteristic Features of Monotremes, Marsupials and Placentals		15
Student learning outcomes			
The student at the completion of the course will be able to.			
<ul style="list-style-type: none"> • Demonstrate comprehensive identification abilities of chordate diversity • Explain structural and functional diversity of chordate • Explain evolutionary relationship amongst chordate 			

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Books recommended :

1. Boolootian, R. A and Stiles, K. A., College Zoology, 10th edition, Macmillan Publishing Co., Inc. New York, 1981.
2. Colbert, E H., Morales, M. and Minkoff, E. C. Colbert's Evolution of the Vertebrates. A history of the backboned animals through time, 5th edition, John Wiley - Liss, Inc., New York, 2002. (29)
3. Farner, D. S. and King, J. R., Avian Biology (in several volumes), Academic Press, New York, 1971. 4. Goodrich, E. S, Studies on Structure and Development of Vertebrates, Dover Publication, New York, 1958.
4. Harvey et al: The Vertebrate Life (2006)
5. Hildebrand, M. Analysis of Vertebrate Structure, 4th edition, John Wiley & Sons, Inc., New York, 1995.
6. Jordan, E. L. and Verma, P. S., Chordate Zoology. S. Chand & Company Ltd, 1998.
7. Kenneth V Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
- 8 Kotpal, R. L The Birds, 4th edition, Rastogi Publications, Shivaji Road, Meerut, 1999
9. Marshall, A. J., Biology and Comparative Physiology of Birds, Volume I & II, 1960.
10. McFarland, W. N., Pough, F. H., Cade, T. J. and Heiser, J. B., Vertebrate Life, Macmillan Publishing Co., Inc , New York, 1979.
11. Moore, J. A , Biology of Amphibia, Academic Press, 1964.
12. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford
13. Parker, T. S. and Haswell, W. A., TextBook of Zoology, Vol. II, ELBS, 1978.
14. Romer, A. S. and Parsons, T. S., The vertebrate body, 6th edition, CBS Publishing Japan Ltd, 1986.
15. Sinha, A. K., Adhikari, S. and Ganguli, B. B.: Biology of Animals, Vol. II, New Central Book Agency, Calcutta, 1988.
16. Young, J. Z. The life of vertebrates, 3rd edition, ELBS with Oxford University Press, 1981

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M.Sc. I Year (Semester-II)
MZOC 412 Paper II DEVELOPMENTAL BIOLOGY

Course Code: MZOC 412		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Developmental Biology	
Course objectives			
The objective of this course is to provide insight on:			
<ul style="list-style-type: none"> • How the single cell formed at fertilization forms an embryo and then a fully formed adult organism. • Integration of genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development, and • The treatment of birth defects and infertility in humans. 			
Unit	Topics		No. of Lectures
I	Cellular differentiation, signalling, Potency, Induction, Competence, morphogenetic gradient, cell fate and cell lineages, Stem cells,		15
II	Structure and recognition of gametes, Sperm capacitation and acrosomal reaction, Fertilization, Prevention of polyspermy, egg activation Nature of Egg, Cleavage Pattern, Blastula formation, Gastrulation, Formation and fate of the germinal layers, Causes of fetal deformities		15
III	Organogenesis of vertebrate eye and heart, Evolution of viviparity in mammals, Cellular and Biochemical events in Amphibian and Insect metamorphosis,		15
IV	Determination of polarity and symmetry, Induction and Organizer concept, Regeneration of salamander limbs, morphallactic regeneration in Hydra, Transgenic animals, Aging and cellular death		15
Student learning outcomes			
The student at the completion of the course will be able to understand:			
<ul style="list-style-type: none"> • A variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features, • How a cell behaves in response to an autonomous determinant or an external signal, and • The scientific reasoning exhibited in experimental life science. 			
Books recommended :			
<ol style="list-style-type: none"> 1. Gilbert: Developmental biology. Sinauers, 2003. 2. Kalthoff: Analysis of biological development. McGraw-Hill, 1996. 3. Wolpert: Principles of development. Oxford, 2002. 			

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- 4 Roger A. Pedersen, Gerald P. Schatten. Current Topics in Developmental Biology: 1998 Elsevier.
- 5 Russ Hodge Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: 2009, Infobase Publishing.
6. Michael J. F. Barresi, Scott F. Gilbert. Developmental Biology. 2019, Oxford University Press
7. T. Subramaniam. Developmental Biology. (Reprint) 2013, Narosa Publishing House Pvt. Ltd., New Delhi
8. Werner A Müller. Developmental biology: 2012, Springer Science & Business Media.
9. Jonathan M. W. Slack. Essential Developmental Biology:, (3rd ed.) 2012, Wiley-Blackwell.
10. Bruce M. Carlson. Human Embryology and Developmental Biology E-Book:, 2018, Elsevier Health Sciences
- 11 B.l Balansky . An introduction to embryology by, CBS college publishing

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M.Sc. I Year (Semester-II)
MZOC 413 Paper III Genetics and Cytogenetics

Course Code: MZOC 413		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Genetics and Cytogenetics	
Course objectives			
<ul style="list-style-type: none"> • To study the structure of gene and learn how the information contained within them gets transferred from one generation to another. • Human genetics will impart knowledge about the human chromosome constitution that would help in applying basic principles of chromosome behaviour to disease context. • To create awareness of genetic diseases. 			
Unit	Topics		No. of Lectures
I	Mendelian Principles of Inheritance, Current status of Mendelism, Concept of gene, allele, multiple alleles, Pseudoalleles		15
II	Cytoplasmic Inheritance, Environment and heredity, lethal genes, chromosomal mapping, Extension of Mendelian principles- codominance, incomplete dominance, gene interactions, pleiotropy, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage		15
III	Euchromatin and heterochromatin, chromosomal aberration, DNA Replication, transposable elements in prokaryotes and eukaryotes		15
IV	Bacterial transformation, transduction, conjugation, mapping of genes interrupted, elements of eugenics , imprinting of genes, gene therapy		15
Student learning outcomes			
The students will get the idea about			
<ul style="list-style-type: none"> • Mendelism, cytoplasmic inheritance, aberration, gene therapy • The student will have awareness about genetic diseases, their types and causes. • The principles of inheritance, linkage and crossing over which lead to variations will be made clear as well as the application thereof in gene mapping 			

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Books recommended :

- 1 Brooker: Genetics : Analysis and Principles (Addison-Wesley, 1999)
- 2 Gardner et al: Principles of Genetics (John Wiley, 1991)
3. Griffith et al: Modern Genetic Analysis (Freeman, 2002)
4. Hartl & Jones Essential Genetics: A Genomic Perspective (Jones & Bartlet, 2002)
- 5 Lewin, Genes VIII (Wiley, 2004)
- 6 Russell: Genetics (Benjamin Cummings, 2002)
- 7 Snustad & Simmons: Principles of Genetics (John Wiley, 2003).
8. Alberts et al: Essential Cell Biology (Garland, 1998)
- 9 Alberts et al: Molecular Biology of the Cell (Garland, 2002)
10. Bostock & Sumner: Eukaryotic Chromosome (North-Holland, 1987)
11. De Robertis & De Robertis. Cell and Molecular Biology (Lee & Febiger, 1987)
12. Karp. Cell and Molecular Biology (John Wiley & Sons, 2002)
13. Lewin, Genes VIII (Wiley, 2004)
14. Lodish et al: Molecular Cell Biology (Freeman, 2000) 8. Pollard & Earnshaw: Cell Biology (Saunders, 2002)

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M.Sc. I Year (Semester-II)
MZOC 414 Paper IV ECOLOGICAL PRINCIPLES

Course Code: MZOC 414		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Ecological Principles	
Course objectives			
<ul style="list-style-type: none"> • To develop in the student an understanding of • Ecosystem structure and function • Ecological development • Ecosystem modelling 			
Unit	Topics		No. of Lectures
I	Concept of habitat and niche, ecosystem – structure and functions, concept of limiting factors, Liebig's law of the minimum; Shelford law of tolerance; energy flow, first and second law of thermodynamics, biogeochemical cycles (carbon, nitrogen and phosphorus)		15
II	Characteristics of population, population growth curve, life history strategies (r and k selection), nature of community, community structure, edges and ecotones; ecological indicator		15
III	Ecological pyramids, ecological succession-types, mechanism; species interaction; tritrophic interaction, concept of homeostasis and feedback		15
IV	Ecosystem modelling, acclimation and acclimatization; different types of ecosystem –terrestrial and aquatic; conservation of natural resources; wetlands		15
Student learning outcomes			
The students will get the idea about			
<ul style="list-style-type: none"> • Ecological relationships between organisms and their environment. • Explained and identified the role of the organism in energy transfers • Described the habitat ecology and resource ecology. 			

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Books recommended :

1. Clifford B. Knight. Basic concepts of Ecology, The Macmillan Company, New York
2. E.P. Odum. Fundamental of Ecology, Oxford and IBN Publishing Co., New Delhi
3. Grant, W.E. and Swannack. T.M Ecological Modeling. (2008), Blackwell.
4. Kimon Hadjibros. Ecology and Applied Environmental Science
- 5 Margaret Brown. Ecology, Apple Academic
6. Gurkirat Kaur Environmental Law, Shree Publishers and Distributors, New Delhi
- 7 Benton and Werner. Field Biology and Ecology, McGraw-Hill Book Company
- 8 Conklin A R Jr. Field Sampling: Principles and Practices in Environmental Analysis (2004), CRC Press
9. Wilkinson, D.M. Fundamental processes in Ecology: An Earth system Approach, (2007). Oxford University PRESS , UK,
- 10 Fahey, T.J. and Knapp, A.K. Principles and standards for Measuring Primary Production, (2007), Oxford University press, UK.

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MZOL 415: PRACTICAL Syllabus

Distribution of marks:

Time: 6 hour

Exercise	Marks
Cytogenetics exercise	10
Ecology exercise	15
Embryology exercise	15
Preparation	10
Spotting (10 spots)	25
Viva-voce	15
Class Record	<u>10</u>
Total marks	<u>100</u>

Chordata

Urochordata: Study of museum specimens/ whole-mount: *Oikopleura*, *Herdmania*, *Ascidia*, *Pyrosoma*, *Doliolum*, *Salpa*

Cephalochordate: Study of museum specimen: *Branchiostoma*.

Cyclostomata: Study of museum specimens /models: peltromyzon , Myxine; Ammocoete larva.

Pisces:

Natural history of cartilaginous fishes (class Chondrichthyes): *Scoliodon*, *Sphyrna* (hammer headed shark), *Torpedo* (electric rays), *Pristis*, *Rhinobatus*, *Raja* (skate), *Trygon* (string rays), *Chimaera*

Natural history of bony fishes (class Osteichthyes)

Polypterus, *Acipenser*, *Polydon* , *Amia*, *Lepidosteus*, *Salmo*, *Hilsa*, , *Notopterus*, *Labeo*, *Catla*, *Cyprinus*, *Cirrhina*, *ariys* , *Heteropneustes*, *Clarius*, *Wallago*, *Mystus*, *Anguilla*, *Exocoteus*, *Hippocampus*, *Channa*, *Amphipmous*, *Anabas*, *Synaptura*, *Echeneis*, *Syngnathus*, *Pleuronectes*, *Lophius*, *Tetradon*, *Diodon*, *Ostracion*

Lung Fishes: *Protopterus*, *Lepidosiren*, *Neoceratodus*

Study of disarticulated bone of carp.

Amphibia: Study of museum specimen/models: *Ichthyophis*, *Uraeotyphlus*, *Cryptobrunchus*, *Ambystoma*, Axolotl larva, *Salamandra*, *Amphiuma*, *Triturus*, *Proteus*, *Necturus*, *Siren*, *Alytes*, *Bufo*, *Hyla*, *Rhacophorus*,

Study of disarticulated bone to frog

Reptilia . Study of museum specimen/models: *Testudo*, *Chelone*, *Kachuga*, *Trionyx*, *Sphenodon*, *Hemidactylus*, *Phrynosoma*, *Calotes*, *Draco*, *Lguana*, *Chamaeleon*, *Heloderma*, *Varanus*,

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Ophisaurus, Typhlops, Python, Ptyas, Natix, Eryx, Dendrophis, Hydrophis, Crotalus, Bungarus, Naja, Russel Viper, Pit Viper, Crocodilus, Alligator, Gavialis,

Study of disarticulated bones of *Varanus*

Aves: Study of museum specimens / models:

Archaeopteryx, Phoenicopterus (Flamingo), *Pavo* (Peacock), *Columba* (Pigeon), *Eudynamus* (Koel), *Psittacula* (Parrot), *Bubo* (Owl), *Dendrocopus* (Woodpecker), *Passer domesticus* (House sparrow), *Corvus* (Crow)

Study of disarticulated bones of fowl

Mammalians. Study of museum specimens/models: *Ornithorhynchus, Tachyglossus, Erinaceus, Talpa, Sorex, Macropus, Pteropus*, (Bat), *Loris, Funambulus, Rattus, Oryctologus, Hystrix,*

Study of disarticulated bones of rabbit

Developmental Biology

- Experiments on artificial ovulation, insemination in study of the life history stages of frog
- Study of hormonal control of amphibian metamorphosis
- Incubation and mounting of chick embryos;
- Study of prepared slides of the embryology of frog, chick and mammals and mammalian placentation
- Microtomy of embryonic stages of chick embryonic
- Application of window techniques for in-situ study of chick embryo with special reference to morphogenetic movement
- Determination of the effect of temperature on the embryonic development of chick;
- Study of the development of selective organs through preserved specimen and prepared slides: Experiment on regeneration in earthworm; regeneration of lizards.

Genetics and Cytogenetics

- Study of mitosis in onion root tip
- Meiosis in testis of grasshopper with the acetocarmine squash method
- Study of the salivary gland chromosomes of *Drosophila* and *Chironomus*.

Ecological Principles

- Study of different structural adaptation of animals to ecological conditions
- Study of micro and macro fauna of soil by froth floatation method
- Comparative estimation of physicochemical eco factor of/ in different localities; Temperature, pH, Carbonate, sulphate, nitrate, and turbidity, in fresh water sample; moisture contenting soil sample
- Study of seasonal variation in plankton population demonstration of parallax vision and height perception
- Analysis of plant community and biodiversity and biomass
- Study of seasonal plankton population both qualitative and quantitative

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M.Sc. I Year (Semester-II) Paper VI

Course Code: MZOP 417	Credit: 4	Project
		Course Title: Research Project
<ul style="list-style-type: none">• Each Student will do a research project under the guidance of supervisor.• Evaluation of the research project will be done after the second semester		

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M.Sc. II (Semester-III)

MZOC 501 Paper I ANIMAL TAXONOMY, BEHAVIOUR AND CHRONOBIOLOGY

Course Code: MZOC 501	Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4	Course Title: Animal Taxonomy, Behaviour and Chronobiology	
Course objectives The course is so designed that students will learn: <ul style="list-style-type: none">• Basic concepts of biosystematics, which will enable the students not only to understand the subjects but also to solve the biological problems related to the environment• animal behaviour in the context of evolutionary and ecological biology• recent approaches in animal behavior• how the rhythmic geophysical environment impacts the internal rhythms• how environmental cues are perceived by the organisms and modulate the circadian physiology at molecular, cellular and systems levels• diagnosis of clock disruption and related disorders• Time dependent treatment to different lifestyle disorders		
Unit	Topics	No. of Lectures
I	Definition and basic concept of animal taxonomy, its importance and application in biology, species concept and taxonomic characters, procedure in taxonomy – collection, preservation and identification and nomenclature: International Code of Zoological Nomenclature (ICZN), type concept	15
II	Introduction of behaviour, proximate and ultimate, causation, types of learning (non associative and associative), social learning (cultural transmission), learning and memory - conditioning, habituation, insight learning, sensitization	15
III	Pattern of communication – chemical, visual, light, audio, species specific songs, evolution of language with respect to primate, social behaviour with respect to insects, sexual selection and kin selection, hormones and behaviour	15

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IV	Introduction, scope of chronobiology, types and properties of biological rhythms (Circadian, Circatidal, Circalunar, Circannual), seasonal variation in fishes and birds, Life style disorders – Depression and sleep disorder, clock repair, chronotherapy and Chrono medicine	15
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Student learning outcomes

The students will get the idea about

- principles of taxonomy for identification, classification and naming the organisms scientifically
- understanding and identify behaviour in a variety of taxa
- discussing the proximate and ultimate causes of various behaviour
- designing and implementing experiments to test hypothesis relating to animal behavior
- understanding about the molecules, cells, and systems of biological timing systems
- Conceptualizing how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
- studying and analyzing the scientific literature
- planning studies on biological rhythms in both human and non-human species
- interpreting the cause and effect of lifestyle disorders
- contributing to public understanding of biological timing

Books recommended :

- 1 Ernst Mayr. Principles of Systematic Zoology, McGraw Hill, New York
2. G.G. Simpson. Principles of Animal Taxonomy, Columbia University Press, Scientific Publisher
3. Manning and MS Dawkins. An Introduction to Animal Behaviour Cambridge University Press, UK.
4. John Alcock. Animal Behaviour, Sinaer Association, INC.
- 5 P. Silverman. Animal Behaviour in the Laboratory, London. Chapman and Hall.
6. Rishikesh and Niraj. Introduction to Animal Behaviour, Campus Bools.
7. Peter Marter and J Hamilton. Mechanism of Animal behavior, John Wiley & Sons, USA
8. Mc Gure and Wallace Perspective on Animal Behaviour. John Wiley & Sons, USA.
- 9 Lec Alan Dugatkin, W.W Norten. Principles of Animal behavior . New York.
10. FB Mannl. Text Book of Animal Behaviour, PH learning Pvt.
11. Binkley, S. (1990): The clockwork sparrow: time, clocks, and calendars in biological organisms, Prentice-Hall, New Jersey.
12. Chandrashekar, M. K. (1985): Biological rhythms, Madras Science Foundation, Chennai.
- 13 Shapiro, C. M and Heslegrave, R. J. (1996): Making the shift work, Joli Joco Publications, Inc. Toronto.

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14. Nelson, R. J. (2000) *An Introduction to Behavioural Endocrinology*, 2nd edition, Sunderland Publishers, Massachusetts

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M.Sc. II (Semester-III)

MZOC 502 Paper II ENVIRONMENTAL BIOLOGY, WILD LIFE AND ECONOMIC ZOOLOGY

Course Code: MZOC 502		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Environmental Biology, Wild life and Economic Zoology	
Course objectives The course is so designed that students will learn to develop in the student an understanding of <ul style="list-style-type: none">• environmental structure and function• global environmental issues• significance and conservation of wild life			
Unit	Topics	No. of Lectures	
I	Meaning and scope of environmental biology, environmental problems: (pollution, acid rain, green house effects and global warming, depletion of ozone layer, climatic change). environmental diseases with special references to carcinogenesis and radiation injury, management of industrial and biochemical waste, environmental laws	15	
II	General study of wild life, wild life conservation programmes, project tiger, project crocodile, project elephant, wild life sanctuaries, national parks, biosphere reserves and zoos in India	15	
III	Vermiculture –Ecology and distribution of earthworms: vermiculture and vermicomposting methods: chemical composition of waste based vermicompost: species of earthworms for vermicomposting; use of earthworm in land improvement and reclamation	15	
IV	Prawn, Pearl Culture, poultry farming and pharmaceuticals from the animals	15	
Student learning outcomes The students will get the idea about <ul style="list-style-type: none">• complexities and interconnectedness of various environmental levels and their functioning• global environmental issues, their causes, consequences and amelioration• significance and conservation of wild life			

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- distribution of wildlife in ecological sub division of India); IUCN categories, biosphere reserves, national parks, sanctuaries and zoos

Books recommended :

- 1 Stanley and Manahan, E. Environmental Chemistry. 2010. CRC, Taylor & Francis. London.
- 2 Raven, Berg, Johnson Environment, 1993, Saunders College Publishing.
3. A.N. Moen. Wildlife ecology
- 4 E.G. Balen. Wildlife ecology and management
- 5 Ramesh Bedi. Indian wildlife
6. Rajesh Gopal Wildlife management.
7. Caughley, G., and Sinclair, A R.E. (1994). Wildlife Ecology and Management. Blackwell Science.
8. Pushpesh. J. Wildlife & Forest Conservation A Status Report. Swastik
9. Anderson Stanley. Managing Our Wildlife Resources. Prentice Hall, 3rd Edition
- 10 Martin Winter. Wildlife Biology. Syrawood Publishing House
- 11 Kasen Hurst Wildlife Conservation & Management. Larsen & Keller
12. Martin Winter. Wildlife Conservation & Management .Syrawood Publishing House
13. Martin Winter. Wildlife Protection & Management Callisto Reference
- 14 Kendall W.L. Wildlife Study Design. SJ 25. Andrew Wright. Forest Ecology Black Prints
15. Rajesh Gopal. Fundamental of Wildlife Management. Natraj Publishers
17. Venkitaraman: Economic Zoology (Sudarsana Publishers, 1983)
18. Srivastava : A Text Book of Applied Entomology, Vol. II & III (Kalyani Publishers, 1988 & 1991)
- 19 Shukla & Upadhyaya : Economic Zoology (Rastogi Publishers, 1999-2000
- 20 Morley A. Jull. .Poultry Husbandry
21. Harbans Singh and E N. Moore. Life stock and Poultry Production

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M.Sc. II (Semester-III)

MZOE 503 A Paper III

Elective Paper - Fish Biology

Paper I –Morphology, Physiology and Development of Fishes

Course Code: MZOE 503 A		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Morphology, Physiology and Development of Fishes	
Course objectives The aim is to provide students with the knowledge of: <ul style="list-style-type: none">• Biology and physiology of fishes.• Endocrine gland and development of fishes.			
Unit	Topics	No. of Lectures	
I	Scale-Types structure and composition, different type of caudal fins, origin of paired fins, accessory respiratory organs and swim bladder (structural modifications), function of swim bladder, Weberian ossicles, light and sound producing organs.	15	
II	Food and feeding habits in fishes, physiology of digestion, respiration, excretion, osmoregulation (fresh water and marine fish).	15	
III	Gonads: Male and female, reproductive cycle and maturation, spawning, development in fishes, parental care.	15	
IV	Endocrine glands: structure function and hormones secreted by these glands (hypophysis, thyroid, adrenal, ultimobranchial body, corpuscles of Stannus and Urophysis)	15	
Student learning outcomes The present course provides the basic concepts of fish biology and genetic resources, which will enable the students to: <ul style="list-style-type: none">• Utilize the knowledge in fish biology researches, manage the fish under controlled conditions, and understand the status of fish biogenetic resources of India			

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Books recommended :

1. Tony J. Pitcher. Behaviour of teleost fishes. Chapman and hall.
2. Khanna, S.S An Introduction to Fishes.
3. Srivastava, C.B.L. A. textbook of Fishery Science and Indian Fisheries.
4. N.B. Marshal. Fish life Environment and diversity. Agrobios (India).
5. W.S Hoar & D J Randall. Fish physiology edited Vol I and II academic press INC.
6. Datta Munshi, J.S. and M.P. Srivastava. Natural History of Fishes and Systematic of Fresh water Fishes of India. 2006 Narendra Publ House, New Delhi.
7. Norman, J.R. A History of Fishes.
8. Kyle, H.M.A Biology of Fishes
9. Jhingran: Fish and Fisheries of India.
10. Lagler et. al Ichthyology
11. Brown ME 19 Physiology of fishes Volume 1 & Volume 2 Academic Press, New York.
12. Hoar WS, Randall DJ and Donaldson EM. 1983. Fish Physiology. Vol. IX. Academic Press, New York

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M.Sc. II (Semester-III)

MZOE 503 B Paper III

Elective Paper - Endocrinology and Reproductive Physiology

Paper I - Principles of Endocrinology

Course Code: MZOE 503 B		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Principles of Endocrinology	
Course objectives The course focuses on helping the students to understand the basics of endocrinology and impart knowledge about the endocrine regulation of different body functions. Besides, it aims to understand the integrative working of signaling system in maintaining homeostasis			
Unit	Topics	No. of Lectures	
I	Introduction to Endocrine System Classification of Hormones, synthesis and secretion of hormone Hormone receptor and mechanism of Hormone Action Neurotransmitters and Neuropeptides	15	
II	Thyroid Gland- Hormone biosynthesis, Chemistry, Mechanism of action, Functions Pancreas – Insulin, Glucagon, Regulation of Feeding and Digestion	15	
III	Endocrine Hypothalamus Hormones of Pituitary gland and their functions Hypothalamic Regulation of Pituitary gland	15	
IV	Hormones and Homeostasis – Electrolytes and Water balance (Renin and Angiotensin System) Energy Homeostasis Parathyroid Gland – Calcium Homeostasis Endocrine Regulation of Bone	15	
Student learning outcomes The course will enable the students to develop			

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- an understanding of the basic endocrinology
- the endocrine regulatory molecules mediating physiology and behavior
- the neural and endocrine components of physiological function and neuroendocrine regulation
- the role of hormones in metabolic regulation and maintaining homeostasis
- the integrative working of signaling system

Books recommended :

1. David O. Norris, James A. Carr . Vertebrate Endocrinology, 2013, 5th Edition, Academic Press
2. H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen. Williams Textbook of Endocrinology: 2008, 11th Edition, Saunders, Elsevier
3. P. J. Bentley. Comparative Vertebrate Endocrinology, 3rd Edition. Cambridge University Press
4. Charles B. Nemeroff. Neuroendocrinology, xxxx, CRC, US
5. Richard E Brown. An Introduction to Neuroendocrinology, 2005, Cambridge University Press
6. Mac E. Hadley, Jon E. Levine. Endocrinology, 2009, 6th Edition, Pearson Education
7. F. F Bolander. Molecular Endocrinology, 3rd Edition, 2004, Elsevier Academic Press
8. Darville Brook, C.G & Marshall. Essential Endocrinology, Wiley Blackwell
9. Greenstein B. Endocrinology at a Glance, Wiley Blackwell
- 10 V. M. Montori. Evidence-Based Endocrinology: (ed.), Humana Press
11. Ernst Knobil and Jimmy D. Neill. Encyclopedia of Reproduction, Volumes 1-4, Academic Press

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M.Sc. II (Semester-III)

MZOE 503 C Paper III

Elective Paper - Molecular Biology

Paper I – Genome Structure and Replication of DNA

Course Code: MZOE 503 C		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) – 4		Course Title: Genome Structure and Replication of DNA	
Course objectives <ul style="list-style-type: none">• The Syllabus is designed in such a way so that the student get the chance to develop the understanding about the concept of molecular biology.• It aims to enable the students to study the Genome Organization, Genome replication, Genome expression and genome regulation.			
Unit	Topics	No. of Lectures	
I	DNA: A carrier of genetic information, Chemical structure of DNA and Base composition, biologically important nucleotides. Watson-Crick model, Supercoiled DNA, structure of different types of nucleic acids, hydrolysis of nucleic acids. Conformation of nucleic acids: A-, B-, Z-, DNA, t-RNA, micro-RNA. Stability of nucleic acid structure, DNA Topology and Linking Number	15	
II	Proteins involved in prokaryotic and eukaryotic DNA Replication	15	
III	Mechanism of Prokaryotic and Eukaryotic DNA Replication; Unit of replication, replication origin and replication fork, fidelity of replication, extrachromosomal replicons	15	
IV	The Mutability and Repair of DNA: Internal and external agents causing DNA damages, DNA damages (Oxidative damages, Depurinations, Depyrimidinations, O6-methylguanines, Cytosine deamination, single and double strand breaks), Mechanisms of DNA damage (transition, transversion, frameshift, nonsense mutations), Repair mechanisms (Photo	15	

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reactivation, excision repair, mismatch repair, post replication repair, SOS repair)	
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Student learning outcomes

The student at the completion of the course will be able to:

- Understand the genome organization and difference between RNA and DNA
- Understand how to DNA replicate by DNA Polymerase and also understand base pairing of nitrogen bases in double strand DNA

Books recommended :

1. Benjamin A Pierce. Genetics A Conceptual Approach
2. Karsten Rippe WileyVCH Verlag GmbH & Co. KGaA Genome organization and function in the cell nucleus; edited, Germany.2012.
3. Bacterial Genomics: Genome Organization and Gene Expression Tools by Aswin Sai Narain Seshasayee, Publisher Cambridge University Press (2015) ISBN-10: 1107079837.
4. Genomes. 2nd edition. Brown TA Oxford: Wiley-Liss; 2002.
5. Organization of the Prokaryotic Genome by Robert L. Charlebois ASM Press, 1999.
- 7 The Cell: A Molecular Approach. 2nd edition. by Cooper GM. Sunderland (MA) Sinauer Associates; 2000.
8. Molecular Biology of the Cell. 4th edition by Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002
- 9 DNA Damage Repair, Repair Mechanisms and Aging by Allison E. Thomas Nova Science Publisher's, 2010.

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M.Sc. II (Semester-III)

MZOE 503 D Paper III

Elective Paper – Entomology

Paper I –INSECT MORPHOLOGY, PHYSIOLOGY AND DEVELOPMENT THEORY

Course Code: MZOE 503 D		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) – 4		Course Title: Insect Morphology, Physiology and Development Theory	
Course objectives <ul style="list-style-type: none">• The Syllabus is designed in such a way so that the student get the chance to develop the understanding about the morphology of insect.• It aims to enable the students to study the physiology of insects.			
Unit	Topics	No. of Lectures	
I	The integumentary system histology of the integument, physical property and chemical composition of cuticle, sclerotization, colouration and moulting, Morphology of the head, tentorium, antenna and mouth parts and their modification, thorax, tergites, legs and their modifications, wing structure and venation, their modifications coupling mechanism and abdomen, pregenital abdominal appendages, external genitalia	15	
II	Nervous system: the neurons, central visceral and peripheral nervous system. Sensory mechanisms; mechanoreceptors (tango reception, proprioception, sound perception), chemoreception, thermoreceptor, hygrometereception and photoreception (compound eyes, image formation, stemmata, ocelli), Bioluminescence and sound production.	15	

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III	Alimentary system : nutrition, feeding behavior, morphology of the gut and physiology of digestion and absorption, Circulatory system: dorsal vessel, accessory pulsating structures, sinuses and diaphragms mechanism of circulation, composition and function of haemolymph : Respiratory system structure of trachea, tracheoles, air sacs , spiracles, physiology of respiration, respiratory adaptation of aquatic and parasitic insects; Excretory system : malpighian tubules and its arrangements, physiology of excretion (nitrogenous excretion, salt and water balance)	15
IV	Reproductive system male and female development, post embryonic development, metamorphosis, types of larvae and pupae. Exocrine glands: structure and function, pheromones, Endocrine glands: structure and function of non-neural, neural and peptide hormones, regulation of general body function and metabolic activities, moulting, polymorphism and diapauses.	15

Student learning outcomes

The present course has been designed to.

- The present course provides the knowledge of the morphology of insects.
- The knowledge about physiology of insects.

Books recommended :

1. Mathur, R. A text Book of Entomology, Campus books
2. Nayar, K.K, T.N. Ananthkrishnana & B.V. David. General and applied Entomology by (1979), Tata McGraw Hill publication Co Ltd., New Delhi
3. Mani, M.S. General Entomology (1982) Oxford and IBH publishing Co. Pvt. LTD. New Delhi
4. Kuzman H. General text book of Entomology, Apple academics
5. Richerds, O.W. and R.G Davis. Imm's General text book of Entomolgy (1977) Vol I (structure, physiology, and development), 10th Edition, Chapman & Hall, London, New York
6. Evans H.E. Insect Biology A text Book of Entomology. (1984) Addison Wisley publishing company, Reading EGKFOKY
7. Pant, N.C and S. Ghai. Insect physiology and Anatomy (1981), ICAR , New Delhi
8. W Hening. Insect physiology, John Wiley and Sons
9. Van Emden, H. F. Insect plant Relationships. (1972) Black Well, London
10. Fox. R.M. and Fox. J.W. Introduction to comparative Entomology (1964), Van Nostrand Reinhold, New York
11. Van Emden . H.F. Pest control (1992) 2nd Edition Cambridge University Press, New York
12. Patnaik, D.D. A text book Entomology (2013), Dominant Pbl.
13. Snod Grass, R.E. Principles of insect Morphology (1935) , McGraw Hill, New York
14. Pruthi, H.S. Text book on Agricultural Entomology (1969), ICAR New Delhi
15. Gullan P.J. and Cranston. P. The Insects: An Outline of Entomology (2010) 4TH Ed., Wiley Blackwell Press 584 pp
16. Chapman. R.F. The Insects Structure and Function (1998), 4th Edition. Cambridge University Press.

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17. Wigglesworth.V.V. The Principles of Insect physiology (1982), Chapman & Hall, London
18. Romoser, W.S. and J.G. Stoffolano. The Science of Entomology (1994), 3rd Edition, Wm.C.Brown Publisher, USA.
19. Rockestein , M. Biochemistry of insects (1978), Academic Press, New York
20. Essig, E O. College Entomology (1942) Macmillan, New York
21. Kerkut, GA and B.I Gilbert. Comprehensive insect Physiology, Biochemistry and Pharmacology (1985) volume 1-13, Pergamon press Oxford New York
22. Singh, R. Elements of Entomology (2015) Rastogi publ. MERRUT
23. Tyagi B.K Entomology Ecology and Biodiversity. (2011), Scientific Publishers (India)
24. Elzinga, R.J. Fundamentals of Entomology (2004) 6TH edition. Publication. Prentice Hall
25. Blum, M.S. Fundamental s of insect physiology (1985) , Wile and sons , New York

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M.Sc. II (Semester-III)
MZOE 504 A Paper IV
Elective Paper – FISH BIOLOGY
Paper II – TAXONOMY AND FISH ECOLOGY

Course Code: MZOE 504 A		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Taxonomy and Fish Ecology	
Course objectives The aim is to provide students with the knowledge of Taxonomy and ecology- <ul style="list-style-type: none"> • Characteristics of Fishes • Classification of Fishes • Adaptation, Migration in Fishes 			
Unit	Topics	No. of Lectures	
I	Characteristics and classification of fishes: detail taxonomic studies of following orders of fishes of U.P. upto families: Clupeiformes, Cypriniformes, Beloniformes, Cyprinodontiformes, Mugiliformes, Ophiocephaliformes, Symbranchiformes, Perciformes, Mastacembeleformes and Tetrodontiformes.	15	
II	Adaptation of fishes; Hill-stream and deep sea. Impact of pollution on aquatic organism. Fish migration with particular reference to Salmon and Eel.	15	
III	Hormonal regulation of fish migration. Influence of abiotic factors (density and pressure, temperature, salt content in water, light, sound, electric current, bottom deposits and particle suspended in water).	15	
IV	Influence of biotic factors (interspecific and intraspecific interrelationship among fishes with different other organisms- parasitism, commensalism, mutualism, predation and cannibalism). Sewage fed fisheries	15	
Student learning outcomes The present course has been designed to <ul style="list-style-type: none"> • The present course provides the knowledge of the classification, adaptation and migration in fishes • The knowledge biotic and abiotic factors. Influencing the life of fish. 			

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Books recommended :

1. G.V. Nikolsky. Ecology of fishes. Academy press, London.
2. Bria Mass. Ecology of fresh waters, Willey Blackwell
3. S.S Khanna. Fish and fisheries
4. C.B.L Srivastava. Fish
5. Moyle PB. 1982. Fishes: An introduction to ichthyology. Printice-Hall, Englewood cliffs.
6. Jayaram KC. 2008. Fundamentals of Fish Taxonomy
7. Gopal Ji Srivastava. 1995. Fishes of U.P. and Bihar.
- 8 Paul J.B. Hart and John D. Reynolds. 1979. Handbook of Fish Biology and Fisheries

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M.Sc. II (Semester-III)

ZOE 504 B Paper IV

Elective Paper - Endocrinology and Reproductive Physiology

Paper II - Endocrine Disorder and their Diagnostics

Course Code: MZOE 504 B	Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4	Course Title: Endocrine Disorder and their Diagnostics	
Course objectives To study the <ul style="list-style-type: none"> • endocrine techniques used in endocrine researches • the endocrine disorders and pathophysiology • various reproductive technologies in treating infertility • current state of Endocrinology and Reproductive Biology • conditions resulted from abnormal hormone secretion and the laboratory tests that are used to diagnose these conditions 		
Unit	Topics	No. of Lectures
I	Disorders of <ul style="list-style-type: none"> • Pituitary Gland • Thyroid Gland • Adrenal Gland • Osteoporosis • Polycystic Ovary Syndrome 	15
II	Primary and Secondary Infertility: Implantation failure, Recurrent Abortion Reproductive Techniques: In vitro Fertilization, Embryo Transfer GIFT, ZIFT, Cryopreservation of Gametes and Embryos Contraceptives	15
III	Hormone Assay – RIA, ELISA, HPLC Hormone Pellet Construction Organ/Tissue Manipulation – Subcutaneous Injections Histological Methods Surgeries	15
IV	RNA Extraction- RTPCR, qPCR Hormone Localization – Northern Blot	15

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Student learning outcomes

The present course has been designed to:

1. Provide students the knowledge and understanding of the concepts and theories related to endocrine disorders.
2. Carry out the researches related to the basic and modern aspects of endocrinology.

Books recommended :

1. David O. Norris, James A. Carr. Vertebrate Endocrinology, 2013, 5th Edition, Academic Press
2. H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen. Williams Textbook of Endocrinology, 2008, 11th Edition, Saunders, Elsevier
3. P. J. Bentley. Comparative Vertebrate Endocrinology, 3rd Edition, Cambridge University Press
4. Charles B. Neuroendocrinology. Nemeroff, xxxx, CRC, US
5. Richard E. Brown. An Introduction to Neuroendocrinology, 2005, Cambridge University Press
6. Mac E Hadley, Jon E Levine. Endocrinology, 2009, 6th Edition, Pearson Education
7. F. F Bolander Molecular Endocrinology, 3rd Edition, 2004, Elsevier Academic Press
8. Darville Brook, C.G. & Marshall Essential Endocrinology, Wiley Blackwell
9. Greenstein B. Endocrinology at a Glance, Wiley Blackwell
10. V. M. Montori. Evidence-Based Endocrinology, (ed.), Humana Press
11. Ernst Knobil and Jimmy D. Neill Encyclopedia of Reproduction, Volumes 1-4, Academic Press

M.Sc. II (Semester-III)

MZOE 504 C Paper IV

Elective Paper – MOLECULAR BIOLOGY

Paper II –EXPRESSION OF GENOME

Course Code: MZOE 504 C		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) – 4		Course Title: Expression of Genome	
Course objectives			
The objective of this course is to provide insight on:			
<ul style="list-style-type: none">• Organization of Prokaryotic and eukaryotic genes and how the genes transcribe in prokaryotes and eukaryotes.• How the hn RNA is processed in eukaryotes and processed RNA transport to the cytoplasm from the nucleus where the translation of mRNA takes place.			
Unit	Topics	No. of Lectures	
I	Structure of Prokaryotic genes; Organization of prokaryotic genes into operons, Structure Eukaryotic Genes;(introns, exons, UTRs, core & proximal promoters, enhancers), Transcription Factors	15	
II	Prokaryotic and Eukaryotic Transcription; Transcriptional Machinery and Mechanism of Transcription (Initiation, Elongation, Termination)	15	
III	Post Transcriptional Modifications; Processing of hn RNA, t RNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability	15	
IV	Prokaryotic and Eukaryotic Translation; Ribosome Assembly and composition, Genetic codon. Translational Machinery, Mechanism of Translation; Initiation, Elongation and Termination	15	
Student learning outcomes			
The student at the completion of the course will be able to understand:			
<ul style="list-style-type: none">• The structure of eukaryotic and prokaryotic promoters and how RNA polymerase bind to promoter.• How the mature RNA synthesized by the processing of primary transcript and this transcript as a cargo transport from the nucleus to cytoplasm• The students use the scientific knowledge of translation and transcription for their future research work			

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Books recommended:

1. Lewin's Genes XI (Jocelyn E. Krebs, Benjamin Lewin, Elliott S. Goldstein, Stephen T Kilpatrick)
2. Molecular biology of the Gene (James D Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick)
3. Genomes 4 (T.A. Brown)
4. Molecular Biology of the Gene by James D. Watson , A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael, Losick Richard (Pearson 7th Edition)
5. Molecular Biology of the Cell by Bruce Alberts, Alexander D. Johnson , Julian Lewis , David Morgan, Martin Raff, Keith Roberts - 6th Edition
6. Cell and Molecular Biology. Concepts and Experiments by Gerald Karp , James G. Patton -7th Edition

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M.Sc. II (Semester-III)

MZOE 504 O Paper IV

Elective Paper – ENTOMOLOGY

Paper II – ECOLOGY, EVOLUTION AND TAXONOMY

Course Code: MZOE 504 D	Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4	Course Title: Ecology, Evolution and Taxonomy	
<p>Course objectives</p> <p>The objective of this course is to provide insight on:</p> <ul style="list-style-type: none"> • Ecology of insects. • Evolution and taxonomy of insects. 		
Unit	Topics	No. of Lectures
I	Insects and the abiotic environment: effect of temperature, moisture and light on insect population; insect plant interaction; plant and insect herbivore relationship; primary and secondary metabolic plant products. Host selection by insects, chemical defence in plants; allocation of protective chemicals, primary role of toxic chemicals; response of insects to chemical defence; temporal avoidance of chemical semiochemicals.	15
II	Insect origin and evolution: Ancestry of insect origin and evolution of insects, relationship between entognathous and ectognathous apterygotes, outline classification of insects: classification, characters, economic importance and examples of following: Entognatha (proturan, collembola, dipluran); Thysanura (Lepismatidae); Palaeoptera (Ephemeroptera, Odonata) Orthoptera (Schizodactylidae, Tettigoniidae, Gryllidae, Gryllotalpidae, Acrididae), Phasmida (Phasmidae, Phyllidae); Dictyoptera (Blattaria, Mantodea) Isoptera (Kalotermitidae, Termitidae); Phthiraptera (Mallophaga, Anoplura - Haematopinidae, Pediculidae)	15
III	Classification, characters, economic importance, and examples of following : Hemiptera (Fulgoridae, Lophopidae, Cicadidae, Membracidae, Cicadellidae, Psyllidae, Aleyrodidae, Aphididae, Margarodidae, Kerridae, Pseduoecidae, Coccidae, Diaspididae, Redividae, Cimicidae, Anthoconidae, Lygaeidae, Pyrrhocoridae, Coreidae, Scutelleridae, Pentatomidae, Gerridae, Notonectidae, Belostomatidae, Nepidae); Thysanoptera (Terebrantia—Thritidae, Tubulitera); Neuroptera	15

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	(Chrysopidae); Coleoptera (Carabidae, Cicindellidae, Dytiscidae, Gyrinidae, Hydrophilidae, Lucanidae, Scarabaeidae, Buprestidae, Elateridae, Lampyridae, Dermestidae, Coccinellidae, Tenebrionidae, Meloidae, Cerambycidae, Chrysomelidae, Bruchidae, Curculionidae.)	
IV	Siphonophera (Pulicidae, Ceratophyllidae); Diptera (Pschodidae, Culicidae, Simuliidae, Chironomidae, Bibionidae, Mycetophilidae, Cecidomyiidae, Tabanidae, Asilidae, Bombyliidae, Syrphidae, Agromyzidae, Drosophilidae, Gasterophilidae, Muscidae, Calliphoridae, Hippoboscidae), Lepidoptera (Tineidae, Psychidae, Plutellidae, Nymphalidae, Pieridae, Papilionidae, Geometridae, Bombycidae, Sphingidae, Arctidae, Noctuidae); Gelechiidae; Pyralidae; Hymenoptera (Tenthredinidae, Ichneumonidae, Braconidae, Evanidae, Cynipidae, Chalcidae, Eulophidae, Trichogrammatidae, Scolidae, Formicidae, Vespidae, Sphecidae, Xylocopidae, Aphidae)	15

Student learning outcomes

The student at the completion of the course will be able to understand.

- Ecology of insects.
- Evolution and taxonomy of insects

Suggested Readings

1. Singh R. Elements of Entomology, (2015), Rastogi Publ, Meerut.
2. Ananthkrishnana, T N & A Raman. Dynamics of Insect-Plant Interaction (1988). Oxford & IBH Publishing Co Pvt Ltd., New Delhi.
3. Barbosa. P. and D.K. Letoumeau. Navel aspects of insect plant interaction (1988). John Wiley & Sons New York. 32
4. Boudreaux, B.H. Arthropoda Phylogeny (1997), with special reference to insects, Wiley and Sons, New York, pp. 320.
5. Grimaldi, D and Engel M. Evolution of the insects (2005), Cambridge University Press, New York and Cambridge, pp. 755.
6. Gupta, A. P. Arthropoda Phylogeny (1979), Van Nostrand reinhold, New York.
7. Price, P W. Insect Ecology 1984, 2nd edition, John Wiley & Sons, New York.

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MZOL 505L Core Paper practical

Taxonomy, Animal Behaviour and Chronobiology

- Study of Taxis, Kinesis, Habituation, Trial and error learning; Visual discrimination, Feeding behavior, Pheromonal communication with reference to sexual/special behavior.
- To study the geotaxis behavior of earthworm; to study the orientation responses of first instar noctuid larvae to photo stimuli.
- To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly
- To study the orientation responses of larvae to volatile and visual stimuli

MZOL 505 A Elective paper Practical

Fish Biology

- Identification of Indian common fish faunal resources from cold water, warm water, marine water and ornamental fishes
- Physico-chemical parameters of freshwater bodies.
- Collection of phytoplankton and zooplankton from natural resources and their identification.
- Study of fishing gears and nets with the help of models.
- Salinity tolerance in selected fishes.
- Determination of age and growth
- Experiments on chemoreception using different attractants and repellents.
- Study of organ system of *Scoliodon*, *Labeo* and *Wallago*;
- Study of accessory respiratory organs and their blood supply in *Heteropneustes*, *Clarias*, *Channa* and *Anabas*
- Study of air bladder and ear connection in *Notopterus* and *Gudusia* or *Hilsa*
- Study of prepared microslides: osteology of *Wallago*.
- Qualitative and quantitative study of freshwater planktons
- Estimation of Dissolved oxygen, free carbon dioxide, alkalinity in a local fish pond; oxygen consumption in local fish in different habitats.
- Study of food and structural modifications due to feeding habits, gills and gill-rakers, mouth, eye, alimentary canal, olfactory organs, etc.
- Study of amphibious, exotic poisonous, venomous larvivorous and sound producing fishes.
- Estimation of liver glycogen
- Visit to a coastal/ fish farm
- Collection of fishes of different orders
- Viva-voce
- Practical record

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Endocrinology and Reproductive Physiology

- Dissection of endocrine glands in Vertebrate/Invertebrates with display and diagram.
- Biochemical estimation of proteins, glycogen in endocrine tissue with colorimeter,
- Determination of blood sugar level
- Microtomy of endocrine material

Molecular Biology

- Preparation of Molecular Biology Buffers
- Isolation of genomic DNA from Animal tissue
- DNA Extraction from Human blood sample by using salting out method.
- Induction of mutants using chemical agents
- Checking of DNA Purity and concentration – agarose and spectrophotometer
- Problems on DNA Kinetics
- T_m determination of DNA
- Comet Assay for the detection of DNA Damage
- Plasmid DNA isolation
- In silico primer designing exercise
- Isolation of mRNA – trizol method
- In silico Analysis Prokaryotic Promoter Sequence
- In silico Analysis of Eukaryotic Promoter Sequence

ENTOMOLOGY

- Detailed study of the external features of grasshopper
- Dissection of different systems of Gryllotalpa, Dysdercus, Housefly/Calliphora, Moth/butterfly/Catterpillars/Wasp, honey bee, Dung beetle, Water beetle.
- Permanent preparation of testis of Cockroach, salivary gland of dysdercus, ovary, spermatheca and accessory gland of house fly.
- Sting apparatus of wasp/ honey bee.
- Spiracles of the caterpillar and wing scales of a lepidopteran insect
- Legs of terrestrial and aquatic insects showing simple adaptation concerning locomotion.
- Study of prepared slides: T.S / L.S. of integument and the various region of gut, ovary, testis and brain.

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- Whole mounts of thoracic/ abdominal spiracles, different types of antennae, legs, moth parts, wings and sting apparatus of honey bee/ wasp.
- Determination of pH of insects guts and haemolymph.
- Qualitative assay of free amino acids and haemolymph and fat body.
- Quantitative estimation of glycogen, protein and lipid.
- Qualitative determination of uric acid from fat body/ Malpighian tubules.
- Determination of the rate of passage of food through gut.

Distribution of Marks

Exercise	Marks
Dissection(Major + Minor)	15 + 5
<small>(For Fish Biology Entomology, Endocrinology)</small>	
OR	
Molecular Biology Exercise	20
Preparation	10
Behavior exercise	15
Taxonomy (Identification of 2 Fish/ Insect)	10
OR	
Isolation of Nucleic Acid	10
Microtomy	05
Spotting (10 Spots)	20
Viva-voce	10
Class Records	10

Total Marks : 100

M.Sc. II Year Semester III (Paper VI)

Course Code: MZOP 506	Credit: 4	Project
Course Title: Research Project		
<p>Each Student will do a research project under the guidance of supervisor .Evaluation of the research project will be done after the fourth semester.</p>		

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- Educational tour is in paper II MZOC 502 (Environmental biology, Wild life and Economic Zoology)

M.Sc. II (SEMESTER - IV)
MZOC 511 Paper I BIOINSTRUMENTATION AND BIOTECHNIQUES

Course Code: MZOC 511		Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Bioinstrumentation and Biotechniques	
Course objectives			
<ul style="list-style-type: none"> • To explain the principle and working of instruments in a biology laboratory. 			
Unit	Topics	No. of Lectures	
I	Fluorescence and Electron Microscopy (SEM and TEM) with Principles and Working	15	
II	Chromatography- Paper and thin layer chromatography, Ion exchange chromatography, High performance liquid chromatography (HPLC), Electrophoresis and Centrifugation	15	
III	Histochemical and Immuno techniques Enzyme-linked immunosorbent assay (ELISA), Radioimmunoassay (RIA), Western blot, Chromatin Immunoprecipitation (CHIP), flow cytometry, Fluorescence in situ hybridization (FISH) and Genomic in situ hybridization (GISH), Polymerase Chain Reaction (PCR)	15	
IV	Absorption Spectrophotometry with Principle and Working	15	
Student learning outcomes			
<ul style="list-style-type: none"> • To get the ideas microscopy like electron microscope and fluorescence. • To get the ideas of separation and identification of biomolecules by Chromatography: Paper and thin layer Chromatography. This course is useful in various competitive exams like CSIR-NET etc. 			

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Books Recommended

1. Boyer: Modern Experimental Biochemistry and Molecular biology (2nd Ed), Benjamin/Cumin, 1993
2. Freifelder: Physical Biochemistry (2nd Ed.), Freeman, 1982
3. Holme and Peck: Analytical Biochemistry (3rd Ed.), Tata McGraw Hill, 1998
- 4 Plumer: An Introduction to Practical Biochemistry (3rd Ed.), Tata-McGraw Hill, 1990
- 5 Switzer and Garrity: Experimental Biochemistry 92nd Ed.), Freeman, 1999
6. Wilson and Walker: Practical Biochemistry (3rd Ed.), Cambridge Univ. Press, 2000.
7. Electron Microscopy: Principles and Techniques of Biologist by John J. Bozzola, Lonnie D. Russell, Jones & Bartiett Publ
- 8 L. Veerakumari: Bioinstrumentation, MJP Publishers
9. Alberts et al: Molecular Biology of the Cell, Garland, 2002
10. Karp: Cell and Molecular Biology, John Wiley & Sons, 2002.
11. Lodish et al: Molecular Cell Biology, Freeman, 2000

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M.Sc. II (SEMESTER - IV)

MZOC 512 Paper II COMPARATIVE ANATOMY OF VERTEBRATES

Course Code: MZOC 512	Max. Marks: 25+75	Core Paper
Total no. of Lectures (in hours per week) - 4	Course Title: Comparative Anatomy of Vertebrates	
Course objectives The course is so designed that students will learn: <ul style="list-style-type: none"> • Comparative anatomy of different system in Vertebrates 		
Unit	Topics	No. of Lectures
I	Comparative Anatomy of the following system of the vertebrates (Fish , Amphibia, Reptile, Birds and Mammals) Integumentary System and Skeletal System	15
II	Comparative Anatomy of the following system of the Vertebrates (Fish , Amphibia, Reptile, Birds and Mammals) Digestive System and Respiratory System	15
III	Comparative Anatomy of the following system of the vertebrates (Fish , Amphibia, Reptile, Birds and Mammals) Circulatory System and Excretory System	15
IV	Comparative Anatomy of the vertebrates (Fish , Amphibia, Reptile, Birds and Mammals) Reproductive System	15
Student learning outcomes After the course the students will be able to understand the basics of this course. <ul style="list-style-type: none"> • To understand the applications of this course in different field of Science and Technology • Think and develop new ideas in this subject, benefit of this course in various national and international competitive examinations 		
Books recommended : 1. Herbert W. Rand. Comparative Anatomy of vertebrates, Harvard University Press 2. M.D.L. Srivastava. Comparative Anatomy of Vertebrates 3. Saurav Singh. Text book of Comparative Anatomy of Vertebrate by, Centrum Press 4. T Mishra , Mishra D & Srivastav S , Comparative Anatomy of Vertebrates , Mahaveer Publications.		

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M.Sc. II (SEMESTER - IV)
MZOE 513A Paper III

Elective Paper – FISH BIOLOGY

Paper I APPLIED FISH AND FISHERIES

Course Code: MZOE 513 A		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Applied Fish and Fisheries	
Course objectives			
The course is so designed that students will learn:			
<ul style="list-style-type: none"> • About lay-out of different types of Ponds, fishing gears and crafts • Marketing and trade, byproducts • Disease related to fishes 			
Unit	Topics		No. of Lectures
I	Marine, Estuarine fisheries of India, Physico-chemical and biological characteristics of pond water and manuring (organic and inorganic) and fertilization in pond fish		15
II	Construction and lay-out of different types of ponds (nursery, rearing and stocking); formulation and operation of different type of hatcheries; transport and mortality of fish fry; eradication of predatory and weed fishes		15
III	Method of fishing, fishing gears and crafts with particular reference to Uttar Pradesh; fish preservation and processing (traditional and advanced methods); fishing marketing and trade; fish byproducts		15
IV	Fish pathology, prevention, prophylaxis and treatment of fungal, bacterial, viral and protozoan diseases; larvivorous fishes, fisheries cooperative societies of India		15
Student learning outcomes			
<ul style="list-style-type: none"> • The present course will prepare the students to understand types of hatcheries, fishing gears, brood stock and management of fisheries pond 			

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- The students will study about preservation and processing methods, common enemies, symptoms, etiology and treatment of food fishes.

Books recommended

1. Jhingran, V.G. Fish and Fisheries of India.
2. Aggarwal, S.C. Fishery Management.
3. Govindan, T.K. Fish Processing Technology.
4. Beavan, C.R. Handbook of Freshwater fishes of India.
5. Bal and Rao, Marine Fisheries.
6. William RD and Matthew G. 1984. Multivariate Analysis, Methods and Applications. John Wiley & Sons.
7. Bıradar RS. 2002. Course Manual on Fisheries Statistics. 2nd Ed. CIFE, Mumbai.
8. Welch PS. 2003. Limnological Methods. Narendra Publ House.
9. Nelson JS. 2006. Fishes of the World, John Wiley and Sons, Inc., New Jersey

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M.Sc. II (SEMESTER - IV)
MZOE 513 B Paper III

Elective Paper - Endocrinology and Reproductive Physiology

Paper I Reproductive Endocrinology I

Course Code: MZOE 513 B		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Male Reproductive Endocrinology	
Course objectives			
The course focuses on helping the students to understand			
<ul style="list-style-type: none"> • the basics of male reproductive endocrinology and impart knowledge about the testis and spermatogenesis. • the male reproductive organs, gametes, physiology and their hormonal regulation. 			
Unit	Topics		No. of Lectures
I	Differentiation of the testes and male genital ducts. Histology and ultra structure of testis. Spermatogenic function of the testis. Hormonal regulation of spermatogenesis Structure and functional significance of sertoli cells		15
II	Endocrine and paracrine function of sertoli cells. Structure and functional role of leyding cells. Metabolism of testicular androgens		15
III	Biochemistry of semen and analysis of semen. Structure and physiology of male reproductive tract. Effects of environmental factors on reproduction. Inhibin and activin		15
IV	Ultrastructure of mammalian sperm Metabolic changes in spermatozoa during maturation Capacitation of spermatozoa		15

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	Testicular disorders and their remedies. Regulation of fertility in male. Contraception through male	
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Student learning outcomes

The students will get the idea about

- Male Genital tract, histology, hormones
- Male gamete, Testicular disorder, regulation of fertility in male

Books recommended :

1. Vertebrate Endocrinology: David O. Norris, James A. Carr, 2013, 5th Edition, Academic Press
2. Williams Textbook of Endocrinology: H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen, 2008, 11th Edition, Saunders, Elsevier
3. P. J. Bentley. Comparative Vertebrate Endocrinology, 3rd Edition, Cambridge University Press
4. Charles B. Nemeroff Neuroendocrinology, xxxx, CRC, US
5. Richard E. Brown. An Introduction to Neuroendocrinology, 2005, Cambridge University Press
6. Mac E. Hadley and Jon E. Levine Endocrinology, 2009, 6th Edition, Pearson Education
7. F. F. Bolander. Molecular Endocrinology, 3rd Edition, 2004, Elsevier Academic Press
8. Darville Brook, C.G. & Marshall. Essential Endocrinology, Wiley Blackwell
9. Greenstein B. Endocrinology at a Glance, Wiley Blackwell
10. V. M. Montori. Evidence-Based Endocrinology, (ed.), Humana Press
11. Ernst Knobil and Jimmy D. Neill. Encyclopedia of Reproduction, Volumes 1-4, Academic Press
12. C.D. Turner and J.T. Bagnara. General Endocrinology. W.B. Saunders

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M.Sc. II (SEMESTER - IV)
MZOE 513 C Paper III

Elective Paper – MOLECULAR BIOLOGY

Paper I Regulation of Gene Expression

Course Code: MZOE 513 C		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Regulation of Gene Expression	
Course objectives			
The course focuses on helping the students to understand the concept of gene regulation in prokaryotes and eukaryotes.			
Unit	Topics	No. of Lectures	
I	Gene regulation in prokaryotes ; Lac Operon and Tryptophan operon, gene regulation in Bacteriophage Lambda (λ)	15	
II	Gene Regulation in Eukaryotes; Activators and Repressors, DNA Binding Proteins (Homeodomain Proteins, Zinc- Containing DNA Binding Proteins, Leucine Zipper Motif, Helix- loop Helix Proteins), Action at Distance ; Loop and Insulators	15	
III	Gene Regulation by Regulatory RNA: In Bacteria by Riboswitch, Gene Regulation in eukaryotes by RNA interference. Regulatory RNA (Si RNA, Mi RNA) generation, Structure and Mechanism of Action	15	
IV	Epigenetic Regulation of Gene Expression; Overview of epigenetic regulation, Chromatin remodeling and gene expression, Histone modifications and gene expression, Small RNA based epigenetic regulation, Propagation of epigenetic regulation (genome imprinting)	15	
Student learning outcomes			
The students will get the idea about			
<ul style="list-style-type: none"> • How the different type of genes express in different type of cells • How the DNA binding protein bind to the promoter of eukaryotic and prokaryotic genes • How the operon of catabolic and anabolic genes get regulated 			

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Books recommended :

1. Jocelyn E. Krebs, Benjamin Lewin, Elliott S. Goldstein, Stephen T. Kilpatrick. Lewin's Genes XI
2. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular biology of the Gene
3. T A. Brown. Genomes 4
4. James D. Watson , A. Baker Tania, P. Bell Stephen, Gann Alexander, Levine Michael, Losick Richard Molecular Biology of the Gene (Pearson 7th Edition)
5. Bruce Alberts, Alexander D. Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts. Molecular Biology of the Cell- 6th Edition
6. Gerald Karp, James G. Patton. Cell and Molecular Biology: Concepts and Experiments - 7th Edition

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M.Sc. II (SEMESTER - IV)
MZOE 513 D Paper III

Elective Paper – ENTOMOLOGY

Paper I ECONOMIC ENTOMOLOGY

Course Code: MZOE 513 D		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) – 4		Course Title: Economic Entomology	
Course objectives			
The course focuses on helping the students to understand the economic importance of insects			
Unit	Topics	No. of Lectures	
I	Beneficial insects: biology of beneficial insects (Apis, Bombyx and Kerria), Insect products, use of insects in medicines, insects in biological Research, Pollination by insects, insects as consumers, Scavengers and as food, forensic entomology.	15	
II	Harmful insects. life history, damage caused and control measures of following insects pests: household insects: insect injurious to man (Aedes, Anopheles, Culex, Phlebotomus, Cimex, Xenopsylla, Pediculus) and life stock (Simulium, Tabanus, Hypoderma, Cochliomyia, Hippobasca), insects transmitting viral diseases in plants : pests of cotton (Aphis gossypii, Earias spp., Pectinophora Gossypiella, Dysdercus koenigi, Myllocerus undecimpustulans, Amrasca hibiscus, Pectinophora gossypiella, Dysdercus koenigi, Myllocerus undecimpustulans, Amrasca hibiscus), pests of sugarcane (Scirpophaga excerptalis, Chilo infuscatellus, Emmalocera depressella, Pyrausta nubilalis, Aleurolobus borodensis.)	15	
III	Life history, damage caused and control measures of following insects pests, pest of cereal crops (Leptocorisa acma, Scirpophaga incertulus, Chilo suppressalis, Hieroglyphus banian, Diuraphis brassicae, Nephotettix spp., Sesamia inferens); pest of pulses (Hemiptera brassicae), pests of vegetables (Aulacophora indica, Leucinodes orbanalis, Bactrocera cucurbitae, Henosepilachna spp., Phthorimaea operculella, Pieris brassicae)	15	
IV	Life history, damage caused and control measures of following insects pests pests of oilseeds (Atractodes spp., Lipaphis pseudobrassicae, Athalia lugens proxima, Bagrada hilaris). Pests of fruits and fruit trees (Quadraspidiotus perniciosus, Eriosoma lanigerum. Amritodesatkinsoni, Oryctes rhinoceros, Papillodemoleus); pests of stored	15	

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	commodities: Sitophilus oryzae, Trogodermagranarium, Tribolium spp., Callosobruchuschinensis, Corcyra cephalinica, sitotrongacereaiella).	
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Student learning outcomes

The students will get the idea about

- Beneficial insects
- Harmful insects
- their life cycle

Books recommended:

- 1 Alford, D.V. A text book of Agricultural entomology (1990), Wiley –Blackwell.
- 2 Atwal, A.S and Dhalwal, G S. Agriculture pests of South Asia and their Management (1997), Kalyani Publishers, New Delhi.
3. Awasthi, V.B Agricultural pests and their control. (2001), Scientific Publishers, New Delhi
- 4 David, B V Elements of economic entomology (2000), Popular Book Depot, Chennai

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M.Sc. II (SEMESTER - IV)
MZOE 514 A Paper IV

Paper II AQUACULTURE FISHERIES

Course Code: MZOE 514 A		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Aquaculture Fisheries	
Course objectives			
The students will learn about			
<ul style="list-style-type: none"> • Induced breeding, • integrated fish farming, • fish culture • problems and prospective related to fish culture 			
Unit	Topics		No. of Lectures
I	Problems and prospects of aquaculture: breeding habit of carps, induced, and bundh breeding of carps (indigenous and exotic)		15
II	Polyculture and monoculture, aquatic weeds and their control, aquarium fish and their maintenance, cage culture, integrated fish farming and their management, nets and boats used for fishing		15
III	Gynogenesis, androgenesis, transgenic fish, advances in fishery science		15
IV	Freshwater reservoir and cold water fisheries of India, problems and prospects of mariculture, fisheries in India with particular reference elasmobranchs, crustacean and molluscan fisheries		15
Student learning outcomes			
The present course will prepare the students for			
<ul style="list-style-type: none"> • To understand the economic importance of different type of fisheries • The self-employment and job related to fish and fisheries 			

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Books recommended :

1. Jhingran V. G. 1991. Fish and Fisheries of India , Hindustan Publishing Corporation
2. Pillay TVR and Dill WMA. 1979. Advances in Aquaculture Fishing New Books, Ltd. England
3. Nikolsky GV. 1963. Ecology of Fishes Academic Press
4. Ojha J.S. 2005. Aquaculture Nutrition and Biochemistry. Daya Publication
5. Rath R. K. 2000. Freshwater Aquaculture, Scientific Publication
6. De Silva SS and Anderson TA. 1995. Fish Nutrition in Aquaculture. Chapman and Hall Aquaculture Series
7. Landau M. 1992. Introduction to Aquaculture John Willey and Sons.
8. Reid G R. 1961 Ecology and Inland water and Estuaries Rein Hold Corp, New York.

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M.Sc. II (SEMESTER - IV)
MZOE 514 B Paper IV
Paper II Reproductive Endocrinology II

Course Code: MZOE 514 B		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Reproductive Endocrinology II	
Course objectives			
The course focuses on helping the students to understand			
<ul style="list-style-type: none"> • the basics of female reproductive endocrinology and impart knowledge about the ovary and female genital duct. • the female reproductive organs, gametes, physiology and their neurohormonal regulation. 			
Unit	Topics		No. of Lectures
I	Differentiation of the ovary and female genital ducts. Histology of ovary and ultrastructure of ovum. Estrous and Menstrual cycle in mammals.		15
II	Puberty and its hormonal control. Implantation and its hormonal regulation. Pregnancy and its hormonal regulation. Hormonal regulation of parturition and lactation		15
III	Fine structure and types of placentation and their significance. Placental hormones- secretions and significance. Corpus luteum and its functional significance. Control of fertility in female due mechanical, chemical and biological means.		15
IV	Prostaglandins and their role in reproduction. Endocrine control of ovulation and lutenization. Endocrine control and function of mammalian oviduct.		15
Student learning outcomes			
The students will get the idea about			
<ul style="list-style-type: none"> • female reproductive system and their hormonal regulation. 			

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Books recommended :

1. David O. Norris, James A. Carr Vertebrate Endocrinology, 2013, 5th Edition, Academic Press
2. H. M. Kronenberg, S. Melmed, K. S. Polonsky and P. R. Larsen. Williams Textbook of Endocrinology, 2008, 11th Edition, Saunders, Elsevier
3. P. J. Bentley Comparative Vertebrate Endocrinology, 3rd Edition, Cambridge University Press
4. Charles B. Nemeroff. Neuroendocrinology, xxxx, CRC, US
5. Richard E. Brown An Introduction to Neuroendocrinology, 2005, Cambridge University Press
6. Mac E. Hadley, Jon E. Levine. Endocrinology, 2009, 6th Edition, Pearson Education
7. F. F. Bolander Molecular Endocrinology, 3rd Edition, 2004, Elsevier Academic Press
8. Darville Brook, C.G. & Marshall. Essential Endocrinology, Wiley Blackwell
9. Greenstein B. Endocrinology at a Glance, Wiley Blackwell
10. V. M. Montori. Evidence-Based Endocrinology: (ed.), Humana Press
11. Ernst Knobil and Jimmy D. Neill. Encyclopedia of Reproduction, Volumes 1-4, Academic Press
12. C.D. Turner and J.T. Bagnara General Endocrinology. W.B. Saunders

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**M.Sc. II (SEMESTER - IV)
MZOE 514 C Paper IV**

Elective Paper – MOLECULAR BIOLOGY

Paper II: Applied Molecular Biology

Course Code: MZOE 514 C		Max. Marks: 25+75	Elective Paper
Total no. of Lectures (in hours per week) - 4		Course Title: Applied Molecular Biology	
Course objectives			
The course focuses on helping the students to understand the concept of genetic engineering and how the genes transfer from organism to other organism			
Unit	Topics	No. of Lectures	
I	Enzymes used in DNA technology ; Restriction and modification enzymes; nucleases, Polymerases, Ligase, kinases and phosphatases, Cloning vectors; Plasmids, Cosmids, Artificial chromosomes, Shuttle vectors Expression vectors, Construction of genomic and cDNA libraries	15	
II	Screening and characterization of clones, Preparation of probes, Principles of hybridizations and hybridization based techniques (colony, plaque, Southern, Northern and in situ hybridizations)	15	
III	Basic principles and applications of the following techniques; DNA sequencing, Oligonucleotide synthesis, Polymerase Chain Reaction, Microarray, Promoter characterization: promoter analysis through reporter genes, electrophoretic mobility shift assay, DNA foot-printing	15	
IV	Mutagenesis; Site directed mutagenesis, Transposon mutagenesis and Construction of knock-out mutants, Gene transfer techniques; Electroporation and microinjection, Transfection of cells: Principles and methods ,Germ line transformation in Drosophila and transgenic mice: Strategies and methods, Genome editing using CRISPR/Cas9 system, Applications of Recombinant DNA Technology ; Crop and live-stock improvement ,Gene therapy somatic and germ line gene therapy, DNA drugs and vaccines	15	
Student learning outcomes			
The students will get the idea about			
<ul style="list-style-type: none"> • How the restriction enzyme recognize the cutting site in the gene and the selected part • How the genes transfer to one organism to other organism with the help of suitable vector 			

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- How the sequence of gene will be deciphered by sequencing technique.

Books recommended :

1. Ausubel et al (2002). Short Protocols in Molecular Biology. Wiley
- 2 Brown (2000) Essential Molecular Biology VI. AP
- 3 Brown (2000). Essential Molecular Biology VII. AP 4. Brown (2006). Gene Cloning and DNA Analysis - An Introduction Blackwell
- 5 Glick and Pasternak (2003). Molecular Biotechnology. ASM Press
6. Kracher. Molecular Biology - A Practical Approach.
7. Krenzer and Massey (2000) Recombinant DNA and Biotechnology. ASM
- 8 Micklos and Freyer (1990). DNA Science. CSHL
9. Primrose (2001). Molecular Biotechnology. Panima
10. Robertson et al (1997). Manipulation & Expression of Recombinant DNA. AP
- 11 Sambrook et al (2001). Molecular Cloning CSHL

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**M.Sc. II (SEMESTER - IV)
MZOE 514 D Paper IV**

Elective Paper – ENTOMOLOGY

Paper II: Applied Entomology

Course Code: MZOE 514D		Max. Marks: 25+75	ELECTIVE PAPER
Total no. of Lectures (in hours per week) - 4		Course Title: Applied Entomology	
Course objectives			
The course focuses on helping the students to understand the concept of genetic engineering and how the genes transfer from organism to other organism.			
Unit	Topics	No. of Lectures	
I	Methods of pest management: physical control measures (temperature, electromagnetic fields and ionizing radiations, temperature); mechanical control measures (handpicking of infested plants and their destruction, netting, bagging and dislodging insect pests, trenching, insect barriers, insect traps, destruction of crops residues, weeds and trash); cultural control measures (selected of quality seeds, clean cultivation, destruction/provision of alternative/trap plants, crop rotations, tillage operations, timing of planting/harvesting, nutrient/water management).	15	
II	Chemical control measures: insecticides: classification, properties, synergistic, repellants, attractions: feeding deterrents: feeding deterrents, formulations, biopesticides; benefits and risks of chemical control, application; modes of action of insecticides, developments of insect resistance against insecticides	15	
III	Biocontrol measures organisms used in biocontrol, inoculation, augmentation and conservation of natural enemies – pathogens, predators and parasitoids; selected criteria of a promising natural enemy). Feasibility of biocontrol: genetic control measures(sterile- male techniques, artificial manipulation of gene composition of pest insects; breeding of insect-resistant host plants); legal control measures (enactment and enforcement of quarantines);	15	
IV	Mass production of quality biocontrol agents: Techniques, formulations, economics, field release/application and evaluation, Successful biological control projects, analysis, trends and future possibilities of biological	15	

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	control, Importation of natural enemies: Quarantine regulations, biotechnology in biological control. Semiochemicals in biological control, concept of integrated pest management (IPM) in agroecosystem; ticks and Mites of Economic importance.	
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Student learning outcomes

- To study the methods of pest management physical control measures mechanical control measures elected of quality seeds,
- clean cultivation, destruction of alternative/trap plants,
- crop rotations, tillage operations, timing of planting/harvesting,
- nutrient/water management.

Books recommended:

- 1 Abrot, D P. Integrated pest management (2014) Academic press, USA
- 2 Alford, D V. A textbook of Agricultural entomology (1990), Wiley –Blackwell.
3. Atwal, A S & Dhalwal, G.S. Agriculture pests of South Asia and their Management (1997), Kalyam Publishers, New Delhi
- 4 Awasthi, V.B. Agricultural pests and their control (2001), Scientific Publishers, New Delhi
5. David, B.V. Elements of economic entomology (2000), Popular Book Depot, Chennai
6. Ananthkrishnana, T N and A Raman. Dynamics of Insect-Plant Interaction (1988) Oxford & IBH Publishing Co Pvt. Ltd , New Delhi.

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M.Sc. II (SEMESTER - IV) **General Practical (MZOL 515)**

Bioinstrumentation

Study of electron micrograph, basic principles and functioning of absorption spectrophotometry, paper and thin layer chromatography, centrifugation

Comparative Anatomy of Vertebrates

To study comparative anatomy of following systems of vertebrates (slides and bones)

Integumentary system, digestive system, respiratory system, circulatory system, excretory system, nervous system and reproductive system

Elective Paper Practical (MZOE 515)

Fish Biology

- Estimation of hydro biological parameters temperature, pH, conductivity, salinity, dissolved oxygen, primary productivity, ammonia, nitrite, nitrate, phosphate, biological oxygen demand, chemical oxygen demand, of nursery rearing, stocking and breeding ponds.
- Demonstration of breeding pools and hatcheries. Induced breeding of Indian major carps and catfishes. Identification of eggs, spawn, fry and fingerlings of cultivable fishes of India.
- Collection and identification of aquatic weeds and aquatic insects: Study of feeding habits of fishes by gut content analysis, isolation and estimation of fish immunoglobulins; Molecular techniques in fish health management: Aquarium design and maintenance formulation and preparation of artificial fish food for Indian major carps and Prawns; Analysis of proximate composition of fish and processed products.

Reproductive Endocrinology

- Dissection of various reproductive glands in vertebrates.
- Operations in male rat: castration, vasectomy
- Confirmation of pregnancy in urine using antibody method.
- Identification of permanent slides of reproductive organs.
- Identification of chemical structures of steroidal hormones.
- Dissection of reproductive gland accessory organ with display and diagrams.
- Experiments in living rats (two) Operation in male and female rats Vaginal smear and sperm studies

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Molecular Biology

- Epigenetic Analysis – Insilico
- Understanding Human genome project
- Serum mRNA analysis
- In silico study of regulatory RNA
- Isolation of genomic DNA from any bacterial strain* genome.
- PCR amplification of any gene and analysis by agarose gel electrophoresis
- Preparation of plasmid, pET-28a from E.coli DH5α and gel analysis
- Restriction digestion of vector (gel analysis) and insertion of the target gene
- Vector and Insert ligation
- Transformation in *E.coli*.
- Plasmid isolation and confirming recombinant by PCR and RE digestion.
- Transformation of recombinant plasmid in BL21 (DE3).
- Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE
- Identification of restriction enzymes for RFLP analysis using NEB cutter software.
- Visit to any research lab related to molecular biology and write the project on them

ENTOMOLOGY

- Collection of different kinds of larvae and pupae of insects.
- Collection, preservation and identification of locally available insects.
- Permanent preparation of mouth parts, antennae, wings, legs, Spiracles and external genitalia of insects from different groups.
- Identification of various insects pests, their life -history and materials damaged by them.
- Study of various groups of insecticides and equipment's used for insecticide application.
- To study histology and to demonstrate the presence of lipid and glycogen in microtomy sections of suitable material.
- Study of life -history of beneficial insects and their products.

Distribution of Marks (Practical)

Technique/ Instrumentation	20
Exercise for Fish Biology/ Endocrinology/ Molecular Biology/ Entomology	15+15
Spotting(10 Spots)	30
Viva Voce	10
Class Record	10

Total Marks : 100

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M.Sc. II Year (Semester Paper II) Paper VI

Course Code: MZOP 516	CREDIT: 4	PROJECT
	Course Title: Research Project	
Each Student will do a research project under the guidance of supervisor .Evaluation of the research project will be done after the fourth semester.		

*** EACH STUDENT WILL DO RESEARCH PROJECT UNDER THE GUIDANCE OF SUPERVISOR AND PRESENT THEIR RESEARCH PROJECT. EVALUATION OF RESEARCH PROJECT WILL BE DONE IN II AND IV SEMESTER.**

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MZOM-406

MINOR PAPER –CONCEPTS OF ANIMAL SCIENCE

Course Code: MZOC - 406	Max. Marks: 25+75	Course Paper MINOR
Total no. of Lectures (in hours per week) - 4	Course Title: Concepts of animal science	
Course objectives		
The course focuses on helping the students to understand		
<ul style="list-style-type: none"> • The basics of animal physiology • About endocrine glands, hormones, related diseases • Get knowledge about economic zoology and environmental biology 		
Unit	Topics	No. of Lectures
I	Environmental Biology Introduction, concept of ecosystem, population and environmental health - population dynamics, population density and structures, biological communities and species interactions, types of interactions between two species, interspecific competition, environmental health and toxicology, types of pollution, bioaccumulation and bio magnification Conservation and management of natural resources -biodiversity	15
II	Economic Zoology sericulture, apiculture, lac culture fish culture and pearl culture poultry insect pest management	15
III	Animal Physiology Nutrition: carbohydrates proteins, fats, vitamins and minerals Respiration in animals Blood: composition, coagulation, blood pressure, Blood groups, Rh factor, and blood related diseases Structure and function of nervous system Structure & function of muscles Excretory products Structure and function of male and female reproductive systems	15
IV	Hormones & Diseases Scope of endocrinology	15

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	Pituitary gland – introduction, dwarfism, gigantism, acromegaly, diabetes insipidus Thyroid gland – introduction, goiter, myxoedema, cretinism Parathyroid gland – introduction, osteoporosis, tetany Islets of Langerhans – introduction, diabetes mellitus Adrenal gland – introduction, Addison's disease, Cushing's syndrome hormones and stress	
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Student learning outcomes

The students will get the idea about

- The various concepts in lac Cultivation and also to know the economic importance of lac cultivation, sericulture and apiculture.
- Environmental health hazards and conservation of biodiversity.

Books recommended

1. E.J W. Barrington, General and Comparative Endocrinology, Oxford, Clarendon Press.
2. P.J. Bentley, Comparative Vertebrate Endocrinology, Cambridge University Press.
3. R.H. Williams, Text Book of Endocrinology, W.B. Saunders.
4. C.R. Martin, Endocrine Physiology, Oxford University Press.
5. A. Gorbman et. al. Comparative Endocrinology, John Wiley & Sons.
6. W.S. Hoar General and comparative Animal Physiology.
7. David A. Bender et al Harpers Biochemistry
8. Mac E. Hadley: Endocrinology, Prentice Hall, International Edition, 2000
9. Wilson and Foster, Williams Text Book of Endocrinology 8th edition, W.B. Saunders Company Philadelphia, 1972.
10. Venkitaraman: Economic Zoology (Sudarsana Publishers, 1983)
11. Srivastava : A Text Book of Applied Entomology, Vol. II & III (Kalyani Publishers, 1988 & 1991)
12. Shukla & Upadhyaya : Economic Zoology (Rastogi Publishers, 1999-2000)
13. Odum : Fundamentals of Ecology (Saunders, 1971)
14. Odum . Basic Ecology (Saunders, 1985)
15. Turk and Turk : Environmental Science (4th ed. Saunders, 1993)
16. Primark : A Primer of Conservation Biology (2nd ed. Sinauer Associates)
17. Calabrese : Pollutants and High-Risk Groups (John Wiley, 1978)
18. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)
19. Sharma . Ecology and Environment (Rastogi Publication, 7th ed. 2000)
20. David O. Norris and James A. Carr. Vertebrate Endocrinology, 2013, 5th Edition, Academic Press

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