



JECRCTM
UNIVERSITY
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School of Sciences

Department of Zoology

Course Structure and Syllabi

M.Sc. Zoology
(Session 2021-2023)

**JECRC UNIVERSITY
SCHOOL OF SCIENCES
SESSION 2021-2023**

M.Sc. Zoology

Details of Scheme for M Sc. (Zoology) with various Courses and their credits with contact hours are given below:

Semester-I

S.No.	Subject	Code	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1	Taxonomy and Evolution	MZO001A	4	-	-	4			4	Core
2	Structure and Function of Invertebrates	MZO002A	4	-	-	4			4	Core
3	Biochemistry	MZO003A	4	-	-	4			4	Core
4	Biostatistics and Computer Application	MZO004B	4	-	-	4			4	Core
5	Laboratory Exercises of Biochemistry, Biostatistics, Taxonomy & Invertebrates	MZO005B	-	-	12			6	6	Core Practical
			16		12	16		6	22	

Semester II

S.No	Subject	Code	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1	Biology of Chordates & Immunology	MZO006B	4	-	-	4			4	Core
2	Tools and Techniques	MZO007B	4	-	-	4			4	Core
3	General Physiology	MZO008A	4	-	-	4			4	Core
4	Molecular Biology and Biotechnology	MZO009A	4	-	-	4			4	Core
5	Laboratory Exercises of Immunology, Physiology, Molecular Biology & Chordates	MZO010B	-	-	12			6	6	Core Practical

6	Research Methodology	MZO030A	3	-	-	3	0	3	Elective
			19		12	19	6	25	

Semester III

S.No	Subject	Code	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1	Genetics & Developmental Biology	MZO011 B	4	-	-	4			4	Core
2	Ethology & Applied Zoology	MZO012 B	4	-	-	4			4	Core
3	Laboratory Exercises of genetics, developmental biology, ethology & applied Zoology	MZO017 B	-	-	4			2	2	Core Practical
<p><i>A student has to choose one Discipline elective from each of the following two groups</i></p>										
Group-A: Entomology										
4	Insect Diversity, Society and Insect Physiology	MZO031 A	4	-	-	4			4	DE
5	Insect Toxicology and Ecology	MZO032 A	4	-	-	4			4	DE
6	Agricultural & Medical Entomology	MZO026 A	4	-	-	4			4	DE
7	Practicals in Entomology	MZO027 A	-	-	8			4	4	DE Practical
Group-B: Environmental Biology										
8	Principles of Ecology	MZO028 A	4	-	-	4			4	DE
9	Environment & Natural Resources	MZO015 A	4	-	-	4			4	DE

10	Eco-toxicology & Biodiversity conservation	MZO016 A	4	-	-	4			4	DE
11	Laboratory Exercises of Environmental Biology	MZO017 C	-	-	8			4	4	DE Practical
			20		12	20		6	26	

Semester IV

S.No	Subject	Code	Lecture (Hr.)	Tutorials (Hr.)	Practical (Hr.)	Credits			Total Credits	Paper Category
						L	T	P		
1	Project / Dissertation	MZO021B	0	-	0	0		0	16	Core
2	Seminar	MZO022A	0	-	0	0		0	2	Core
3	Review Report/Scientific Writing	MZO029A	0		0	0		0	3	Core
									21	

	I Sem	II Sem	III Sem	IV Sem	Total
Credits	22	25	26	21	94

JECRC UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF ZOOLOGY

Programme Educational Objectives:

The programme **M.Sc. in Zoology** aims to equip students with recent advances in Zoology from organismic to reductionist biology. It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Behavior and Biological time keeping, Cancer Biology, Microbiome and their roles in health and diseases, Bioremediation of pollutants and pesticides, etc.

This course is designed to ignite the inquisitive mind to enter into research in interdisciplinary areas.

In this program, the student gains an in-depth study of various invertebrate and vertebrate specimens. The purpose of this program is:

- To acquaint students with the identification, systematics, life history, anatomy, and adaptive strategies of the invertebrate and vertebrates and to expose them to field techniques used in their study.
- To inculcate in the students an understanding, appreciation and respect for the other animals which share our planet.
- To make students aware of the various disciplines encompassed by the field of zoology and to encourage them to pursue those areas that interests them through further reading and coursework.
- To understand the systemic and functional morphology of various groups of chordates.
- To know the principles of genetics, pedigree analysis and population genetics.
- To generate up-to-date knowledge on environmental conservation and management through a comprehensive understanding of the components of ecosystem, biological cycles, habitat ecology, resource ecology, pollution and its management.
- To comprehend the chemical constituents of living matter, chemistry of food stuffs and their transformation in animal systems, the energy changes associated with these transformation and hormonal regulation.

PROGRAM OUTCOMES (PO's)

PO1. Disciplinary Knowledge and Skills: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, theoretical principles and experimental findings in Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases), and other related fields of study, (ii) ability to use modern instrumentation including detailed and recent update knowledge about the tools and techniques used in zoology.

PO2. Skilled communicator and digitally literate: Ability to impart complex technical knowledge relating all areas in zoology in a clear and concise manner in writing and oral skills. Able to describe the Biological applied solutions. capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources and to use appropriate software for analysis of data.

PO3. Critical thinker and problem solver: Ability to have critical thinking and efficient problem solving skills in the basic and advanced areas of Zoology (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases etc.).

PO4. Sense of inquiry: Capability for asking relevant/appropriate questions relating to issues and problems in the field of zoology, and planning, executing and reporting the results of a theoretical or experimental investigation.

PO5. Skilled project manager: Capable of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and laboratory hygiene regulations and practices. Also acquaint with the instruments used in biological field.

PO6. Ethical awareness/reasoning and Environmental Sustainability: Capable of conducting their work with honesty and precision thus avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues and adopt objective, unbiased and truthful actions in all aspects of work. Research ethics committee expects them to declare any type of conflict of interest that may affect the research. Any plan to withhold information from researchers should be properly explained with justification in the application for ethical approval. Understand the issues of environmental contexts and sustainable development.

PO7. Self-directed, Team player and Life-long Learners: Acquire the ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. Capable of working effectively and interact respectfully with diverse teams in classroom, laboratory and in industry and field-based situations. The broad skills and the deeper knowledge in the field would make them highly successful and excellent researcher in advanced areas of research in the Biological sciences. Capable of acquiring knowledge and skills through self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling.

JECRC UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF ZOOLOGY
Session 2021-22
M.Sc. ZOOLOGY

SEMESTER –I		
Code	Title of Course	Credits
MZO001A	Taxonomy and Evolution	4
MZO002A	Structure and Function of Invertebrates	4
MZO003A	Biochemistry	4
MZO004B	Biostatistics and Computer Application	4
MZO005B	Laboratory Exercises of Biochemistry, Biostatistics, Taxonomy & Invertebrates	6
	Total Credits	22
SEMESTER –II		
MZO006B	Biology of Chordates & Immunology	4
MZO007B	Tools and Techniques	4
MZO008A	General Physiology	4
MZO009A	Molecular Biology and Biotechnology	4
MZO010B	Laboratory Exercises of Immunology, Physiology, Molecular Biology & Chordates	6
MZO030A	Research Methodology	3
	Total Credits	25
SEMESTER –III		
MZO011B	Genetics & Developmental Biology	4
MZO012B	Ethology & Applied Zoology	4
MZO017B	Laboratory Exercises of genetics, developmental biology, ethology & applied Zoology	2
	<i>A student has to choose one group of Discipline elective from the following two groups</i>	
	Discipline Elective Group A - ENTOMOLOGY	
MZO031A	Insect Diversity, Society and Insect Physiology	4
MZO032A	Insect Toxicology and Ecology	4
MZO026A	Agricultural & Medical Entomology	4
MZO027A	Practicals in Entomology	4
	Discipline Elective Group B – ENVIRONMENTAL BIOLOGY	
MZO028A	Principles of Ecology	4
MZO015A	Environment & Natural Resources	4
MZO016A	Eco-toxicology & Biodiversity conservation	4
MZO017C	Laboratory Exercises of Environmental Biology	4
	Total credits	26
SEMESTER –IV		
MZO021B	Project / Dissertation	16
MZO022A	Seminar	2
MZO029A	Review Report/Scientific Writing	3
	Total credits	21
	Total Credits of all 4 Semesters	94

JECRC UNIVERSITY
SCHOOL OF SCIENCES
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY (Session 2021-22)

SEMESTER-I

Code	Title of Course	Credits
MZO001A	Taxonomy and Evolution	4
MZO002A	Structure and Function Of Invertebrates	4
MZO003A	Biochemistry	4
MZO004B	Biostatistics and Computer Application	4
MZO005B	Laboratory Exercises of Biochemistry, Biostatistics, Taxonomy & Invertebrates	6
	Total Credits	22

MZO001A: TAXONOMY AND EVOLUTION

Credit(s): 4

Unit I

Definition and basic concepts of biosystematics and taxonomy- Importance and applications of biosystematics in biology. Definition and understanding of various taxonomic categories. Species concepts and species categories –subspecies and infra species. Modern trends in taxonomy- Chemotaxonomy. Cytotaxonomy. Molecular taxonomy. Neotaxonomy. Theories of biological classification. hierarchy of categories

Unit II

Taxonomic procedures; collection, preservation, curation and process of identification. Different kinds of systematic Publications. Taxonomic characters of different kinds. Quantitative and Qualitative analysis of variation. Process of typification, different zoological types and their significance.

Unit III

Taxonomic Keys: their kinds, merits and demerits. Use of taxonomic keys. International Code of Zoological Nomenclature (ICZN). Interpretation and application of important rules, Zoological nomenclature and formation of scientific names of different taxa.

Unit IV

Concepts of evolution and theories of organic evolution with an emphasis on Darwinism, Neo- Darwinism: Gene pool, Gene frequency, Hardy-Weinberg law of genetic equilibrium. Destabilizing forces- Natural selection, Mutation, Genetic drift, Migration.

Unit V

Genetics of speciation- Isolation; and role in evolution. Variation, Mimicry, Adaptation

Course outcome (CO) : On completion of the course, students are able to:

CO-1 Understand Definition and basic concepts of biosystematics and taxonomy.

CO-2 Critically analyse the Taxonomic procedures and Taxonomic characters

CO-3 Understand the concept of taxonomic keys, Zoological nomenclature

CO-4 Understand the process of evolution, Lamarckism, Neo-Lamarckism, Darwinism, Neo-Darwinism, Hardy-Weinberg law, destabilizing forces.

CO-5 Understand the concept of Speciation, Isolation, Variation, Adaptations, Mimicry

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	2	1	0	0	2
CO2	3	0	2	1	0	0	2
CO3	3	0	2	1	0	0	2
CO4	3	1	2	2	0	2	0
CO5	3	0	2	1	0	2	0

3 = Highly Related; 2 = Medium 1 = Low

Suggested Readings

- Principle of Animal Taxonomy; G.G Simpson. Oxford IBH Publishing Company.
- Elements of Taxonomy. E. Mayer.
- Theory & Practice of Animal Taxonomy. V.C. Kapoor. Oxford & IBH Publishing Co.Pvt. LTD.
- Advancement in Invertebrate Taxonomy & Biodiversity. Rajeev Gupta. AgrobiosInternational.
- Evolution of the vertebrates, Colbert. E.H. John Wiley and Sons Inc., New York.
- Genes and Evolution. Jha A.P. John Publication, New Delhi
- Evolutinary Genetics. Smith,J.M. Oxford University Press, New York.
- Evolution and population genetics, Rashmi Sisodia, Paragon, International Publishers.

MZO002A: STRUCTURE & FUNCTION OF INVERTEBRATES

Credit(s):4

Unit I

Organization of Body: Uni and multi cellular organisms,

Body cavity: Acoelome, Pseudocoelome , Coelome (schizo and enterocoelous)

Fate of Blastopore (Protostome, Deuterostome) and Blastomeres (Determinate and Indeterminate blastomeres)

Type of cleavage (Spiral and Radial)

Unit II

Type of symmetry: Body planes, Asymmetry, Radial, biradial, bilateral symmetry

Segmentation: Pseudo, superficial and metameric

Locomotion: Flagellar, ciliary movement in Protozoa and Hydrostatic movement in coelenterate, annelid and echinodermata,

Unit III

Nutrition and Digestion in invertebrates and lower Metazoa. Filter Feeding in Polychaeta, Mollusca and Echinodermata.

Respiration: respiratory organs in invertebrates (Gills, book lungs and trachea). Mechanism of respiration, respiratory pigments.

Unit IV

Excretion: Excretory organs in invertebrates (Coelomoducts, Nephridia and Malphigian tubules, organ of bojanus, green gland), Mechanism of excretion

Nervous System : Primitive type (Coelenterata and Echinodermata) and Advanced type (Annelida, Arthropoda (Crustacea and insecta) and Mollusca (Cephalopoda))

Unit V

Reproduction: Asexual (*Paramecium*, *Obelia*) and sexual reproduction (annelida, arthropoda and mollusca)

Larval forms of invertebrates, Evolutionary significance of larval forms.

Course outcome (CO) : On completion of the course, students are able to:

CO-1 Critically analyse the organization, complexity, coelom and cleavage patterns in non-chordates.

CO-2 Understand the types of symmetry and segmentation, locomotion in invertebrates.

CO-3 Understand the process of digestion and respiratory organs in invertebrates.

CO-4 Understand the process of excretion and nervous system in invertebrates.

CO-5 Understand the modes of reproduction in invertebrates and Evolutionary significance of larval forms

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	2	1	0	0	2
CO2	3	0	2	1	0	0	2
CO3	3	0	2	1	0	0	2
CO4	3	0	2	1	0	0	2
CO5	3	0	2	1	0	0	2

3 = Highly Related; 2 = Medium 1 = Low

Suggested Readings

- Invertebrate structure and function. Barrington, E.J.W. Thomas Nelson and Sons Ltd. London.

- Invertebrate Zoology Barnes, RD. W.B.Saunders Co., Philadelphia
- A Biology of higher invertebrates, Russel-Hunter, WD. McMillan Co. Ltd., London
- Text book of Zoology. Parker, T.J., Haswell. W.A.Macmillan Co., London.
- Invertebrates Richard C. Brusca , Gary J. Brusca and Nancy J. Haver

MZO003A: BIOCHEMISTRY

Credit(s): 4

Unit I

Bioenergetics - types of chemical bonds, pH, Acid, Base, Buffer, Concept of free energy. Laws of thermodynamics and biological system, Enthalpy, Entropy.

Enzymes- Classification- (I.U.B. system), Specificity of enzyme action, Mechanism of enzyme action, Enzyme kinetics- Michaelis-Menten equation, Enzyme inhibition, Allosteric enzymes, Iso-enzyme and ribozyme, co-enzymes and cofactors , Factors influencing enzyme action.

Unit II

Vitamins-Classification, structure, occurrence and functions of fat soluble vitamins, Classification, structure, occurrence and biological functions of water soluble vitamins

Unit III

Carbohydrates : Classification with examples, Biological roles of monosaccharides, Disaccharides & Polysaccharides

Carbohydrate Metabolism: Glycolysis, Citric acid cycle, Electron transport system and oxidative phosphorylation; Chemiosmotic hypothesis; Gluconeogenesis, Glycogenesis, Glycogenolysis; Pentose-phosphate pathway (HMP pathway),

Unit IV

Proteins- Classification & Structure of protein, Biological roles of proteins.

Protein Metabolism : Transamination, Deamination, Decarboxylation, fate of ammonia (Ornithine cycle).

Amino acids– Classification & Structure of Amino acid

Unit V

Lipids - Structure, Nomenclature. Classification and Biological roles of lipids.

Prostaglandins – Chemical nature and functions.

Lipid Metabolism: β -oxidation of fatty acids, Biosynthesis of fatty acids, Biosynthesis of cholesterol.

In born errors of metabolism

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the concept of bioenergetics and enzymes.

CO2 Understand the classification, Structure and functions of vitamins.

CO3 Understand the classification, function and Metabolism of Carbohydrates.

CO4 Recognize amino acid structures and illustrates the function and metabolism of proteins.

CO5 Understand the classification, Structure, function and Metabolism of Lipid.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

<i>Course Outcome</i>	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	2	1	0	0	2
CO2	3	0	2	1	0	0	2
CO3	3	0	2	1	0	0	2
CO4	3	0	2	1	0	0	2
CO5	3	0	2	1	0	0	2

3 = Highly Related; 2 = Medium 1 = Low

Suggested Readings

- Deb A.C. Fundamentals of Biochemistry, New Book Agency Pvt. Ltd. Calcutta.
- Stryer L. Biochemistry. W.H.Freeman and Co. New York, 2001
- Voet D. VoetJ.G. and Pratt C.W. Fundamentals of Biochemistry. Johan Wiley and sons Inc. New York, 1999
- Harper's biochemistry by Murray, Granner, Mays Rodwell, McGraw Hill Publication, 2000
- Lenhninger, A.L. (2008), Principles of Biochemistry, Vth edition, CBS publishers and distributors, Delhi
- Devlin,T.M. (2006), A Text of Biochemistry with clinical correlations, John Wiley & Sons

MZO004B:BIOSTATISTICS & COMPUTER APPLICATION Credit(s):4

Unit I

Introduction: Biostatistics: Definition, Terms, Applications & Role of biostatistics in modern research.

Data collection: Types of data: Primary, secondary, qualitative, quantitative

Methods of data collection and classification:- Types of sampling method- Advantages and disadvantages of census and sampling method, Classification of data, Tabulation, Methods of classification, Class intervals- exclusive and inclusive method,

Diagrammatic and graphical presentation of data, Bar diagram – (types), Pie diagram, Histograms, Frequency polygon, Frequency curve (types- skewness, kurtosis, ogive)

Unit II

Statistical Methods: Measures of central tendency and dispersal, Mean, median, mode, quartile; Range, Mean deviation, Quartiles deviation, variance, Standard deviation, Standard error, degree of freedom, Standard error of mean.

Probability distributions: Basic concepts and definition: Laws of probability, Probability distribution: Binomial, Poisson and Normal

Unit III

Correlation and Regression : Types of correlation, Methods to measure correlation, types of Regression analysis, differences between regression and correlation analysis.

Statistical inference: Difference between parametric and non-parametric statistics; Testing of

hypothesis, Errors, Student's t-test, F-test, Testing goodness of Fit, Chi-square test, Chi-square distribution and characteristics, Applications of Chi-square test. Yate's correction. Analysis of Variance (ANOVA) One-way classification. Two-way classification.

Unit IV

Computer Application: Introduction to computers: Computer application, basics, organization, PC, mainframes and Super-computers, Basic components of computers—hardware (CPU, input, output, storage devices), Software (operating systems), concept of file, folders and directories, Commonly used commands.

Unit V

Application software; Introduction to MS Office software- Introduction to MS EXCEL- use of worksheet to enter data, edit data, copy data, move data; Use of in- built statistical functions for computations of mean, S. D., correlation, regression coefficients etc., Use of bar diagram, histogram, scatter plots, etc., Graphical tools in EXCEL for presentation of data; Introduction to MS- WORD word processor- editing, copying, moving, formatting, table insertion, drawing flow charts, Introduction to Power Point, image and data handling and software like Endnote.

Course outcome (CO) : On completion of the course, students are able to:

CO-1 Understand the Functions, scope and application of biostatistics, Data Classification and Graphical presentation of frequency distribution.

CO-2 Understand the measures of central tendency and dispersion like Computation of arithmetic mean, mode and median, Standard Deviation, Standard error of mean and Probability distributions.

CO-3 Understand the concept of correlation and regression, student's 't' test, F-test, chi-square test, ANOVA

CO-4 Gain knowledge about Basic components of computers-hardware and software.

CO-5 perform the data analysis using the statistical tools available on any computer using application software such as excel as well the programs for big and complex data.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

<i>Course Outcome</i>	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	2	1	0	0	2
CO2	3	0	2	1	0	0	2
CO3	3	0	2	1	0	0	2
CO4	3	2	2	1	0	0	2
CO5	3	2	2	1	0	0	2

3 = Highly Related; 2 = Medium 1 = Low

Suggested Readings

- Agarwal, B.L. (1996) Basic statistics, New Age International(P) Ltd. Publishers, New Delhi.
- Bailey, N.T.J. (1981) Statistical methods in Biology. Hodder and Stongtton, London.
- Campell, R.C. (1978), Statistics for biologists. Blacker and Sons Publishers, Bombay.
- Gupta, C.B. and Gupta, V. (2002) Statistical methods. Ika's Publishing House, New Delhi.
- Rostogi, V. B. (2009) Fundamentals of Biostatistics. Ane's Students Edition New Delhi.

MZO005B: Laboratory Exercises Of Biochemistry, Biostatistics, Taxonomy & Invertebrates Credit(s): 6

1. To study and assess taxonomic diversity in a habitat. (grassland, arid land, wet land etc.)
2. To study and identify at least 6-10 orders of insects (upto order level only) by the use of taxonomic keys.
3. To study zooplanktons in different water samples collected from ponds etc..
4. To study methods of Collection, Preservation and curation of specimens.
5. To prepare dichotomous (simple bracket) keys; minimum ten sets from the identified specimens.
6. To identify, classify & study distinguishing features of representatives from :
Phylum Protozoa- Polystomella, Opalina, Paramecium(Fission & conjugation), Vorticella, Euglena.
7. To identify, classify & study distinguishing features of representatives from :
Phylum Porifera-Sycon L.S & T.S, Spicules, Spongin fibres, Leucosolenia, Euplectella
8. To identify, classify & study distinguishing features of representatives from :
Phylum Cnidaria- Obelia,(polyp & Medusa), Millepora, Physalia, Pennatula, Metridium, Madrepora, Alcyonium, Gorgonia, Aurelia.
9. To identify, classify & study distinguishing features of representatives from :
Phylum Helminthes- Ascaris, Taenia, Planaria
10. To identify, classify & study distinguishing features of representatives from :
Phylum Annelida- Aphrodite, Leech, Polygordius, Chaetopterus, Neries, Heteroneries, Arenicola.
11. To identify, classify & study distinguishing features of representatives from :
Phylum Arthropoda- Peripatus, Balanus, Lepas, Limulus, Eupagurus, Julus, Scolopendra, Praying mantis.
12. To identify, classify & study distinguishing features of representatives from :
Phylum Mollusca- Pinctada, Cypraea, Octopus, Nautilus.
13. To identify, classify & study distinguishing features of representatives from :
Phylum Echinodermata- Echinus, Holothuria, Antedon, Asterias, ophiothrix
14. To identify and study the larval Stages: Planula, Redia, Miracidium, Sporocyst, Cercaria, Metacercaria Trochophore,
15. To identify and study the larval Stages: Nauplius, Zoea, Mysis, Velligar, Bipinnaria, Echinopluteus, Auricularia, Tornaria
16. To prepare permanent slides of - Hydra, Obelia,
17. To prepare permanent slides of - paramecium, different zooplanktons.
18. To Determine pH of different solutions.
19. To identify unknown carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose, Dextrin & Starch) by suitable tests.
20. To perform the qualitative estimation of proteins in various tissues/food materials.
21. To perform the qualitative estimation of carbohydrate in various tissues/food materials.
22. To perform the qualitative estimation of lipid in various tissues/food materials.
23. To perform the quantitative estimation of glycogen in given sample.
24. To perform the quantitative estimation of glucose in given sample.
25. To perform the quantitative estimation of ascorbic acid in given sample.
26. To estimate the quantitative estimation of sialic acid in given sample.
27. To perform the quantitative estimation of total proteins in given sample.
28. To perform the quantitative estimation of Total lipid and phospholipids in given sample.
29. To perform the quantitative estimation of cholesterol in given sample.

30. To perform the quantitative estimation of Acid phosphatase in given sample.
31. To perform the quantitative estimation of alkaline phosphatase in given sample.
32. To study and prepare frequency tables, bar diagrams , histograms, frequency curves, ogives and pie diagrams.
33. To calculation standard deviation and coefficient of variation.
34. To estimate significance between samples using Student's t-test, F-test and Chi-square test..
35. To plot regression lines and calculate correlation and regression analysis.
36. To study analysis of variance (One-way & Two –way classification).
37. Introduction to the statistical software like R and SPSS
38. Use of excel sheet and graph pad Prism for data processing.
39. Use of search engines like Pub-Med, Scopus, Science direct for reference material collection and management.

SEMESTER-II

MZO006B	Biology of Chordates & Immunology	4
MZO007B	Tools And Techniques	4
MZO008A	General Physiology	4
MZO009A	Molecular Biology And Biotechnology	4
MZO010B	Laboratory Exercises of Immunology, Physiology, Molecular Biology & Chordates	6
MZO030A	Research Methodology	3
	Total Credits	25

MZO006B: BIOLOGY OF CHORDATES & IMMUNOLOGY Credit(s): 4

Unit I

Origin and outline classification of the chordates.
Salient features and Interrelationships of Hemichordata, Urochordata and Cephalochordata.
Life – histories of- Pyrosoma, Salpa. Doliolum and Oikopleura

Unit II

General characters of Agnatha: Ostracoderms and Cyclostomes.
A general account of the Dipnoi, Difference between chondrichthyes & Osteichthyes.
Parental care in Amphibia, Neoteny in Amphibia
Living reptiles: a brief account of Rhynchocephalia.
Birds. Origin of flight: Flight adaptations. Flightless Birds.
Origins of mammals: Primitive mammals (Prototheria and Metatheria).

Unit III

General account on adaptive radiations in chordates (fishes, amphibians, mammals)
Development and physiology of extra-embryonic membranes in amniotes.
Evolution of viviparity, Placentation.
Metamorphosis in Amphibia, Endocrine control of metamorphosis.
Regeneration: Morphological and histological process in amphibian limb regeneration.

Unit IV

Immunology: Introduction- Innate and adaptive immunity, Cells and organs of the immune system (Primary lymphoid organs, Secondary lymphoid organs , B-lymphocytes, T-lymphocytes and Antigen presenting cells), Humoral and cell-mediated immune responses (CMI), Antigenicity, immunogenicity and Haptens, Factors influencing immunogenicity, Recognition of antigen by B-and T-lymphocytes, Antigens,

Unit V

Antibodies: Structure and functions of Antibody Molecules, Molecular structure of Ig, Immunoglobulin classes (IgG, IgM, IgE and IgD and their biological activities).
Antigen-Antibody Interactions: Strength of Antigen Antibody Interactions, Cross reactivity, precipitation reactions, agglutination reactions,
Immune effector Mechanisms: Cytokines & Antagonists, Compliment System

Course outcome (CO): On completion of the course, students are able to:

CO-1 Understand the classification of Chordates and life-histories of *Pyrosoma*, *Salpa*, *Doliolum* and *Oikopleura*.

CO-2 Understand the concepts of parental care, neoteny, flight adaptations, flightless birds, primitive mammals.

CO-3 Analyze the development and physiology of extra-embryonic membranes in amniotes, evolution of viviparity, metamorphosis and regeneration.

CO4 Understand the concept of Immunology, Mechanism of immunity, Immunity regulating cells, Antigens

CO5 Understand the basic structure, classes and function of Antibodies, Antigen-Antibody interaction, complement system

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	0	2
CO2	3	0	3	1	0	0	2
CO3	3	0	3	1	0	0	2
CO4	3	0	3	1	0	0	2
CO5	3	0	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings

- Comparative anatomy of vertebrates. Kent. C.G.
- The Biology of Hemichordata and Protochordata. Barrington, E.J.W. Olter and Boyd Edinhourgh.
- Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago.
- Chordata structure and function. Waterman. A.J.Macmillan Co. New York.
- Vertebrate evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinburgh.
- The Phylogeny of vertebrate. Lovtrup.S.JohnWiley and Sons. London
- Kuby Immunology, Goldsby R.A., Kindt Thomas J., Osbarne B.A., WH Freeman & Company, (2000).
- Roitt's essential Immunology, Roitt I.M. and Delves P.J., Blackwell Science Ltd., (2001).

MZO007B: TOOLS AND TECHNIQUES**Credit(s): 4****Unit I**

Principle and application of:-Light & electron microscopy

Principle, types and applications of Centrifugation

Unit II

Principle, types and applications of:-Electrophoresis

Principle, types and applications of:- Chromatography,

Unit III

Spectrophotometry :X-ray diffraction, Lamberts – Beer’s Law and Colorimetry, Flow cytometry

Principle and application of : radiation techniques in biology, Radioisotopes and half life of isotopes, Geiger Muller counter, Scintillation Counter, Autoradiography,

Unit IV

Principles and technique of :-Nucleic acid hybridization and cot curves, Blotting techniques (southern, northern and western), Polymerase chain reaction

Assay : Definition and types - Chemical assays, Biological assays-in vivo and in vitro assays.

Principles of cytological and cytochemical techniques : Fixation & staining

Unit V

Cell Culture techniques: Design of tissue culture laboratory, Culture media preparation and cell harvesting methods, cell cloning

Immunotechniques -Detection of molecules using ELISA, RIA, Western Blot, Immunoprecipitation. Monoclonal antibodies-Hybridoma Technology and Applications, Production of monoclonal antibodies, Clinical uses of monoclonal antibodies

Course outcome (CO): On completion of the course, students are able to:

CO1 Understand the Principle and applications of Light & electron microscopy, Centrifugation

CO2 Describe and compare different types of electrophoresis and chromatographic techniques.

CO3 Acquire skills to analyze spectrometric and radiation techniques, autoradiography.

CO4 Understand the Principles of blotting techniques, types of Assays, cytochemical techniques.

CO5 Understand the concept of Cell Culture techniques, Immunotechniques, monoclonal antibodies.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

<i>Course Outcome</i>	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	1	0	0	2
CO2	3	1	3	1	0	0	2
CO3	3	1	3	1	0	0	2
CO4	3	1	3	1	0	0	2
CO5	3	1	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings

- Animals Cell Culture - A practical approach, John R.W.Masters, IRL Press.
- Introduction to Instrumental analysis. Robert Braun. McGraw Hill International Edition
- Principles and Techniques of Biochemistry and Molecular Biology ,(6th edition), K Wilson and J Walker (editor), Cambridge University Press,
- Cell and Molecular Biology, P Sheeler and D E Bianchi, John Wiley & Sons, Inc,
- Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi.
- Bioinstrumentation, J G Webster, John Wiley & Sons Inc.
- Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg New York,
- Spectroscopy for the Biological Sciences, G G Hames, John Wiley & Sons Inc.

MZO008A: GENERAL PHYSIOLOGY

Credit(s): 4

Unit I

Digestion and Metabolism: Nature of food-stuff, various types of digestive enzymes and their action in alimentary canal, Absorption and assimilation of food, control of digestion.

Circulatory system: Composition and function of blood, blood groups, Haemopoiesis, blood clotting, homeostasis, anatomy of heart structure, Myogenic heart, cardiac cycle, ECG – its principle and significance.

Unit II

Mechanism of breathing, Physiology of respiration, Oxygen and Carbon dioxide transport in blood, The role of hemoglobin, control of breathing. Gas Exchange and Acid-base Balance: Respiratory organs (lungs).

Excretory system: Osmoregulation in aquatic and terrestrial environments, physiology of Excretion -Functional architecture of nephron, formation and regulation of nitrogenous end products, formation of urine and its hormonal control, Role of kidney in osmoregulation, counter- current multiplier system.

Unit III

Muscle Function and Movement: Types and properties of muscles, Anatomy of muscle, Regulation of contraction, Excitation-contraction coupling, Molecular theory of muscle contraction, cori cycle.

Nervous system: Functional architecture of neurons, Origin and propagation of nerve impulse through neuron (myelinated, non-myelinated), Action potential, Synapses and neurotransmitters, Reflex arc and reflex action.

Unit IV

Sensory Transduction: Auditory receptors, Chemoreceptors; taste and smell, Mechanoreceptors, Vision and Photoreception, Thermoreception.

Stress Biology : Basic concepts of environmental stress and strain, Adaptation, Acclimation and acclimatization, Concept of Homeostasis, Physiological response to oxygen deficient stress.

Unit V

Endocrinology: Hormones as messengers. Classification of hormones, endocrine glands (Pituitary, pancreas, adrenal, thyroid, testes, ovary).

Neuroendocrine system and neurosecretion, General principles, structure and hormone action.

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the Physiology of Digestion & Circulation.

- CO2 Understand the Physiology of Respiration & Excretion.
 CO3 Understand the Physiology of muscle contraction & nerve impulse and Reflex Action.
 CO4 Understand the concept of Sensory Transduction and Stress Biology.
 CO5 Understand the Physiology & Types of Endocrine glands.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

<i>Course Outcome</i>	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	1	0	2
CO2	3	0	3	1	1	0	2
CO3	3	0	3	1	1	0	2
CO4	3	0	3	1	1	0	2
CO5	3	0	3	1	1	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings

- Animal Physiology Mechanisms & Adaptation. Eckert, R.W.H. Freeman & Company, New York
- General and Comparative Animal Physiology, Hoar, W.S. Prentice Hall of Indian.
- Animal Physiology: adaptation and Environment, Schiemdt Neilsen. Cambridge
- Environmental and Metabolic Animal Physiology, Prosser, C.L. Wiley-Liss Inc., New York.
- General and Comparative Endocrinology, E.J.W. Barrington. Oxford. Clarendon Press.
- Comparative Vertebrate Endocrinology. P.J. Bentley. Cambridge University Press.
- Text Book of Endocrinology, R.H. Williams. W.B. Saunders.
- Endocrine Physiology. C.R. Martin. Oxford Univ. Press.
- Comparative Endocrinology, A. Gorbman et al. John Wiley & Sons.

MZO009A: MOLECULAR BIOLOGY & BIOTECHNOLOGY Credit(s): 4

Unit I

Nucleic acids –DNA & RNA, DNA replication: modes of replication, Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and Accessory proteins involved in DNA replication, Models of DNA replication, Inhibitors of DNA replication, DNA repair mechanisms

Unit II

Transcription in prokaryotes and eukaryotes: Structural organisation and life span of mRNA; rRNA & tRNA, Mechanism of transcription in prokaryotes and eukaryotes. Post transcriptional modification of RNA- Capping, Polyadenylation, Splicing, RNA editing.

Unit III

Genetic code : Characteristics of genetic code, Start codons and stop codons, Degeneracy of the code: Wobble hypothesis

Translation in prokaryotes and eukaryotes: Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis, Translational inhibitors, Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications.

Unit IV

Bacterial genetics: Molecular mapping of genome, genetic and physical mapping. Gene transfer mechanisms-Transformation- molecular mechanism, mapping and other uses of transformation, Transduction- generalized transduction, co-transduction and specialized transduction. Bacterial conjugation, Chromosome transfer in other bacteria. Plasmids and Transposons: types and properties.

Unit V

Molecular markers in genome analysis (RFLP, RAPD and AFLP).

Transgenesis & Transgenic animals: Production, Applications, Animal Cloning.

Stem cell: types and applications.

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the structure of nucleic acid, replication process and DNA repair mechanism.

CO2 Analyze the mechanism of transcription in prokaryotes and eukaryotes.

CO3 Explain the translational process for prokaryotes and eukaryotes.

CO4 Understand about Bacterial genetics and Gene transfer mechanisms.

CO5 Understand the concept of Molecular markers in genome analysis, transgenesis and stem cells.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	0	2
CO2	3	0	3	1	0	0	2
CO3	3	0	3	1	0	0	2
CO4	3	0	3	1	0	0	2
CO5	3	0	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1 = Low

Suggested Readings

- Benjamin Lewin : Genes, Vol. VIII, Pearson Prentice Hall, Singapore
- Elliott, W. H and Elliott, D. C. : Advanced molecular Biology, Viva Books, New Delhi
- Freifelder, D. : Molecular Biology, Narosa Publishing House, New Delhi
- Russel, P. J. : Cell and Molecular Biology, Cengage learning
- Molecular Biology of the Gene. I.D Watson, N.H. Hopkins, J.W. Roberts, J.A. Steiz and AM Weiner The Benjamin/Cummings Pub. Co., Inc., California.
- De Robertis E.D.P. and De Robertis Jr, E.M.F., Cell and Molecular Biology. K. M. Varghese Cop. Bombay.

MZO030A: RESEARCH METHODOLOGY

Credit(s): 3

Unit-I

Basic Concepts of Research : Introduction, definition and characteristics and objective of research, types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical), research approaches, significance of research, research methods versus methodology, research in decision making, role of research in various areas, limitations of research, Literature-review and its consolidation; Library research; field research; laboratory research.

Unit-II

Scientific Methods and Research: Scientific method, definitions of scientific method, characteristics of scientific method, basis of scientific method, scientific methods and scientific research, components of scientific approach, bias and prejudice in scientific research
Formulating Research Problem and Hypothesis: Introduction, Research process/planning process, research problem-need for defining, pre-requisites for formulating research problem, selection of the research problem, points to ponder on research problem, units of analysis, time and space co-ordination, characteristics of interest, environmental conditions, technique involved in defining a problem, formulation of a research problem and hypothesis testing

Unit-III

Data Collection and Documentation of Observations: Maintaining laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Overview of Biological Problems: History; Key biology research areas, Model organisms in biology (A brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit-IV

Ethics and Art of Scientific Writing: Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct / plagiarism.

Course outcomes (CO) : At the end of the course the students will be able to-

CO1 Understand the concept of research and different types of research in the context of biology

CO2 Have basic awareness of Scientific Methods and Research

CO3 Develop competence on data collection and process of scientific documentation

CO4 Analyze the ethical aspects of research and Evaluate the different methods of scientific writing and reporting

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	2	0	0	2
CO2	3	3	2	2	0	0	2
CO3	3	2	3	2	1	0	2
CO4	3	2	3	2	1	3	2

3 = Highly Related, 2 = Medium, 1 = Low

Suggested readings

- Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
- Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.

- Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
- S. C. Gupta. Fundamentals of Statistics. Himalaya Pub. House.

MZO010B: LABORATORY EXERCISES OF IMMUNOLOGY, PHYSIOLOGY, MOLECULAR BIOLOGY & CHORDATES **Credit(s): 6**

1. To identify, classify & study distinguishing features of representatives from :
Lower Chordates: Salpa, Doliolum, Botrylus, Herdmania, and Amphioxus.
2. To identify, classify & study distinguishing features of representatives from :
Cyclostomata: Petromyzon, Myxine, Pisces: Pristis, Trygon, Chimaera, Polydon,
3. To identify, classify & study distinguishing features of representatives from :
Pisces: Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus,
4. To identify, classify & study distinguishing features of representatives from :
Pisces : Exocoetidae, Echinoids, Pleuronectes, Diodon, Tetradon, Ostracion,
5. To identify, classify & study distinguishing features of representatives from :
Syngnathus, Hippocampus, Anguilla, Labeo.
Amphibia: Ichthyophis, Necturus, Proteus, Ambystoma, Axolotl,
6. To identify, classify & study distinguishing features of representatives from :
Amphibia: Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus.
7. To identify, classify & study distinguishing features of representatives from :
Reptilia: Testudo, Chelonea, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus,
8. To identify, classify & study distinguishing features of representatives from :
Reptilia: Chamaleon, Cobra, Hydrophis, Viper, Pit Viper, Krait, Eryx, Gavialis, alligator, crocodile.
9. To identify, classify & study distinguishing features of representatives from :
Aves: Talor Bird, Indian koel, Jungle fowl, Pavo cristis, Columba, parrot, Wood pucker, ostrich, Archéoptéryx.
10. To identify, classify & study distinguishing features of representatives from :
Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat.
11. To identify and study the permanent slides of: Lower Chordates: *Herdmania* spicules, ascidian tadpole larva, *Amphioxus* :T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete larva (whole mount).
12. To identify and study the permanent slides of: Pisces: Placoid scale, Cycloid scale, Ctenoid scale.
13. To identify and study the permanent slides of: Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary.
14. To identify and study the permanent slides of: Reptilia: V S skin of lizard.
Aves: V S skin of bird, contour feather, down feather.
15. To identify and study the permanent slides of: Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney,
16. To identify and study the permanent slides of: Mammals: testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord.
17. To study a comparative account of Skull of Frog, Varanus, Fowl and Rabbit.
18. To study a comparative account of pectoral girdle of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
19. To study a comparative account of pelvic girdle of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).

20. To study a comparative account of forelimb of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
21. To study a comparative account of hindlimb of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
22. To perform the Differential leucocytes count.
23. To separate serum from blood.
24. To Study the Double immuno diffusion test using specific antibody and antigen.
25. To identify blood groups in man.
26. To separate proteins and DNA by agarose electrophoresis.
27. To separate proteins and isoenzymes on SDS-PAGE and PAGE.
28. To separate amino acids by paper chromatography.
29. To separate phospholipids by TLC.
30. To prepare salivary gland chromosomes from Drosophila / Chironomous larva and stain with acetocarmine/aceto-orcein/ fuelgen.
31. To estimate DNA by Diphenyl Amine method.
32. To estimate RNA by Orcinol method.
33. To estimate Protein by Lowry' method.
34. To isolation RNA from Yeast.
35. To demonstrate agglutination reaction.
36. To demonstrate ELISA technique.
37. To determine haemoglobin in given blood samples.
38. To enumerate the RBC in given blood samples.
39. To enumerate the WBC in given blood samples.
40. To enumerate the MCV, MCH, MCHC of the given sample of blood.
41. To determine the blood clotting time, erythrocyte sedimentation rate, haemolysis and crenation.

SEMESTER-III

MZO011B	Genetics & Developmental Biology	4
MZO012B	Ethology & Applied Zoology	4
MZO017B	Laboratory Exercises of genetics, developmental biology, ethology & applied Zoology	2
	Discipline Elective Group A - ENTOMOLOGY *	
MZO031A	Insect Diversity, Society and Insect Physiology	4
MZO032A	Insect Toxicology and Ecology	4
MZO026A	Agricultural & Medical Entomology	4
MZO027A	Practicals in Entomology	4
	Discipline Elective Group B – ENVIRONMENTAL BIOLOGY *	
MZO028A	Principles of Ecology	4
MZO015A	Environment & Natural Resources	4
MZO016A	Eco-toxicology & Biodiversity conservation	4
MZO017C	Laboratory Exercises of Environmental Biology	4
	Total credits	26
*A student is required to take any one Discipline Elective ie either Group A or Group B		

MZO011B: GENETICS & DEVELOPMENTAL BIOLOGY Credit(s): 4

Unit I

Reproductive Genetics : Spermatogenesis, oogenesis, Computer assisted Semen Analysis (CASA), Assisted Reproductive Techniques (ART) IUI, IVF, ICSI, ZIFT, GIFT.

Pre-implantation Genetic Diagnosis (PGD).

Mutation: molecular mechanism of mutation, forward & reverse mutation, transition, transversion, chemical induced mutations, applications of mutations.

Study of human birth defects (Teratology)- Syndromology, Dymorphology, Neural tube defect, Anencephaly, Meningocele, Spina bifida, Herlequin ichthyosis. Environmental disruptions of normal development (Teratogenesis), Teratogenic agents- Alcohol, retinoic acid, bisphenol, heavy metals, pathogen, Environmental oestrogens.

Unit II

Molecular Diagnosis : DNA fingerprinting, Linkage analysis - RFLP, blotting techniques (southern, northern and western), Gene sequencing, *in situ* hybridization, FISH, application of FISH.

Prenatal Diagnosis: Non-invasive techniques- Ultrasonography, foetal MRI, Invasive techniques- Amniocentesis, chorionic villus sampling (CVS), Chromosome analysis, metabolic disorders, DNA Analysis, Current knowledge of prenatally diagnosed genetic disorders, haemoglobinopathies, Treatment of genetic disorders. Genetic counseling, Eugenics, Euthenics, Euphenics

Unit III

Introduction: Basic concepts of development: Potency, Commitment, Specification - autonomous, conditional, Induction, Competence, Determination and differentiation, Morphogenetic gradients

Environmental regulation of animal development: Environmental regulation of normal development– types of polyphenism

Sex determination in *Bonellia*; primary and secondary sex determination, environmental sex determination,

Unit IV

Gametogenesis, fertilization and early development : Production of gametes, Cell surface molecules in sperm-egg recognition in animals, Zygote formation, Cleavage and blastula formation, Gastrulation and formation of germ layers in amphibian.

Cellular and Molecular basis of development : Cellular interactions during development, Epithelial - mesenchymal interactions, paracrine factors, RTK pathway, cell death pathways, Cellular interactions concerned in fertilization, Cellular changes during blastulation and gastrulation, Cellular interactions in organogenesis, Molecular basis of cellular differentiation –cadherins.

Unit V

Embryogenesis and Organogenesis : Axis formation in amphibians - primary embryonic induction, Anterior posterior patterning in Amphibians - Hox code hypothesis, Anterior posterior patterning in *Drosophila* - gap genes, bicoid gradient, segmentation genes, pair rule genes, homeotic selector genes, realistor genes, Dorsoventral patterning and Left right patterning - dorsal protein gradient, Limb development in chick, Insect wings and legs
Ageing– cellular and extra cellular aging, Causes- Wear and tear, Oxidative damage, Mitochondrial genome damage, genetically programmed ageing.

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the concept of Reproductive Genetics, mutation and teratology..

CO2 Understand the concept of Molecular Diagnosis, Prenatal Diagnosis, Genetic counseling, Eugenics, Euthenics, Euphenics

CO3 Understand the Basic concepts of development, Environmental regulation of animal development and sex determination.

CO4 Understand the process of gametogenesis and Cellular and Molecular basis of development.

CO-5 Understand the concept of Embryogenesis and Organogenesis, ageing.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	2	0	2
CO2	3	0	3	1	2	2	2
CO3	3	0	3	1	0	0	2
CO4	3	0	3	1	0	0	2
CO5	3	0	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings

- Gardnor: Principles of Genetics
- Pierce Benjamin: Genetics- A Conceptual Approach
- Scriver *et al.*: The metabolic and molecular basis of inherited diseases. 8th edition, McGraw–Hill.
- Stratchan, T. and Read, A.P.: Human molecular Genetics. John Wiley, New York
- Tomarin Robert, H: Principles of Genetics
- Development Biology S.F.Gilbert, Sinauer Associates Inc., Massachusetts
- An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp.
- Developmental Biology. R.M Twyman. Viva Books Private Limited. New Delhi.
- Principles of Development. Wolpert, L. Oxford University Press, Oxford, UK.
- Berril, N. J. Developmental biology.
- Snustad, D. P., J. M. Simmons & J. B. Jenkins. Principles of Genetics.

MZO012B: ETHOLOGY AND APPLIED ZOOLOGY

Credit(s): 4

Unit I

An evolutionary approach to Animal behavior: History of the study of animal behavior, objectives of behaviour, mechanism of behavior: Neural control of behavior, sensory processes and perception

Complex behavior: Instinct and learning, Innate releasing mechanisms: key stimuli, stimulus filtering, supernormal stimuli, open and closed IRM.

Fixed action pattern- characteristics and evolutionary features.

Unit II

Mechanism of orientation: primary and secondary orientation; kinesis and taxis. Learning and cognition: habituation, classical conditioning, operant conditioning, latent learning, social learning, Homeostasis and behaviour: motivational system and their physiological basis,

motivational conflict and decision making, displacement activity, Hormonal regulation of behaviours.

Unit III

Parental care and mating systems: parental manipulation, evolutionarily stable strategy, cost benefit analysis of parental care.

Altruism: reciprocal altruism, group selection, kin selection and inclusive fitness.

An over view of Sociality in animal systems. Social organization in honey bees. Cooperation and conflict in animals.

Unit IV

Economic importance of Protozoa and Helminthes, Arthropods, Mollusca.

Important insect pest and their management.

A brief account of sericulture, apiculture, vermiculture, lac culture and pearl culture.

Unit V

Edible Freshwater and Marine Fishes of India. Pisciculture and products of fishing industry, Prawn fisheries. Poultry, Dairy farming and Wildlife tourism.

Course outcome (CO) : On completion of the course, students are able to:

CO-1 Demonstrate knowledge of key concepts in animal behavior

CO-2 Understand the concepts of orientation, learning and Hormonal regulation of behaviour.

CO-3 Understand the concept of Parental care and mating systems, Altruism and Sociality in animal systems.

CO4 Understand and study the economical importance of Protozoa, Helminthes, Arthropods, Mollusca and a basic idea of IPM, vermiculture, Apiculture, Sericulture, lac culture, Pearl culture.

CO5 Recognize Edible Freshwater and Marine Fishes of India and understand general topics like Pisciculture, prawn culture, poultry, dairy industry and Wildlife tourism

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	0	2
CO2	3	0	3	1	0	0	2
CO3	3	0	3	1	0	0	2
CO4	3	0	3	1	1	0	2
CO5	3	0	3	1	1	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings

- An Introduction to Animal Behaviour (6th Edition). Aubrey Manning and Marian Stamp Dawkins, Cambridge University Press.
- Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, Sinauer Associate Inc., USA, 2009.
- Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA, 2018.
- Neuroscience of Emotion: A New Synthesis. Ralph Adolphs and David J. Anderson, Princeton University Press, 2018.

- Economic Zoology by G.S Shukla & V.B. Upadhyay, 1991-92 Rastogi Publications, Meerut,
- A hand book on Economic Zoology by Jawid Ahsan and Subhas Prasad Sinha, S. Chand & company Ltd. Ramnagar.
- Dennis, H. (2009). Agricultural Entomology. Timber Press (OR).
- Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher
- Dunham R.A. (2004). Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
- Pedigo, L.P. (2002). Entomology and Pest Management, Prentice Hall.

MZO017B: LABORATORY EXERCISES OF GENETICS, DEVELOPMENTAL BIOLOGY, ETHOLOGY & APPLIED ZOOLOGY Credit(s): 2

1. To study Karyotyping of normal human cells.
2. To study Karyotyping of abnormal human cells.
3. To study the developmental stages of Frog.
4. To study the developmental stages of Chick.
5. To study the chick embryo culture.
6. To study the Life cycle of *Drosophila*.
7. To study the sex chromatin.
8. To prepare slide of salivary gland , polytene chromosome from *Drosophila* larva.
9. To study various meiotic stages in Grass hopper – (testes –squash preparation).
10. To study various mitotic stages in onion root tip by squash preparation.
11. To study various chromosomal abnormalities.
12. Study of life cycle and developmental stages of *Drosophila melanogaster*.
13. Study of developmental stages of chick embryo.
14. Isolation of mitochondria from liver tissue by differential centrifugation.
15. To study the geotaxis, phototaxis, chemotaxis and hydrotaxi of earthworm.
16. To study the Fixed action pattern in spider.
17. To study the Territorial behaviour in stray dogs.
18. To study and prepare slides of protozoan species of economic importance.
19. To study selected species of Platyhelminthes of economic importance.
20. To study the characters of Mites, Ticks, Spiders, Insects.
21. To study the Life cycle of silk worm,
22. To study the Life cycle of honey bee.
23. To study the Life cycle of mosquitos.
24. To Visit a fish industry/Poultry farm/ Dairy/ Leather industry etc.
25. To prepare and study protozoan culture.

Discipline Elective

Group A - ENTOMOLOGY

MZO031A: INSECT DIVERSITY, SOCIETY & INSECT PHYSIOLOGY Credits-4

Unit I

Introduction to insects and their biology: Morphology: external features and their articulation.

Comparative study of head-antennae, mouth parts; thorax – legs, wings; abdominal appendages, genitalia of the different orders of insects

Unit II

Historical development of classification of insect: basis of insect classification; classification of insects up to sub orders and up to super families in economically important groups

Insect Society: group of social insects and their social life. Evolution of sociality; Social organization and social behaviour in honey bee, ants, termites, aphids and wasps

Unit III

Integumentary system: Structure, function & formation, Growth, Moulting and Metamorphic development, hormonal influence, Sclerotization.

Respiratory system: Tracheal system and physiology of gas exchange.

Unit IV

Digestive & Excretory system: Alimentary tract, digestive and excretory physiology, Malpighian tubules, osmoregulation.

Circulatory system: Open circulatory system, hemolymph, hemocytes, Immunity and thermoregulation

Unit V

Reproductive system: Female & Male reproductive systems; Usual and unusual modes of reproduction.

Nervous system: Components of the nervous system, Sensing the environment - Sensory receptors, vision & acoustics.

Endocrine system: Insect hormones- with reference to metamorphosis & reproduction

Course outcome (CO) : On completion of the course, students are able to:

CO1 Critically analyze the value and importance of insects, the basic biology and the significant identification characters of the insects belonging to different orders.

CO2 Recognize the insects upto suborders and understand the concept of insect societies and would develop an ability to appreciate their implications on societal impacts.

CO3 Understand the structure and function of various physiological systems like integumentary and Respiratory system operating in insects

CO4 Understand the properties, processes, and functions of insect systems like Digestive, Excretory and Circulatory system.

CO5 Identify the influence/control (neural and/or hormonal) within each system and develop a sense of how physiology can be infused in major research topics in entomology.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	1	0	2
CO2	3	0	3	1	1	0	2
CO3	3	0	3	1	1	0	2
CO4	3	0	3	1	1	0	2
CO5	3	0	3	1	1	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Reading:

- A general text book of entomology, Imms , A. D., Chapman & Hall, UK
- Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F.,M Saunders College Publication, USA
- Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA
- The Insect Societies, Wilson, E. O., Harvard Univ. Press, UK .
- Whitfield, J. B. and A. H. Purcell III. 2014. Daly and Doyen's Introduction to Insect Biology and Diversity. 3rd Edition. Oxford University Press, Oxford, UK.
- The Principles of Insect Physiology, Wigglesworth, Vincent B, Chapman & Hall Ltd. USA.
- The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK
- Physiological system in Insects, Klowden, M. J., Academic Press, USA
- The Insects, An outline of Entomology, Gullan, P. J., and Cranston, P. S., Wiley Blackwell, UK
- Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA

MZO032A: INSECT TOXICOLOGY AND ECOLOGY**Credits-4****Unit 1**

Introduction : Definition of pesticides, brief history, pesticides registration, pesticide industries and markets in world and India.

Toxicology of pesticides : LD50 and LC 50 , Dose-response relationship; Carcinogenic, Mutagenic and Teratogenic effects, Method of testing chemicals on insect and evaluation of toxicity.

Unit II

Group characteristics and function of pesticides :Organochlorines, Organophosphorus insecticides, Carbamates, Pyrethroids, other plant origin bio-insecticides, neonicotinoids and nitrogenous insecticides; fumigants; IGRs, attractants, repellents and anti-feedants. Properties of few individual insecticides i.e. DDT, HCH (BHC), Lindane, Endosulfan, Parathion, Malathion, Carbaryl, Cypermethrin, etc.

Unit III

Mode of action : Central Nervous system, Acetylcholinesterase and unknown modes of action.

Metabolism of insecticides: Phase I and Phase II reactions and metabolism of other pesticides.

Toxicological symptoms of Organochlorinres, Organophosphorus, Carbamates, Pyrethroids, plant origin insecticides and other bioinsecticides.

Unit IV

Safer pesticides:Next generation molecules to be used as pesticides for plant protection and their chemistry.Nano-pesticides: Use of nanopesticides in plant protection, delivery technology and their behavior in different ecosystem.

Therapy and antidotes: Type and severity of contamination and medical aid.

Unit V

Ecology and biodiversity of insects: Insect biodiversity and their functioning in Terrestrial and aquatic ecosystem, Restoration of terrestrial ecosystem using the soil biota.

Global environmental impact on insects: Impact of global climatic changes on insect behavior, physiology and reproduction.

Toxic chemicals and survival of insects: Impact of Pesticides, Heavy Metals, Pharmaceuticals and other pollutants on insect physiology, their survival, reproduction and biodiversity.

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the concept of pesticides and Toxicology of pesticides.

CO2 Understand about Group characteristics and function of pesticides, insecticides, bio-insecticides.

CO3 Understand and analyze the Mode of action, metabolism and Toxicological symptoms of insecticides.

CO4 Analyze handling of the pesticides in crop protection and understand the therapy and antidotes at the time of poisoning.

CO5 Understand the biodiversity of insects in different ecosystems and the impact of global climatic changes on insects diversity and their behaviour

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	1	0	0	2
CO2	3	1	3	1	0	0	2
CO3	3	1	3	1	0	0	2
CO4	3	1	3	1	0	0	2
CO5	3	1	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Reading:

- Toxicology and Risk Assessment: A Comprehensive Introduction, Greim H.,and Snyder, R. (ed), John Wiley and Sons, UK
- The Complete Book of pesticide management, Whitford, F., Wiley Interscience, John Wiley and Sons, UK
- Safer Insecticides, Hodgson, E., and Kuhr, R. J., (ed), Marcel Dekker Inc., New York, USA
- Pesticide Application Methods, Matthews, G. A., Blackwell Science, London, UK
- Pesticide Biochemistry and Physiology, Wilkinson, C. F., Plenum Press, New York, UK
- Metabolic pathways of agrochemicals Part II, Roberts, T. R., and Hutson, D. H.The Royal Society of Chemistry, UK
- Chemical Ecology of Insects, Carde, R. T., and Bell, W. J., Chapman & Hall, New York, USA

MZO026A: AGRICULTURAL & MEDICAL ENTOMOLOGY Credits-4

Unit I

Agricultural Entomology: Agricultural pests: Pest status and factors responsible for achieving the status of pest, economic injury level, economic threshold, action threshold, pest spectrum, pest complex, carrying capacity, secondary pest outbreak, pest surveillance and sampling.

Insect Plant Interactions - Theory of co-evolution, role of allelochemicals in host plant mediation, tritrophic interaction, host-plant selection by phytophagous insects, establishment of insect population on a plant surface.

Unit II

Crop pests biology & control: Identification, seasonal history, nature of damage and control measures of pests, of cereals, pulse crops, cotton, vegetables (summer vegetable and winter vegetable), oil seeds, fruit crops, sugarcane and stored grains.

Locusts- different species and phases, phase transition, periodicity, migration, biology and control measures.

Unit III

Integrated Pest Management: Physical, Cultural, Chemical, Biological control, Genetic methods (SIT, F1 sterility, etc) and biotechnological methods of pest control. Biorational methods (Using Pheromones, JH mimics, MH agonists, etc) in pest management.

Stored grain pests: Control and quarantine

Plant resistance to insects: types of resistance, mechanism of resistance-antibiosis, antixenosis, tolerance, factors mediating resistance. Transgenic plants (using genes of *Bacillus thuriengensis*, etc) by recombinant DNA technology, resistance management of Bt crops.

Unit IV

Medical Entomology: Introduction-Vector biology, medical importance and management of the medically important insects (fleas, lice, bugs, mosquitoes and flies); Modes of Transmission of arthropod borne communicable diseases; Epidemiology of Vector-Borne diseases through Parasites and Pathogens of Public Health Importance- Occurrence, causative agents, transmission and control of protozoan, bacterial, rickettsial and viral diseases. e.g Malaria, Leishmaniasis, Sleeping sickness, Filariasis, Plague, Japanese Encephalitis, Yellow fever, Dengue, Chikungunya; Ecto- & endoparasites- of skin, Internal Insect Parasites (myiasis causing insects).

Unit V

Control of insect vectors of public health importance: Management of Vector-Borne Diseases by Integrated Vector Management.

Forensic Entomology: Forensically important insects, role of insects/arthropods in criminal investigation, by predicting time and cause of death.

Course outcome (CO) : On completion of the course, students are able to:

CO-1 Demonstrate knowledge of key concepts in Agricultural Entomology, Agricultural pests and Insect Plant Interactions

CO-2 Understand the concept of Crop pests biology & control.

CO-3 Understand Integrated Pest Management and Plant resistance to insects.

CO4 Understand Vector biology, medical importance and management of the medically important insects.

CO5 Analyze control and management of insect vectors of public health importance and Forensic Entomology.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	1	3	2	0	0	2
CO2	3	1	3	2	0	0	2
CO3	3	1	3	2	0	0	2
CO4	3	1	3	2	0	1	2
CO5	3	1	3	2	0	1	2

3 = Highly Related, 2 = Medium, 1 = Low

Suggested Readings:

- Insect Plant Biology, Schoonhoven, L. M., van Loon, J.A., & Dicke, M., Publisher Oxford University Press, USA
- Interrelationship between insects and Plants, Jolivet, P., CRC Press, USA
- Entomology & Pest Management, Pedigo, L. P., Prentice Hall, New Jersey, USA
- Concepts of IPM, Norris, Caswell-Chen and Kogan, Prentice-Hall, USA
- Agricultural insects pests of the tropics and their control, Hill, D. S., Cambridge University Press, UK
- Medical and Veterinary Entomology Mullen, G. , Durden, L., Academic Press, USA
- Medical and Veterinary Entomology, Kettle, D. S., Cabi Press, USA
- Medical Entomology for students, Service, M. Cambridge University Press, UK .

MZO027A: PRACTICALS IN ENTOMOLOGY

Credits-4

1. Morphology: Study of head and its sclerites of honeybee and cockroach.
2. Study of mouth parts of cockroach, housefly, honeybee, mosquito and butterfly.
3. Study of wings and their venation, Different types of antennae and legs of insects.
4. Study of stinging apparatus of honey bee.
5. Taxonomy: Identification of insects belonging to different groups up to orders and sub orders.
6. Social Insects: Morphological studies of various castes of Polistes, Apis, Camponotus, and Odontotermes.
7. Study of various types of social insects and their nests.
8. Dissection of alimentary canal of Dysdercus, honeybee, butterfly and grasshopper.
9. Reproductive system: Dissection of male & female reproductive system of moths; Apyrene & Eupyrene sperm in moths.
10. Filter chamber of homopteran; salivary glands of mosquito, honeybee and Dysdercus.
11. Excretory system detection of uric acid in malpighian tubules, uptake of dye in malpighian tubules.
12. Circulation: haemocyte count, estimation of protein in hemolymph.
13. Respiratory system: dissection of butterfly, Dysdercus and grasshopper.
14. Nervous system: dissection of Dysdercus, butterfly, honey bee and locust, stomodeal nervous system of cockroach and grasshopper.
15. Insect Toxicology: Estimation of LD50 and LC 50 using insects.
16. Pesticide residue analysis of contaminated soil, vegetable and water using TLC, GLC and HPLC.
17. Studies on dissipation of pesticides from soil and half- life estimation.
18. Estimation of uncertainty and variability in pesticide residue analysis.
19. Estimation of acetylcholinesterase activity to evaluate the toxicity of xenobiotic compounds.
20. Ecology: Measuring insect microclimate
21. Agricultural Entomology: Collection and identification of economically important insects and various stages of their life history.
22. Methods of rearing insects in the laboratory.
23. Identification of important insect pests of different crop plants and stored products.
24. Visits to agricultural fields and forests for on spot study of pests and damage caused by them.
25. Vector Biology: Study of life history stages of medically important arthropods, Diptera, Phthiraptera, Siphonoptera.
26. Identification and anatomical studies of major vector species of Anopheles, Culex and

- Aedes.
27. Field collection of immature stages of mosquitoes. Study of few available pathogens of arthropod-borne diseases.

Discipline Elective

Group B - ENVIRONMENTAL BIOLOGY

MZO028A: PRINCIPLES OF ECOLOGY

Credits-4

Unit I

Concept of Ecology - Introduction to ecology, evolutionary ecology, environmental concepts – laws and limiting factors, ecological models. Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure. Competition and coexistence, intraspecific and inter-specific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.

Unit II

Ecosystem - Nature of ecosystem, production, food webs, energy flow through ecosystem, bio-geochemical cycles, resilience of ecosystem, ecosystem management. The biosphere, biomes and impact of climate on biomes.

Unit III

Climate change - Environmental Stresses and their management, global climatic pattern, global warming, atmospheric ozone, acid and nitrogen deposition, coping with climatic variations.

Unit IV

Bioremediation - Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants.

Factors influencing bioaccumulation from food and trophic transfer.

Pesticides and other chemical in agriculture, industry and hygiene and their disposal.

Impact of chemicals on biodiversity of microbes, animals and plants.

Bioindicator and biomarkers of environmental health.

Biodegradation and bioremediation of chemicals.

Unit V

Biodiversity – assessment, conservation and management, biodiversity act and related international conventions. Sustainable development, natural resource management in changing environment. Molecular ecology, genetic analysis of single and multiple population, phylogeography, molecular approach to behavioural ecology, conservation genetics.

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand the fundamental aspects of ecology.

CO2 Understand the concepts of ecosystem and biosphere.

- CO3 Analyze about the impact of anthropogenic activities on the environment like climate change, global warming etc.
- CO4 Understand the concept of bioremediation
- CO5 Understand about biodiversity, natural resources and their conservation.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

<i>Course Outcome</i>	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	1	2
CO2	3	0	3	1	0	1	2
CO3	3	0	3	1	0	1	2
CO4	3	2	3	1	0	1	2
CO5	3	1	3	1	0	1	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings:

- Field Sampling: Principles and Practices in Environmental Analysis. 2004. Conklin, A.R. Jr. CRC Press.
- Principles and Standards for Measuring Primary Production. 2007. Fahey, T.J. and Knapp, A.K. Oxford University Press, UK.
- Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.
- Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford University Press, UK.
- Principles of Terrestrial Ecosystem Ecology. 2011. Chaplin, F.S., Matson, P.A. and Vitousek, P.M. Springer.
- Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.
- Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.

MZO015A: ENVIRONMENT & NATURAL RESOURCES

Credit(s): 4

Unit I

Environment and climate, Earth (core, mantle, tectonic plates); Atmosphere- structure and composition;

Clouds and their formation and Cloud categories:

Element and factors of climate: External factors: solar radiation, Internal factors.

Biosphere and Biogeochemical cycles.

Environmental monitoring and impact assessment.

Unit II

Cause, effects and remedial measure of Air pollution, Water pollution.

Noise. radioactive and thermal pollution.

soil pollution.

Solid waste management.

Unit III

Global warming : Cause of global warming, Impact of global warming – acid rains and ozone depletion, green house effect, Control measures of global warming

Natural Disasters and their management (floods, earthquake, Cyclones, landslides etc.)

Unit IV

Natural Resources:-Renewable and nonrenewable natural resources.

Forest , Land, Water, Mineral, Food resources

Energy resources

Unit V

Biomes: Desert, Grassland, Tundra, Tropical and temperate forests, Deciduous and evergreen rain forests; Ecozones of India

Species interactions: Herbivory, Carnivory, parasites, Prey– Predator, Commensalisms, mutualism and Symbiosis

Course outcome (CO) : On completion of the course, students are able to:

CO1 Understand about Environment and climate, Environmental monitoring and impact assessment.

CO2 Analyze the problems of pollution, its cause, effects and remedial measures.

CO3 Understand the concept of Global warming, Natural Disasters and their management.

CO4 Understand the Natural Resources and Energy resources.

CO5 Understand the concept of biomes, Species interactions.

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	1	2
CO2	3	0	3	2	0	1	2
CO3	3	0	3	2	0	1	2
CO4	3	0	3	1	0	1	2
CO5	3	0	3	1	0	1	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested readings:

- Bottain : Environmental studies
- Clark : Elements of ecology
- Kormondy : Concepts of ecology
- Odum : Ecology
- Simmons : Ecology of estuaries and costal water
- Pawlosuske : Physico-chemical methods for water
- South Woods : Ecological methods
- Trivedi and Goel : Chemical and biological methods for water pollution studies

MZO016A: ECO-TOXICOLOGY & BIODIVERSITY CONSERVATION Credit(s): 4

Unit I

Environmental indicators and their role in environmental balance.

Toxicology- Basic concepts, toxicological methods.

Toxicity testing principles, hazards, risks and their control methods.

Food toxicants and their control methods.

EIA

Unit II

Pesticides, types, nature and their effects on environment.
Important heavy metals and their role in environment.
Agrochemical use and misuse, IPM.
Occupational Health Hazards and their Control.

Unit III

Biodiversity : concept ,principle and significance of biodiversity
Causes for the loss of biodiversity, threats to biodiversity
Biodiversity hot spots.

Unit IV

Wildlife of India according to ecological zones
Values of wildlife : positive and negative
Wildlife protection Act and its major amendments
Endangered and threatened species
Wildlife corridors and wildlife translocation .
Biodiversity crisis – habitat degradation poaching of wild life.

Unit V

Conservation of Biodiversity: - In-situ and ex-situ conservation
National Parks and Sanctuaries
Project Tiger, Project Gir Lion and Crocodile breeding project
Wildlife in Rajasthan with references to Reptiles, Birds and mammals
Study of state bird – and state animal
Biospheres reserves

Course outcome (CO) : On completion of the course, students are able to:

CO1 Demonstrate knowledge of Environmental indicators and their role in environmental balance and eco-toxicology

CO2 Understand the concept of pesticides, IPM, Occupational Health Hazards and their Control

CO3 Understand the concept, principle and significance of biodiversity.

CO4 Understand Wildlife of India according to ecological zones.

CO5 Demonstrate knowledge of Conservation of Biodiversity, Wildlife in Rajasthan and Biospheres reserves

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcome	Program Outcome						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	0	3	1	0	0	2
CO2	3	0	3	1	0	0	2
CO3	3	0	3	1	0	0	2
CO4	3	0	3	1	0	0	2
CO5	3	0	3	1	0	0	2

3 = Highly Related, 2 = Medium, 1= Low

Suggested Readings :

- Wild life management - Hossetti
- V.B. Saharia wildlife in India
- S.K. Tiwari wildlife in central India
- R.K. Tondon Biodiversity Taxonomy & Ecology
- P.C. Kotwal Biodiversity and conservation

MZO017C: Laboratory Exercises of Environmental Biology Credits-4

1. To Mark important sanctuaries and national parks of Rajasthan on map, and write details of any three.
2. To estimate any environmental toxicants (biochemical/ GC/TLC).
3. To determine chloride concentration in the given water sample.
4. To estimate the total hardness of given water sample.
5. To determine the acidity of water.
6. To determine the alkalinity of water.
7. To estimate total dissolved solid in water sample.
8. To determine the dissolved oxygen in given water sample.
9. To determine the BOD of given water sample.
10. To determine the free CO₂ of given water sample.
11. To determine hardness of water.
12. Estimate salinity, phosphates, sulphates, silicates and nitrates in water samples.
13. Separate and identify soil arthropods using Berlese funnel.
14. Determine organic matter in soil sample.
15. Determine Carbonates & bicarbonates in soil sample.
16. Determine moisture content and water holding capacity of soil sample.
17. Physical and chemical characteristics of soil.
18. Physico-chemical properties of water.
19. Assessment of density, frequency and abundance of plants/ animals in a community using various techniques i.e. transect, quadrat etc.
20. Decomposition of various organic matters and nutrient release mechanisms/role of arthropods and other micro- and macro-fauna in decomposition.
21. Understanding ecosystem succession by studying various stages of vegetation/community assemblages development.
22. Application of molecular techniques in ecological study.
23. Study of Insect diversity in soil.
24. Identification of aquatic organisms of different trophic levels and construction of food chain and food web.
25. Principles of GIS, GPS and RS technology.
26. Interpretation (visual and automated) of remote sensing information for landscape differentiation.
27. FIELD STUDY-A study tour of at least five days duration (need not be at a stretch) to observe the ecology and behaviour of animals should be undertaken. The places of visit include inter tidal region, fresh water bodies, lakes, rivers, hill streams, wetlands, mangroves, forests grasslands, drinking water treatment plants, and sewage treatment plants.

A report of the field study is to be included in the practical record to be submitted at the time of Examination

SEMESTER IV

MZO021B	Project/ Dissertation	16
MZO022A	SEMINAR	2
MZO029A	Review Report/Scientific Writing	3
	Total credits	21

MZO021B: Project/ Dissertation

Credit(s):16

The students should carry out a project/dissertation work for at least 16 weeks in a National Lab/Private industry/reputed lab/institute. Dissertation will be based upon research and actual bench work. It will begin from the end of III semester and will continue through the IV semester. Dissertation report will be submitted and evaluated at the end of IV semester and students should defend their work in front of a selected committee in their last semester.

MZO 022A: Seminar

Credit(s): 2

MZO029A: Review Report/Scientific Writing

Credit(s): 3

Student will compile the review of literature (at least a ten year data) on any topic related to the importance of Zoology and its applied fields. The review matter will be supported by the publication in indexed Journal of National/International repute and/or submission of manuscript.