SHRI GURU RAM RAI UNIVERSITY

[Est. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

SYLLABUS FOR

M.Sc. Zoology

(Two-Year Course- Semester System)

School of Basic and Applied Sciences

Effective from Academic Session 2023-2024

(Revised on 30th July 2024 & 12th August 2025)

Patel Nagar, Dehradun, Uttarakhand

Master of Science (Zoology)

OUTCOME BASED EDUCATION

Programme outcomes (POs)

Students will be able to:

PO 1	Implement strong theoretical and practical knowledge of biological science to solve complex scientific problems.
PO2	Problem Analysis: Identify the situation-based problem, formulation and action is taken based on analytical thinking and principles of science.
PO3	Execute effective communication through interactive and presenting skills, technical report writing and proper documentation of ideas.
PO4	Formulate, design, experimental techniques, scientific tools, analysis of scientific data, interpretation of data and establish a hypothesis for various interdisciplinary research problem.
PO5	Create a new conceptual, theoretical and operational approach to address various problem of interdisciplinary fields.
PO6	Enables individuals to function effectively in cross-cultural environment as an individual and as a member or leader.
PO7	Understand ethical issues, academic and research ethics, need and value of adding, learning, scientific misconduct of a scientist to serve society.
PO8	Understand the contribution of scientific knowledge in environmental sciences for sustainable development.
PO9	Enhance and adopt employability skills through research, internship and dissertation.
PO10	Successfully compete in the state level, national level and international level exam or competition.
PO11	Understands the complex evolutionary processes and behavior of animals.
PO12	Understanding of environmental conservation processes and its importance, pollution control and biodiversity and protection of endangered species.

Program Specific Outcome (PSOs)

After completion of this course, the student will be able to

PSO-1	Understand the fundamental concepts and principles of cell biology, genetics, molecular biology, developmental biology, taxonomy, physiology, ecology, wildlife biology, and applied zoology to build a strong theoretical foundation.
PSO-2	Apply experimental and analytical skills to design and conduct multi-disciplinary research projects in zoology, integrating modern tools and techniques.
PSO-3	Evaluate the applications of biological sciences in areas such as apiculture, sericulture, aquaculture, agriculture, and medicinal biology, understanding their scientific and practical significance.
PSO-4	Develop competence in research methodologies, data analysis, scientific writing, and effective communication skills necessary for professional and academic growth.

Eligibility for admission:

Any candidate who has passed the B.Sc. with Zoology as one of the subject/ course papers with not less than 45% marks in aggregate is eligible for admission. However, SC/ST, OBC, and other eligible communities shall be given relaxation as per university norms.

STUDY & EVALUATION SCHEME
Master of Science (Zoology)

First Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MZOC101	Cell Biology & Genetics	3	0	0	3	40	60	100
2	Core	MZOC102	Lower Non-Chordata	3	0	0	3	40	60	100
3	Core	MZOC103	Molecular Biology, Evolution & Systematics	3	0	0	3	40	60	100
4	Core	MZOC104	Computer Application, Biostatistics, and Tools & Techniques in Biology	3	0	0	3	40	60	100
Practical										
1	Core	MZOL105	Lab course I, based on MZOC 101 & 102	0	0	4	4	40	60	100
2	Core	MZOL106	Lab course-II, Based on MZOC 103 & 104	0	0	4	4	40	60	100
			Total	**12**		8	20	**240**	**360**	**600**

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MZOC201	Biotechnology and Microbiology	3	0	0	3	40	60	100
2	Core	MZOC202	Higher Non-Chordata	3	0	0	3	40	60	100
3	Core	MZOC203	Animal Physiology	3	0	0	3	40	60	100
4	Core	MZOC204	Developmental Biology	3	0	0	3	40	60	100
Practical										
1	Core	MZOL205	Lab course-I, Based on MZOC201 & MZOC202	0	0	4	4	40	60	100
2	Core	MZOL206	Lab course-II, Based on MZ0C203 & MZOC204	0	0	4	4	40	60	100
Total				**12**			8	20	**360**	**600**

L – Lecture, T – Tutorial, P – Practical, C – Credit

Third Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MZOC301	Endocrinology and Animal Behavior	3	0	0	3	40	60	100
2	Core	MZOC302	Chordata	3	0	0	3	40	60	100
3	Elective-I	MZOE303/ MZOE304/ MZOE305 (Any one)	General Ichthyology/ Entomology-I/ Environmental Biology- I	3	0	0	3	40	60	100
4	Elective-II	MZOE306/ MZOE307/ MZOE308 (Any one)	Applied Ichthyology/ Entomology II / Environmental Biology II	3	0	0	3	40	60	100
5	Self-Study*	MZOS311/ MZOS312/ MZOS313 (Any one)	Aquatic Biodiversity/ Economic Zoology & Parasitology/ IPR, Patenting and Bioethics	3	0	0	3	40	60	100
Practical										
1	Core	MZOL309	Lab course-I, Based on MZOC301 & MZOC302	0	0	4	4	20	60	100
2	Elective	MZOL310	Lab course-II, Based on Electives (MZOE303 & MZOE306/ MZOE304 & MZOE307/ MZOE305 & MZOE308)	0	0	4	4	20	60	100
Total				**12**		8	20	**240**	**360**	**600**

L – Lecture, T – Tutorial, P – Practical, C – Credit

*Self-study marks not to be included while calculating grades.

Fourth Semester

S. N.	Course Category	Course Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	MZOC401	Ecology and Wildlife	3	0	0	3	40	60	100
2	Core	MZOC402	Immunology & Biochemistry	3	0	0	3	40	60	100
3	Elective-I	MZOE403/404/405 (Any one)	Fisheries Science/ Applied Entomology/Applied Environmental Biology	3	0	0	3	40	60	100

4	Elective-II	MZOE406/407/408 (Anyone)	Research Methodology in Fishery Science/ Research Methodology in Entomology/ Research Methodology in Environmental Biology	3	0	0	3	40	60	100
5	***Elective***	***MZOE411***	***Dissertation*** *(in lieu of Electives; MZOE 403 /404 /405 & 406 /407 /408+MZOL410)*	**-**	**-**	10	***10***	***60***	***240***	***300***
Practical										
1	Core	MZOL409	Lab course-I, based on C401 & C402	0	0	4	4	40	60	100
2	Elective	MZOL410	Lab course-II, based on E 403/404/405 and E 406/407/408	0	0	4	4	40	60	100
			Total	**12**		8	**20**	**240**	**360**	**600**

L – Lecture, T – Tutorial, P – Practical, C – Credit

#Dissertation shall be allotted to the students securing above 70% in the First & Second Semesters together. The dissertation (academic writing based on original research/Training) shall be evaluated jointly by an internal examiner and one external examiner.

Total Credits: **80** (Core Credit 60 + Elective Credits **20**) with an additional **03** credits of self-study, (03 credits of self-study shall be mandatory but not to be included while calculating the grades). 01 credits 01 hours of lecture/instructions per week, 01 credit course 15 hours of lecture per semester

Max. Marks for each paper: 100 (40 marks Sessional Tests/exam + 60 marks End Term Test/Exam).

Sessional may be in the form of Mid Term Test/exam, Assignment, Seminar & Laboratory Work, Internship, Industrial / Institutional visits, winter/Summer training-based report Writing & Presentation, Report based on field trips, excursions, etc., organized by the Department.

Examination Scheme:

Components	**Ist internal** (Assignment/Presentation-I, etc.)	**IInd Internal** (Written Exam/Attendance/Presentation-II, etc.)	**External (ESE)**
Weightage (%)	**20 Marks**	**20 Marks**	**60**
Weightage (%) Dissertation	**30 Marks**	**30 Marks**	**240**

Course code : MZOC101	L	T	P	C
Course Name : Cell Biology & Genetics	3	0	0	3
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. **Understand** the structural organization and functions of cells and their components.
2. **Explain** the principles of inheritance based on classical and molecular genetics.
3. **Analyze** genetic factors and molecular mechanisms involved in diseases such as cancer.

Course Contents

UNIT I

Theories on the Origin of Cells and the Cell as a Unit of Life. Prokaryotic and eukaryotic cells; Plasma membrane: ultrastructure, chemical composition, models of the plasma membrane; specializations and functions of the plasma membrane. Structural organization of the cell wall.

UNIT II

Structure and functions of the cell organelles: Mitochondria, Ribosomes, Lysosomes, Centrioles, Golgi complex, Endoplasmic Reticulum, Nucleus and nucleolus, and cytoskeleton.

UNIT III

Molecular aspects of cell division - Cell cycle, Cell cycle regulation; Signal transduction; Cancer and its types, Apoptosis and necrosis, oncogenes and tumor suppressor genes

UNIT IV

Classical aspect: Mendelian laws (Law of dominance, Law of Independent assortment). Exceptions of Mendelian laws, lethal allele, multiple alleles gene interaction (modification of dihybrid ratios) Sex linked inheritance, linkage and crossing over,

UNIT V

Fine Structure of gene, Giant Chromosome (Polytene and Lamp brush chromosome), Pedigree analysis in man, genetic disorder, cytoplasmic inheritance and extrachromosomal inheritance, Operon hypothesis, Hardy-Weinberg law and its application, Mutation and its types.

Reference Books:

1. Lewin: Genes, Vol. VII Oxford, 1998, Inded.
2. Straehan& Read: Human Molecular Genetics 1999, John Wiley & Sons Pte. Ltd.
3. Snustad et al: Principles of Genetics 1997, John Wiley & Sons.

De Robertes & Robertis: Cell & Molecular Biology, 1987, Lee & Fabiger Philadelplna

Text Books:

1. V.B. Rastogi., Introductory Cytology. Ram Nath & Kedar Nath publication, Meerut. (11th Revised Edition)
2. V.B. Rastogi., A Text book of Genetics. Ram Nath & Kedar Nath publication, Meerut.(09th Revised Edition)
3. Pk Gupta , Cell & Molecular Biology
4. Pk Gupta ,Cytology genetics and evolution

Course Outcomes (COs):

Upon successful completion of the course a students will be able

CO1	Identify cell structure, cell organelles, cell cycle, Mendelian law, chromosomes and gene mutation.
CO2	Describe the Mendel's law and the deviations from conventional patterns of inheritance. Structural and functional aspects of the basic unit of life i.e. Cell concepts their structure and function.
CO3	Illustrate structural organization of all cell organelles, cell signaling, sex linked Inheritance and genetic disorder.
CO4	Analyze cell organelles composition, oncogene, tumor and apoptosis
CO5	Summarize the genetic disorder and mutation.
CO6	Outline Operon hypothesis and Hardi-Weinberg law & numerical problem

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	1	2	1	-	1	2	1	2	2	2	1	-	2
CO2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	1
CO3	1	2	2	1	2	1	2	2	1	2	1	1	2	1	2
CO4	1	3	1	2	2	1	2	2	2	2	1	1	2	2	1
CO5	2	1	-	2	2	-	1	1	2	2	1	2	1	2	-
CO6	2	2	1	1	1	-	2	1	1	2	2	-	-	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC102	L	T	P	C
Course Name : Lower Non-Chordata	3	0	0	3
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are
1. To know about Invertebrates.
2. To understand the life cycle of Parasites.
3. To know the phylogeny of invertebrates.

Course Contents

UNIT I

General Classification, Characters of Non-Chordate Phyla, Major and minor Invertebrate phyla, Origin of Higher and lower Invertebrates, Origin of Metazoa, Organization of Coelom (Acoelomates, Pseudocoelomates, Coelomates).

UNIT II

Protozoa: Nutrition in Protozoa, Locomotion, Locomotory organelles and type of locomotion, Reproduction, Asexual, Sexual Reproduction and parthenogenesis, life cycle of *Trypanosoma, Plasmodium, Giardia etc*.

UNIT III

Porifera: Comparative morphology of all classes, Skeleton, Canal system, Reproduction and Phylogeny of porifera.

UNIT IV

Coelenterata: Comparative morphology of all classes, Polymorphism, Coral & coral reefs and their formation.

Ctenophora: Brief account and affinities.

UNIT V

Helminthes: Parasitism in Helminthes with life cycles and Pathogenicity of *Schistosoma,* and *Wuchereria*.

Reference Books:

1. Barnes: Invertebrate Zoology (4th ed.), Holt-Saunders, 1980.
2. Barrington: Invertebrate Structure and function, Nelson, 1987.
3. Iyer: A Manual of Zoology, Part I. Visawanathan, 1973.
4. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th ed) TimesMirror, Mosby, 1984.
5. Marshall & William: Textbook of Zoology, Vol I (Parker &Haswell, 7th ed.) Macmillian, 1972

Text Books:

1. Kotpal, Agrawal & Khetrapal: Modern Text-book of Zoology, Invertebrates. Rastogi, 1976.

2. Iyer: A Manual of Zoology, Part I. Visawanathan, 1973.

Course Outcomes (COs):

Upon successful completion of the course, a students will be able to:

CO1	Identify structural and functional diversity of non-chordates and demonstrate comprehensive identification abilities of non- chordate diversity. Explain evolutionary relationship amongst non-chordate groups.
CO2	Interpret the diversity, origin of Metazoans, Classification and character of lower non chordates. life cycle of *Trypanosoma, Plasmodium, Giardia etc.*
CO3	Construct a chart on origin and comparative morphology and system of Porifera and coelenterate
CO4	Analyze the various aspects concerning the coelom, nutrition, locomotion, and Reproduction of the Protozoa & Porifera and other vertebrate
CO5	Evaluating comparative morphology, reproduction, and phylogeny as well as affinities of Non Chordata.
CO6	Write about helminth parasite and their life cycle. Affinities of Ctenophora.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	2	1	-	2	2	2	2	2	1	2	2	1	1
CO2	1	2	1	2	2	1	2	1	2	2	2	1	2	1	1	1
CO3	2	1	1	2	2	1	2	1	2	2	2	1	1	1	1	2
CO4	2	2	1	1	2	1	1	2	2	2	1	1	2	1	1	2
CO5	1	1	2	1	1	1	2	2	2	1	1	1	2	1	1	2
CO6	1	1	2	1	2	1	2	1	2	2	2	1	2	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC103	L	T	P	C
Course Name : Molecular Biology, Evolution and Systematics	3	0	0	3
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are :

1. To know about molecular biology.
2. To understand the structure of DNA & RNA, replication and repair mechanism of DNA .
3. To know about the origin of life.

Course Contents

UNIT I

DNA replication. Genetic code. Transcription and translation in prokaryotes and eukaryotes. RNA processing. Mutations & DNA repair systems. Theories in support of DNA as a genetic material

UNIT II

The central Dogma of Molecular Biology. DNA: Structure and conformation, supercoiling, packing of DNA into chromosomes. Structural polymorphism of DNA & RNA. Three- dimensional structure of t-RNA.

UNIT III

Concepts of organic evolution and evolutionary theories. Origin of life (including aspects of prebiotic environment and molecular evolution). Micro and macroevolution. Synthetic theory of evolution, Natural selection: Concept; Types of selection and selection coefficient.

UNIT IV

Role of mutation in evolution. Speciation: Isolating mechanisms; Modes of speciation (allopatric, sympatric, parapatric). Fossils and fossilization. Geological distribution of animal. Evolution of Horse and Man.

UNIT V

Introduction, scope and History of animal taxonomy. Species concepts (Typological, Nominalistic, Biological and Evolutionary). Linnean hierarchy. Zoological Nomenclature: ICZN; Taxon, Rank and Categories. Preparation of Keys, Techniques of museum preparation.

Reference Books:

1. De Robertes &Robertis: Cell & Molecular Biology, 1987, Lee &FabigerPhiladelplna
2. Friefelder: Molecular Biology (2nd ed.), 1996 Narosa Publ. House,
3. Alberts et al: Molecular biology of the cell (4th ed.) 1994, Garland Publ. New York.
4. Elliott & Elliott: Biochemistry and Molecular Biology, 1996, Oxford
5. Mayr : Animal species and Evolution Belknap Press, 1966.

6. Strick Berger : Evolution, (Indian Edition). CBS Publ., 1994. 4. Richard Swann Lull: Organic Evolution Seema Publications, 1976.
7. Simpson G.G.: Principles of Animal Taxonomy, Columbia Univ. Press, 1961.
8. Mayr, E. Systematics and the Origin of Species, Columbia Univ. Press, 1942.
9. Blackwelder RE: Guide to the Taxonomic Literature of Vertebrates, Iowa State Univ. Press, 1972.

Text Books:

1. Moody: Introduction to evolution (Indian Edition) Kalyani Publ., 1978.
2. V.B. Rastogi; Organic Evolution, Kedar Nath Ram Nath Publication, Meerut.
3. Molecular Biology, Kreuzer Helen

Course Outcomes (COs): Upon successful completion of the course a students will be able to

CO1	Identify detailed and conceptual understanding of molecular processes, Evolution and systematics.
CO2	Explain the various process of molecular, evolution and systematics.
CO3	Analyze the evolution and evolutionary theories. Life at molecular level, taxonomy and its principles
CO4	Classify the molecular theories, evolutionary outline & theories of Taxonomy.
CO5	Differentiate the role of mutation, Evolution and learn Geological time scale.
CO6	Explain the Scope and history of animal taxonomy, molecular biology and evolution.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	1	2	2	1	1	2	2	2	2	1	2	1	1
CO2	2	1	1	2	1	1	2	1	1	2	2	1	2	1	1
CO3	1	2	1	2	2	1	2	1	1	2	2	1	2	2	1
CO4	1	2	1	2	2	1	1	2	1	2	1	1	2	1	1
CO5	1	1	2	1	1	2	1	2	1	2	1	2	2	2	1
CO6	1	1	2	2	2	1	1	1	2	2	1	1	2	1	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC104	L	T	P	C
Course Name : Computer application, Biostatistics and Tools &Techniques in Biology	3	0	0	3
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about working of computer.
2. To understand the Biostatistics methods used in various fields.
3. To know about tools & techniques in biological instruments.

Course Contents

UNIT I

Introduction to computer: mini, micro, mainframe and super computers, Components of a computer system (CPU, I/O units), Data storage device, memory concepts. Types of software's, Computer application in biology and information communications.

UNIT II

Biostatistics: Importance of statistics in biological research. Calculation of mean, median, mode, range, variance, standard deviation. Concepts of co-efficient of variation, skewness & kurtosis. Simple correlation. Elementary idea of random variables. Students-t, chi-square and F- test of significance. Introduction to some distributions of random variables: Binomial, Poisson, normal.

UNIT III

Microscopy, principle & applications-Light microscope and phase contrast microscope, Fluorescence microscope, Electron microscope, General Principle and applications of, Colorimeter, Spectrophotometer, Flame photometer

UNIT IV

Separation techniques-Chromatography, principal type and applications. Electrophoresis, Principles, types and applications PAGE and Agarose gel electrophoresis. Principles of centrifugation, Ultra centrifuge.

UNIT V

Histological techniques: Principles of tissue fixation, Microtomy, Staining, Mounting.

Reference Books:

1. Introduction to instrumental analysis-Robert Braun-McGraw Hill.
2. Clark &Swizer. Experimental Biochemistry. Freeman, 2000.
3. Robert Braun. Introduction to instrumental analysis. McGraw Hill
4. Locquin and Langeron. Handbook of Microscopy. Butterwaths, 1983.
5. Hoel, P.G.: Elementary Statistics. John Wiley & Sons, Inc. New York.

6. Milton &Tsokos: Statistical Methods in Biological and Health Sciences, McGraw Hill, 1983.

7. Zar JH: Biostatistical Analysis. Pearson.

8. Casselman: Histochemical techniques, John Wiley, 1959.

Text Books:

1. Mahajan BK: Methods in Biostatistics, (4th ed.). Jaypee Bros. 1984.

2. Sharma, V.K.: Techniques in Microscopy and Cell Biology Tata McGraw Hill, 1991.

Course Outcomes (COs):

Upon successful completion of the course, students will be able to:

CO1	Identify the problem-solving methods, various tools & techniques, using knowledge of computer used in biological systems and research.
CO2	Discuss about the SOP of various instruments, analytical tools, and computer knowledge to solve various biostatistical problem.
CO3	Demonstrate the significance of hypothesis testing and inferential statistics by using instrumental techniques and computer.
CO4	Deconstruct the real-world problem using statistical tools and computer software, and reaching them to a solution.
CO5	Conclude the principle and applications of various instrumental techniques like Microscopy, Colorimetry, Centrifuge, Chromatography, Spectrophotometer etc.
CO6	Formulate and devise a plan to Develop skill of solving biological problem using a combination of Biostatistics, computer Tools & its Techniques.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	0	2	3	0	2	0	2	2	2	2	0	3	2	2	0
CO2	3	3	3	2	2	2	2	0	2	3	3	2	3	3	3	2
CO3	3	3	2	2	3	3	3	3	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	2	3	2	0	3	3	2	3	3	3	2	2	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOL105	L	T	P	C
Course Name : Lab Course I Based on MZOC101 & MZOC102	0	0	4	4
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about Lower invertebrate diversity.
2. To understand the cellular organelle types and their structure.
3. To Analyze the cell division stages.

List of Practical's:

1. Study of mutant phenotype of *Drosophila* by chart.
2. Demonstration of law of segregation using *Drosophila* mutant.
3. Study of law of independent assortment.
4. Study of different cell organelles by chart/models.
5. To study squash technique for the study of Mitosis/Meiosis.
6. Identification of mitotic and meiotic stages from permanent slides.
7. To solve the numerical problem related to Mendel's law.
8. To study and classify representative animal specimen belonging to Protozoa to Helminthes with chart and available material.
9. To study of biological diversity of local region.
10. To study life cycle of various lower non-chordates by chart.
11. To study of permanent slides of lower non-chordates.

Course Outcomes (COs):

Upon successful completion of the course students will be able to

CO1	Draw the structure of cell, cell organelles, and their functions.
CO2	Compare the various phases of the cell cycle.
CO3	Practice the problems related to the principle and laws of Mendelian /modern Genetics.
CO4	Evaluate, identify and classification/taxonomic study of various specimens of lower non-Chordates.
CO5	Evaluate the various permanent slides of lower non-chordates and study of the life cycle of various lower non-chordates
CO6	Explain the chart of life cycle of lower non chordate.

Course code : MZOL 106	L	T	P	C
Course Name : Lab course 106 based on MZOC 103 & MZOC 104	4	0	0	4
Semester : Ist sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about DNA, its replication and repair mechanism.
2. To understand the evolutionary stages and taxonomic concepts.
3. To know the uses of computer basics and instrumentation used in the field of Zoology.

List of Practical's:

1. Demonstration of DNA/RNA structure with the help of chart/model.
2. To study the structure and types of DNA/RNA with the help of chat.
3. To isolate DNA from plant leaf.
4. To study the experiments proving the theory of biogenesis and abiogenesis.
5. To study the evolutionary stages of Horse and man.
6. To study the species their types.
7. Demonstrate and discuss the computer and its accessories.
8. Use of excel sheet for data processing.
9. Data mining for sequence analysis.
10. To study normal human karyotype.
11. To study chromosomal abnormalities.
12. To study the various human pedigree.
13. To solve numerical problems related to biostatistics.
14. To study various instruments/tools in biological science.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Draw the DNA structure and its components, RNA and its types
CO2	Characterize the DNA repair systems along with their diagram, Evolutionary theories, etc.
CO3	Uses of computer and its accessories.
CO4	Categorize the various equipment and their use in biology.
CO5	Evaluate the application of various statistical methods/tools in biological Sciences.
CO6	Revise the study of various instruments/tools in biological science

Course code : MZOC201	L	T	P	C
Course Name : Biotechnology and Microbiology	3	0	0	3
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Biotechnology and Microbiology.
2. To understand how Biotechnological and Microbiological processes works for obtaining useful products.
3. To understand the essentiality of Biotechnological and Microbiological products for human welfare.

Course Contents

UNIT I

Biotechnology: History, definition & Scope. Genetic engineering concept, Molecular methods used in genetic Engineering. Introduction to Recombinant DNA technology and applications, cloning vector: Plasmids, Phages, cosmids

UNIT II

Gene therapy, DNA finger printing, transgenic animals and plants. Blotting techniques: Southern, Northern and Western blotting (Methodologies and applications), DNA-sequencing, Polymerase chain reaction. Human genome project and its applications.

UNIT III

Microbiology: Bacteria - classification, staining techniques, pathological significance. Physiology, genetics & reproduction of viruses of plants and animals, Bacteriophage, lysogenic & lytic cycle, Bacterial genetics.

UNIT IV

Microbial culture techniques & media enrichment techniques. Microbial fermentation: Microbes in decomposition and recycling processes. Microbes as pathological agents in plants, animals and man.

UNIT V

Laboratory facilities, Culture media for animal cell culture, Primary culture, cell lines and cloning, Tissue and organ culture, Transgection methods & transgenic animals. Molecular markers CRFLPs, RAPDs, Mini satellites, Microsatellites. Application of animal cell culture.

Reference Books:

1. Michael J. Pelezar, E.C.S. Chan, Noel R. Krieg: Microbiology (5th ed.) Tata McGrall-Hill, 2008.
2. Alcamo's Jeffrey C. Pommerville: Fundamental of Microbiology (8th Ed.) Jones & Bartlet Publ. 2007.
3. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996 4. H.D. Kumar: Modern Concepts of Biotechnology, Vikas Publ. Pvt. Ltd.

4. Pommeruille Jeffery C, Microbiology, Fundamental of Microbiology
5. Powar C B, Microbiology, General Microbiology.

Text Books:

1. Pelczar: Microbiology, Tata McGraw Hill,1993
2. Davis: Microbiology (3rd ed.) Harper & Row, Publ. Inc., 1980
3. Prescott, Harley & Kliens: Microbiology (7th ed.) McGraw-Hill International Edition, 2008.
4. Mathews Bethany J. Encyclopedia of biotechnology

Course Outcomes (COs):

Upon successful completion of the course students will be able

CO1	Identify biotechnological and microbiological techniques in prospect of gene cloning, gene therapy, DNA fingerprinting, culture techniques and fermentation.
CO2	Describe basic concept of Biotechnology, scope, and importance.
CO3	Classify gene cloning, blotting techniques, PCR, gene therapy, DNA fingerprinting, Transgenic plant and transgenic animals' techniques in various fields.
CO4	Characterize various microbial & biotechnological techniques, fermentation & processing.
CO5	Compare culture techniques, microbial culture & Bacteriophage life cycle.
CO6	Explain laboratory facilities used in microbiology & microbes as pathological agent in plant and animals.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO2	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	2	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC 202	L	T	P	C
Course Name : Higher Non-Chordata	3	0	0	3
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Higher Invertebrate animals.
2. To understand how life evolved from simple to complex organization by division of labor.
3. To understand adaptations of huge complex and diverse life forms.

UNIT –I

Minor phyla: Organization and affinities if Rotifera, Entoprocta , Brachiopoda, Phoronida

UNIT-II

Annelida: Comparative Morphology of Various classes of Annelids, Coelom, Segmental Organs (Excretory organs), Adaptive radiation in polychaeta

UNIT-III

Arthropoda: Appendages and Mouth part in insects, larval forms and Parasitism in Crustacea, Affinities of Trilobita and Onchyophora, Arachnida

UNIT -IV

Mollusca: Comparative morphology of all classes, feature of respiratory and reproductive system, torsion and pearl formation.

UNIT- V

Echinodermata: Larval forms of Echinodermata, water vascular system, Affinities of Echinodermata.

Reference Books :

1. Parker TJ & Haswell WA: A Text book of Zoology Vol I & II, McMillan
2. Hyman L: Invertebrate Series, Academic Press
3. Starr et al: Biology, The Unity and Diversity of Life

Text Books:

1. Kotpal R.L: Modern Text Book of zoology: Invertebrates.
2. Nigam: Biology of Non-Chordates, Nagin Chand, 1985.

Course outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify and recall about animals of Higher Non chordata and their behaviour & significance.
CO2	Interpret the organization and affinities minor Phyla and other Non chordates.
CO3	Demonstrate the comparative morphology of various classes, coelom, excretory organ and adaptive radiation in Polychaeta and other Non chordates.
CO4	Analyze the Appendages, Mouthparts, larval forms and affinities of Arthropoda & other group of higher non chordata.
CO5	Evaluate the comparative morphology, respiratory and reproductive system of Non chordata.
CO6	Compare the Larval forms and affinities of Echinodermata and Mollusca and other classes of non chordata.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO2	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO3	1	1	2	2	2	1	2	1	1	2	1	1	1	2	1	1
CO4	1	2	1	2	2	1	2	2	1	2	1	1	2	1	2	1
CO5	1	1	2	2	1	2	2	1	2	2	2	2	2	1	2	2
CO6	1	1	2	2	1	1	2	1	1	2	2	1	1	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC 203	L	T	P	C
Course Name : Animal Physiology	3	0	0	3
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about physiology of animals.
2. To understand physiological processes (Digestion, Respiration, Excretion, Cardiovascular system, Nervous system) in animals.

Course Contents

UNIT I

Physiology of digestion & absorption: Functional anatomy of the gastrointestinal tract. Secretions of the gastrointestinal tract. Liver and biliary system. Mechanism of Digestion and absorption of proteins, fats and carbohydrates.

UNIT II

Physiology of respiration: Exchange of respiratory gases at the pulmonary surface. Transport of respiratory gases by blood. Oxyhaemoglobin dissociation curve. Neural and chemical control of respiration.

UNIT III

Physiology of cardiovascular system: Characteristics of vertebrate cardiac muscle. Initiation, conduction and regulation of heart beat. ECG and myocardial infarction. Blood pressure and its regulation. Circulation (open and closed, blood composition and function). Blood groups. The cascade of biochemical reactions involved in coagulation of blood.

UNIT-IV

Physiology of excretion: Formation of urine: Functional anatomy of the kidney. Glomerular filtration and its control. Reabsorptions & secretions in the tubules. Counter current mechanism. Excretion and control of urea, sodium, potassium and other ions. Functions of aldosterone, antidiuretic hormone and renin-angiotensin system in renal physiology.

UNIT V

Nervous system: Functional differentiation of brain, Neuron - the basic functional unit.

Ionic basis of resting and action potentials of neurons, Mechanism of synaptic transmission. Reflexes and types of reflexes. Neuromuscular physiology: Structural proteins of muscle cells, actin myosin complex and source of energy for contraction. Sliding filament theory of muscle contraction. Excitation-contraction coupling. Photochemistry of vision. Conduction of sound from tympanum to cochlea. Mechanism of thermoregulation in poikilotherms, homeotherms and heterotherms.

Reference Books:

1. KV sastry : Animal physiology and biochemistry
2. Arora Mohan Prakash : Animal Physiology : Himalaya Publishing House.
3. Mishra Surya Prakash : Mammalian physiology: Kalyani Publishers

Text Books:

1. HR Singh and Neeraj Kumar: Animal physiology and Biochemistry: Vishal Publishing House.

Course Outcomes (COs): Upon successful completion of the course students will be able to:

CO1	Identify the various organ system based on their characteristics and the mechanism of absorption in animal world.
CO2	Exemplify the functioning of various components of organ system found in animal world
CO3	To demonstrate the various aspects of the animal physiology, its Hormonal regulation & their function's.
CO4	Outline the animal physiology of organ systems and their regulation.
CO5	Critique and conclude the morphological changes among the organs.
CO6	Formulate and combine the modification within the organ system

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	0	2	3	0	2	0	2	2	2	2	0	3	2	2	0
CO2	3	3	3	2	2	2	2	0	2	3	3	2	3	3	3	2
CO3	3	3	2	2	3	3	3	3	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	2	3	2	0	3	3	2	3	3	3	2	2	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC 204	L	T	P	C
Course Name : Developmental Biology	3	0	0	3
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To understand the fundamentals of Developmental Biology
2. To understand detailed processes of Gametogenesis and fertilization, Early embryonic development, differentiation and Organogenesis. etc. in animals.
3. To understand concept of embryonic induction and organizers.

Course Contents

UNIT I

Gametogenesis: Spermatogenesis and Oogenesis, including structure, differentiation, and longevity of gametes. Chemical and metabolic events during gamete formation. Types of eggs.

UNIT II

Fertilization: Significance of fertilization, approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, Blockage to polyspermy, Parthenogenesis. Infertility.

UNIT III

Cleavage: Patterns, control of cleavage patterns, chemical changes during cleavage, totipotency. Blastulation and Gastrulation (in frog/chick). Fate maps, their formation and significance. Foetal membranes: Their formation and functions.

UNIT IV

Metamorphosis: As exhibited by an ascidian. Regeneration: Morphallaxis and Epimorphosis, Blastema and its significance, mechanisms as exhibited by invertebrates (Hydra and Planaria) and Vertebrates (Limb regeneration in Amphibia).

UNIT V

Placentation in mammals. Embryonic Induction: Origin, structure, and significance of primary organizer. Eye morphogenesis.

Reference books:

1. Gilbert: Development Biology Sinauers Ass. Publ. Massachusetts.
2. Wolpert: Analysis of Biological development, Oxford.
3. Kolthoff, Analysis of Biological development, McGraw- Hill Science, New Delhi, India.
4. Balinsky: Introduction to Embryology Saunders co. Philadelphia and London.

5. Berill: Development Biology Tata McGraw Hill.

Text Books

1. Shastry and Shukla: Developmental Biology: Rastogi Publication
2. P.S Verma, VK Agarwal: Chordate Embryology: S Chand Publication
3. Cell and Molecular Biology: N arumugham, Saras Publication.

Course Outcomes (COs):

Upon successful completion of the course students will be able to :

CO1	Identify basic concepts of developmental biology and organogenesis.
CO2	Elaborate the basic concept of development and gamete formation.
CO3	Illustrate the various aspects concerning the early development.
CO4	Analyze the concept of cellular differentiation, organizer and embryonic inductions and eye morphogenesis.
CO5	Conclude the various stages of development in the animals. vertebrates and flies.
CO6	Explain the process of metaplasia, Trans differentiation and Metamorphosis.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO2	1	2	1	2	2	2	2	1	2	2	1	2	1	1	1	2
CO3	1	2	1	2	2	2	1	2	2	2	1	2	1	1	1	2
CO4	1	2	1	2	2	2	2	1	2	2	1	2	1	1	1	2
CO5	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO6	3	3	2	3	2	2	2	1	2	3	3	3	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOL 205	L	T	P	C
Course Name : Lab Course I Based on MZOC201 & MZOC202	0	0	4	4
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Biotechnological and Microbiological instrumentation
2. To understand processes in Biotechnology and Microbiology
3. To identify the diversity distribution and abundance of Higher invertebrates.

List of Practical's:

1. To study the Biotechnological instrumentation
2. To study the Microbiological instrumentation
3. To study the Isolation of DNA
4. To prepare Media for cultural practices.
5. To study Sterilization techniques.
6. To study Staining techniques
7. To study the permanent slides of higher non-Chordata.
8. To study the Life cycle of higher non-Chordata by chart/ model

Text books:

1. P.S. Verma and VK Agarwal: Practical Manual of Invertebrate Zoology: S Chand Publication.
2. P.K. Gupta: Elements of Biotechnology, Rastogi and Co. Meerut, 1996

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Remember the various microbial staining techniques.
CO2	Understanding of the various Microbial culture techniques & media enrichment techniques
CO3	Carry out the DNA isolation.
CO4	Collection/Demonstration, identification, and classification/taxonomic study of various specimens of Higher non-chordates.
CO5	To evaluate the permanent slides of the Higher non-chordates.
CO6	Learn and study of the life cycle of various Higher non-chordates.

Course code : MZOL 206	L	T	P	C
Course Name : Lab Course II Based on MZOC203 & MZOC204	0	0	4	4
Semester : IInd Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Serological and Biochemical tests
2. To understand Toxicological effects
3. To identify the developmental stages of the Chick embryo.

List of Practical's:

1. Serological Tests (RBC, WBC, HBG, Clotting time of blood, etc.)
2. Biochemical Tests (Carbohydrate, Protein, Fats, Lipids, etc.)
3. Toxicological Tests
4. To study the developmental stages & Comparison of Vertebrates
5. To study the permanent slides of chicks, Amphibians, Mammals, etc.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Remember the various serological and biochemical tests.
CO2	Understand the various toxicological tests.
CO3	Illustrate the permanent slides/ whole mount of the various developmental stages of chicks, Amphibians, Mammals, etc.
CO4	Analyze the various permanent slides/Mounts.
CO5	Evaluate the biochemical test.
CO6	Construct new toxicological techniques.

Course code : MZOC301	L	T	P	C
Course Name : Endocrinology and Animal Behaviour	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about the endocrine gland.
2. To understand the animal hormones.
3. To understand animal behavior.

Course Contents

UNIT I

Hormones and Physiological actions of the following endocrine glands in vertebrates: Pituitary, Thyroid, Parathyroid, Pancreas, Gastro-intestinal tract, Adrenal cortex and Medulla, Thymus & Pineal.

UNIT II

Elementary knowledge of Dwarfism, Gigantism, Acromegaly, Diabetes insipidus, Goitre, Cretinism, Myxoedema, Diabetes mellitus and Addison's disease.

UNIT III

Biosynthesis and secretion of protein hormones.

Biosynthesis of steroid hormones: Steroidogenesis, cellular sites of synthesis, and control of secretion. Biosynthesis and control of secretion of Catecholamines. Biosynthesis, control of secretion of amino acid derived hormones (Thyroid). Mechanism of action of hormones

UNIT IV

Patterns of behaviour: Stereotype innate behaviour: Kinases, Taxes and Reflexes. Concepts of (i) Fixed action patterns (ii) Sign or key stimulus or releasers and (iii) Innate releasing mechanism, Instinctive behaviour. Learned behaviour: Habituation, Conditioned reflexes, Selective learning, Insight learning, Imprinting, Song learning in birds. Hormonal control of Behaviour

UNIT V

Communication: Chemical, Visual, Auditory, Electric and tactile, Dance language of honeybees, Biological clocks. Bird migration with particular reference to the mechanisms of navigation. Introduction to Socio-biology: Social structure in primates.

Reference Books:

1. Alcock : Animal behaviourSinaur Associates, Inc. 1989.
2. Goodenough et al.: Perspectives on animal behaviour. Wiley & SonsNew Youk. 1993.
3. Grier : Biology of animal behaviour, Mosby 1984.
4. Krebs & Davies : An introduction to behavioural ecology (3rd ed.) Blackwell 1993.
5. Mac E. Hadley: Endocrinology, Prentice-Hall International ed.1988/1992.
6. G J Goldsworthy et al: Endocrinology, Blackie, 1981.
7. Maurice Goodman: Basic and Medical Endocrinology, Raven Press.

Text Books:

1. Reena Mathur: Animal behavior
2. Fatik Baran Manda **Textbook of Animal Behaviour**

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Describe hormones and their physiological actions and Biosynthesis. Animal behaviour and communication.
CO2	Explain the concepts of endocrine systems, homeostasis and their physiological actions of various hormones.
CO3	Illustrate the metabolic pathways of hormones biosynthesis and mechanism of actions.
CO4	Explain the evolution and various patterns of the behavioural in animals. Hormonal control of behaviour.
CO5	Conclude the different modes of biological communication in animals.
CO6	Summarize the knowledge about the hormonal and neural control of behaviour.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO2	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO3	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO4	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO5	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO6	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC302	L	T	P	C
Course Name : Chordata	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about vertebrate animals.
2. To understand how life evolved from simple to complex organization by division of labour.
3. To understand adaptations of huge complex and diverse life forms.

Course Contents

UNIT I

Salient features and outline classification (up to order) of various chordate groups as covered under respective taxonomic groups.

Protochordate: Salient features of body organization and systematic position of Herdmania and Amphioxus as a type and its affinities. Agnatha: Character and affinities of Cyclostomes

UNIT II

Pisces: Scales and fins in fishes. Parental care and Migration in fishes. Fishes in relation to man. Amphibia: General characters and affinities of Gymnophiona. Parental care in Amphibia.

UNIT III

Reptilia: A brief knowledge of extinct reptiles. Poisonous and non- poisonous snakes. Poison apparatus of the snake. Snake venom and anti-venom. Adaptive radiation in reptiles.

Adaptations of reptiles to desert life.

UNIT IV

Aves: Flightless birds and their distribution. Flight adaptations in birds. Migration in Birds, Modification of Beaks, feet and Palate in Birds

UNIT V

Mammalia: General organization, distribution and affinities of Prototheria. Adaptive radiation with particular reference to aquatic mammals. Dentition in Mammals.

Reference Books:

1. Barnes: Invertebrate Zoology (4th ed.), Holt- Saunders, 1980.
2. Hickman, Roberts & Hickman: Integrated principles of Zoology (7th) ed Times- mirror, Mosby
3. Kotpal R.L: Modern Textbook Of Zoology: Invertebrates. Rastogi
4. Nigam: Biology of Non-Chordates, Nagin Chand.
5. Parker TJ & Haswell WA: Textbook of zoology Vol I & II, Mcmillan.
6. 6. Hyman L: Invertebrate Series, Academic Press
7. Young JZ: The Life of Vertebrates, Oxford, 1950.

Text Books:

1. E.L.Jordan & P.S.Verma, Chordate Zoology. S.Chand & Company Ltd. 2001.
2. R.L.Kotpal, A Text Book of Chordata.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the basic concepts of chordata, their organization, distribution and adaptive radiation.
CO2	Discuss about classification, general organization, and affinities of Protochordata, Amphioxus and Urochordata, Agnatha. Understand the origin, General organization and affinities of Gymnophiona
CO3	Classify Protochordata, Amphioxus and Urochordata, Agnatha, extinct reptiles & poisonous & non-poisonous snakes. Parental care in Amphibia.
CO4	To examine the Pisces, Reptiles and flightless birds & migration in birds, adaptation in various chordate animals.
CO5	To evaluate the affinities, economic importance and adaptation from protochordates to mammals.
CO6	To assemble the adaptive radiation in Pisces, Reptiles, Aves and aquatic mammal.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO2	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO3	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO4	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO5	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO6	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE303 (Elective-I, Any one)	L	T	P	C
Course Name : General Ichthyology	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are:

1. To know about the evolution and phylogeny of fishes.
2. To understand the physiology of the fishes.
3. To know about the behaviour of the fishes.

Course Content

UNIT I

Classification of Fishes, Systematic Position, Habit and Habitat, Morphology, Distribution, Significance and Affinities of Holocephali and Dipnoi. Fins their Origin and Evolution; Locomotion in Fishes.

Histomorphology and Elementary Physiology (A) Digestive System (With Particular Reference to food And Feeding Habits of Freshwater Fishes) (B) Excretory System (With Particular Reference to Acid Base Balance and Osmoregulation.) (C) Respiration (Structure and function of gill).

UNIT II

Accessory respiratory Organs in Fishes.
Integuments in fishes and coloration and its significance, mechanism of colour change,
Swim bladder its types: Physostomous and Physoclistous type
Bioluminescence: Luminescent organs, Mechanism of light emission
Webberian ossicles: Working mechanism and functions.
Exoskeleton: Structure and development of placoid and non placoid scales, Electric Organs in Fishes.

UNIT III

Brief Knowledge of Sexual Dimorphism, Courtship and Parental Care. Migratory Instincts, Hill Stream Adaptations. Reproduction in a Major Carps - Structure of Gonad, Spawning, Early Development and Metamorphosis.

UNIT IV

Microscopic Structure and Hormonal Functions of the Endocrine Glands: Pituitary, Thyroid, Pancreas, Adrenal, Corpuscles of Stannins, Ultimobranchial Glands, Caudal Neurosecretory System and Sex Hormones.

UNIT V

Brief Knowledge of Sense Organs: Organs of Smell, Eyes, Hearing, Ampulla of Lorenzeni, Bio- Luminescence, Sound Production and Lateral Line System.
Venomous and Non-Venomous Fishes.

Reference Books

1. C.B.L. Srivastava: Fish Biology, Narendra Publication House, 2008.
2. Kyle: The Biology of Fishes, 2007.
3. H.R. Singh: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
4. J.D. Munshi & J.S.D. Munsi: Fundamental of Freshwater Biology, Narendra Publ. House, 1995.
5. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ. Press, 1977.
6. Pankaj Bahuguna and A. K. Dobriyal (2019). Biology of the ornamental fish Puntius conchonius (Ham. - Buch.). Narendra Publishing House, Delhi (India). ISBN: 978-9387590-46-5.

Text Books:

1. SS Khanna & H.R. Singh: Fish & Fisheries.
2. Dr. J. Ojha: Biology of Hill Stream Fish, Narendra Publication House, 2002.
3. C. J. Khune, R. V. Tijare, S. R. Sitre & S. B. Zade**, Principles of Aquaculture First edition 2017**
4. A. K. Saxena**, 2017** ***Aquatic Biology & Fisheries Science***

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the phylogeny, physiology, metamorphosis, and fishery resources and fish behaviour.
CO2	Describe the systematics, Phylogeny and general organization of fishes.
CO3	Interpret the general organization and affinities of Agnatha, Holocephali and Dipnoi.
CO4	Classify the culture systems and Explain the metamorphosis of Teleost and Elasmobranchs.
CO5	Summarize the knowledge of physiology of alimentary canal, electric organs and endocrine Glands in fishes.
CO6	Explain physiology of respiration, sense organs, parental care and reproduction in fishes

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO2	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO3	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO4	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO5	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO6	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlate

Course code : MZOE304 (Elective-I, Any one)	L	T	P	C
Course Name : Entomology I	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about the structure of insects.
2. To understand the general characters of various orders of insects.
3. To know about the behavior of insects.

Course Contents

UNIT I

Introduction to external morphology: body wall, segmentation. The head: structure of head; appendages, and antennae. The thorax: pro, meso and metathorax; legs. The wings: origin, structure and articulation. The abdomen: structure, appendages; external female and male genitalia.

UNIT II

Classification of insect with special reference to that of different orders. General characters, habits, habitats, importance of the insect orders- Collembola, Protura, Diplura, Thysanura, Ephimerida, Placoptera, Odonata.

UNIT III

General characters, habits, habitats, importance of the insect orders-Embioptera, Orthoptera, Phasmida, Dermaptera, Blattaria, Menteodea, Isoptera, Zoraptera.

UNIT IV

General characters, habits, habitats, importance of the insect orders-Psocoptera, Thysanoptera, Heteroptera, Homoptera, Anoplura, Neuroptera, Megaloptera, Trichoptera.

UNIT V

General characters, habits, habitats, importance of the insect orders-Coleoptera, Strepsiptera, Hymenoptera, Lepidoptera, Diptera.

Reference Books:

1. Metcal& Flint: Des truction and useful Insects, Tata McGraw-Hill, 1979.
2. Ayyar, TVR: Hand Book of Economic Entomology for South India, International Book & Periodical Supply Service, 1984.
3. Fernald HT, HH Shepard: Applied Entomology, McGraw-Hill, 1955
4. Frost SW: Insect life and insect Natural History, Dover Publication, New Yark, 1959.
5. Evans JW: Insect Pests and Their Control, Periodical Expert Book Agency, 1984.

Text Books:

1. Pruthi HS: Text Book on Agricultural Entomology, ICAR Publication, 1969.
2. Ananthakrishnan TR: Applied Entomology.
3. Pramod Mall, A.K. Pandey & Ravi Prakash Maurya, Introduction to Fundamentals of Entomology — *2023 (1st ed.)*

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the morphology & concepts of overview of all orders of Entomology
CO2	Describe external morphology of insects (head, thorax, wings & abdomen)
CO3	Classify the insects with special reference to that of different orders
CO4	Analyze the general characters, habits, habitats, importance of the insect orders Embioptera, Orthoptera, Phasmida, Dermaptera, Blattaria, Menteodea, Isoptera, Zoraptera
CO5	Summarize the general characters, habits, habitats, importance of the insect order Psocoptera, Thysanoptera, Heteroptera, Homoptera, Anoplura, Neuroptera, Megaloptera, Trichoptera and reproductive system
CO6	Explain the general characters, habits, habitats, importance of the insect orders- Coleoptera, Strepsiptera, Hymenoptera, Lepidoptera, Diptera

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO2	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO3	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO4	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO5	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO6	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE305 (Elective-I, Any one)	L	T	P	C
Course Name : Environmental Biology I	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about our environment and climate.
2. To understand different biomes of India.
3. To know about population cycle, bio-assimilation and bioaccumulation.

Course Contents

UNIT I

Introduction to Environmental biology, its multidisciplinary nature and scope.
Components of Environment: atmosphere, lithosphere & hydrosphere. Climate (micro, regional and global);
Hydrological cycle; Soil profile. Changing interactions between man and environment (cultural, political, ecological).

UNIT II

Terrestrial biomes of the world their characteristics and major biota (Grassland, Desert, Forest, Tundra). Aquatic biomes (lotic, lentic, marine, estuaries, coral reef), their status. Wetlands of India. Environmental adaptations: Aquatic, Aerial, Desert, Arboreal, Fossorial, Defensive.

Unit III

Island biogeography theory. Habitat fragmentation, Habitat selection, Corridors, Community patterns (gradients and Continuum), Community indices. Ecological niche.

UNIT-IV

Population cycles and fluctuations; Dispersal. Intra & inter specific relationship. Models of succession; Pioneer & climax concept.

UNIT - V

Concept of biological indicators; biological monitoring; Indicator organisms. Invasive species and its impact. Biological control: Biomagnification, Bioassimilation & Bioaccumulation.
Xenobiotics: Carcinogenic (heavy metals, pesticides).

Reference Books:

1. Odum : Fundamentals of Ecology (Saunders, 1971)
2. Turk and Turk :Environmental Science (4th ed. Saunders, 1993)
3. Primark : A Primer of Conservation Biology (2nd ed. Sinauer Associates)
4. Calabrese : Pollutants and High-Risk Groups (John Wiley,1978)
5. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)

Text Books :

1. Sharma : Ecology and Environment (Rastogi Publication, 7th ed. 2000)

2. Odum : Basic Ecology (Saunders, 1985)

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Describe concept of environmental biology, its multidisciplinary nature, scope, and its components
CO2	Discuss the terrestrial biomes of the world their characteristics and major biota
CO3	Illustrate environmental biology, Island biogeography, population cycle and biological control.
CO4	Analyze the Population cycles and fluctuations. Succession model, Pioneer & climax concept
CO5	Determine the concept of biological indicators, community pattern & ecological Niche.
CO6	Explain the techniques of biological control.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO2	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO3	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO4	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO5	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO6	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE306 (Elective-II, Any one)	L	T	P	C
Course Name : Applied Ichthyology	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are
1. To know the cultivable fishes.
2. To understand the various economic important group of fishes.
3. To know the various fishery practices.
4. To know fish farm management and disease identification in fishes .

Course Content

UNIT I

General Survey of the Marine, Estuarine, and Inland Capture Fisheries of India with Particular Reference to Fishery Resources of Uttarakhand,

Important cultivable fresh water species of Uttarakhand, Shellfishes. Biology of Cultivated Fish and Shellfish.

Methods of Fishing: Fishing Gears and Crafts.
Sewage-Fed Fishery and Shellfish Fishery

UNIT II

Carp Culture: Monoculture, Poly Culture and Composite Fish Culture. Live Fish Culture. Management Practices: Weed, Insect and Carnivorous Fishes

Food and their classification and feed formulation: Natural Food and Artificial Feed and their Role in Fish Culture, Fishponds and their types, dry bundh and wet bundhs. Ecology and Productivity of Fish Ponds, Pollution in Relation to Fisheries.

UNIT III

Setting and maintenance of an Aquarium, Important Ornamental fishes and their characteristics , Larvivorous Fishes and Public Health.

Fish Diseases and their Management, Exotic Fishes and Their Merits and Demerits, Cryopreservation of Gametes and Embryos.

UNIT -IV

Aquaculture in World and Aquaculture in India
Integrated Aquaculture: Fish-Cum Poultry, Fish-Cum Piggery, Paddy-Cum Fish Culture and Dairy-Cum Fish Culture**.** Construction and maintenance of fish farm

Transportation of fishes: live fish transport.

UNIT V

Maturation and Fecundity, Spawning and Seed

Collection, Induced Breeding and Hybridization.

Factors Responsive for Induced Breeding, Hypophysation. Use of Different Synthetic and

Natural Hormones. Hatching Techniques and Hatcheries, Nursery Management,

Reference Books

1. C.B.L. Srivastava: Fish Biology, Narendra Publication House, 2008.
2. Kyle: The Biology of Fishes, 2007.
3. H.R. Singh: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
4. J.D. Munshi & J.S.D. Munsi: Fundamental of Freshwater Biology, Narendra Publ. House, 1995.
5. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ. Press, 1977.
6. Pankaj Bahuguna and A. K. Dobriyal (2019). Biology of the ornamental fish Puntius conchonius (Ham. - Buch.). Narendra Publishing House, Delhi (India). ISBN: 978-9387590-46-5.

Text Books:

1. Dr. J. Ojha: Biology of Hill Stream Fish, Narendra Publication House, 2002.
2. SS Khanna & H.R. Singh: Fish & Fisheries
3. *Fish Biology* ("Protocols of Fish Biology") — **Dina Nath Pandit**, 2025.
4. *Fish and Fisheries* — **B. N. Yadav**, 2nd revised & enlarged ed., 2021

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Describe fish culture systems, Aquaculture system,
CO2	Discuss crafts and gear used in fish catching, and Transportation of fishes
CO3	Illustrate the different group of fishes (larvivorous, Ornamental, Exotic fishes etc.) food and its types.
CO4	Analyze the Fish disease, fish pond types etc. and Induced Breeding and Hybridization.
CO5	Summarize the knowledge about Integrated fish farming types
CO6	Explain construction and maintenance of fish farm.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	1	2	1	-	1	2	1	2	2	2	1	-	2	1
CO2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	1	2
CO3	1	2	2	1	2	1	2	2	1	2	1	1	2	1	2	2
CO4	1	3	1	2	2	1	2	2	2	2	1	1	2	2	1	1
CO5	2	1	-	2	2	-	1	1	2	2	1	2	1	2	-	2
CO6	2	2	1	1	1	-	2	1	1	2	2	-	-	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE307 (Elective-II, Any one)	L	T	P	C
Course Name : Entomology II	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about the physiology of Insects.
2. To understand the process of metamorphosis in insects.
3. To know the effect of abiotic factors on insects.

Course Contents

UNIT I

Digestive system: structure, physiology of digestion and absorption of different types of food. Structure of circulatory system: haemolymph its composition and function. Physiology of respiration; the tracheal system, spiracles, respiration in aquatic insects. Nervous system: structural basis, Excretion: structure and physiology of malpighian tubules and its secondary functions. Reproduction: male and female gonads.

UNIT II

Structure of compound eye, mosaic vision. Production and reception of sound. Light producing organs. Hormones: neurosecretion and co-ordination, Metamorphosis: types, hormonal control of metamorphosis, Pheromones.

UNIT III

Structure of the insect egg, maturation, cleavage, formation of blastoderm, gastrulation, blastokinesis, germ layers, Various types of larvae and pupae, moulting, diapauses, Oviparity, viviparity, ovo-viviparity in insects.

UNIT IV

Abiotic factors: effect of temperature, light and humidity on growth of insect population; biotic potential, Malthusian principle and dynamics of population fluctuation, hibernation, aestivation.

UNIT V

Biotic factors: parasitism, predation and social life in insects, phase theory of locust, parental care.

Reference Books:

1. Metcal & Flint: Destruction and useful Insects, Tata McGraw-Hill, 1979.
2. Ayyar, TVR: Hand Book of Economic Entomology for South India, International Book & Periodical Supply Service, 1984.
3. Fernald HT, HH Shepard: Applied Entomology, McGraw-Hill, 1955
4. Frost SW: Insect life and insect Natural History, Dover Publication, New Yark, 1959.
5. Evans JW: Insect Pests and Their Control, Periodical Expert Book Agency, 1984.

Text Books

1. Pruthi HS: Text Book on Agricultural Entomology, ICAR Publication, 1969.

2. Anantha krishnan TR: Applied Entomology

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Describe insects' physiology, growth, development and behavior, metamorphosis and hormonal control. Hibernation & aestivation
CO2	Discuss the circulatory, respiratory & sound and light producing organs
CO3	Illustrate the digestive, excretory and reproductive system of insects
CO4	Analyze the structure of eye & vision and metamorphosis in insects. Formation of germ layers & development of insects
CO5	Summarize the knowledge of about physiology of insects, Pheromones and hormones & environmental factors
CO6	Explain the role of abiotic and biotic factors on the population and growth, social behaviour of the insects

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	2	1	2	2	1	1	2	2	2	2	1	2	1	1	2
CO2	2	1	1	2	1	1	2	1	1	2	2	1	2	1	1	1
CO3	1	2	1	2	2	1	2	1	1	2	2	1	2	2	1	2
CO4	1	2	1	2	2	1	1	2	1	2	1	1	2	1	1	1
CO5	1	1	2	1	1	2	1	2	1	2	1	2	2	2	1	1
CO6	1	1	2	2	2	1	1	1	2	2	1	1	2	1	1	1

Course code : MZOE308 (Elective-II, Any one)	L	T	P	C
Course Name : Environment Biology II	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about natural resources, biodiversity and its conservation.
2. To understand the problem related to environment like pollution etc.
3. To know about the protected areas like National parks, Sanctuary and Biosphere.

Course Contents

UNIT I

Natural Resources: Management & conservation; Renewable & non-renewable resources; Concept and currencies of Sustainable development. Biodiversity & its conservation. Environment Protection laws. Earth Summit, Rio+20.

UNIT II

Concept of Protected areas: Sanctuary, National Parks & Biosphere Reserves. IUCN. Categories, Biodiversity hot spots, conventions on biodiversity.

UNIT III

International efforts in biodiversity conservation (UNFP, IUCN, WWF); CITES; UNESCO's World heritage mission; Convention on Biological Diversity (CBD).

UNIT IV

Global Environmental Problems: Climate change, Greenhouse effect; Acid rain; Ozone layer depletion; Deforestation; Desertification; Marine pollution; Urbanization.

UNIT V

Environmental Problems/Hazards in Hills: Earthquake; Landslide; Soil erosion; Sedimentation; Cloud burst; Flash floods; Glacial retreat. Application of Remote sensing & Geographical Information Systems (GIS) in environment management.

Reference Books

1. Odum: Fundamentals of Ecology (Saunders, 1971)
2. Turk and Turk: Environmental Science (4rth ed. Saunders, 1993)
3. Primark: A Primer of Conservation Biology (2nd ed. Sinauer Associates)
4. Calabrese: Pollutants and High-Risk Groups (John Wiley,1978)
5. Raven, Berg, Johnson : Environment (Saunders College Publishing, 1993)

Text Books:

1. Odum : Basic Ecology (Saunders, 1985)
2. Sharma : Ecology and Environment (Rastogi Publication, 7th ed. 2000)

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Describe natural resources, biodiversity and environmental problems
CO2	Discuss the Natural resources, their management & conservation
CO3	Demonstrate the concept of protected areas, Biodiversity hot spots, and conventions on biodiversity.
CO4	Analyze the International efforts in biodiversity conservation, deforestation, climate change and pollution.
CO5	Criticize the Global Environmental Problems.
CO6	Explain the Environmental Problems/Hazards in Hills

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO2	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	2	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOL309	L	T	P	C
Course Name : Lab Course I Based on MZOC301 & 302	0	0	4	4
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about endocrine glands and diversity of chordates group.
2. To understand the histology of endocrine glands.
3. To know about the biochemistry.

List of Practicals:

1. To identify different endocrine glands with the help of charts.
2. To study the histology of endocrine glands of animals with the help of slides.
3. To determine the concentration of glucose in the diabetic samples.
4. Isolation of hormones from different endocrine glands.
5. To study and classify specimens up to various phyla of chordates with the help of charts.
6. Museum specimens and slides:
7. Protochordates
8. Fishes
9. Amphibians
10. Reptiles
11. Birds
12. Mammals
13. To prepare the taxonomic key based on given characteristics.
14. To identify bones of the chordate.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the localization of different endocrine glands in the animals including humans.
CO2	Describe various diseases caused by the malfunctioning of different endocrine glands in human beings.
CO3	Illustrate the various permanent slides of different tissues/organs of the Chordates.
CO4	Classification/taxonomic study of various specimens/Bones of the Chordates.
CO5	Exercises/Case study based on animal behavior or /field Visits.
CO6	Construct and study of permanent slides of the different body parts of the animals.

Course code	**: MZOL310**	**L**	**T**	**P**	**C**
Course Name	**: Lab Course II Based on MZOE303 & 306**	**0**	**0**	**4**	4
Semester	**: IIIrd sem**				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about diversity of fish group.
2. To understand the histology of fish specimens.
3. To know about the parameters essential for the fish survival.

List of Practical's:

1. To study the specimens of fishes for classification and general studies.
2. To study the permanent slides of fishes for histological studies.
3. To study of feeding habits of fishes by gut content analysis.
4. Aquarium design and maintenance.
5. Estimation of ovarian egg counts.
6. Estimation of hydrological parameters- temperature, pH, conductivity, salinity, dissolved oxygen, COD of nursery, rearing, stocking and breeding points.
7. Demonstration of breeding pools and hatcheries.
8. Induced breeding of Indian major carps and catfishes.
9. Identification of eggs, spawn, fry, and fingerlings of cultivable fishes of India.
10. Visit to freshwater/marine fish farm.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identification, Collection, classification and preparation of a systematic record of freshwater Ichthyofauna.
CO2	Describe general study of the various specimens of Agnatha, Chondrichthyes, Osteichthyes, etc.
CO3	Demonstrate the different types of scales, Vertebrae, Girdles, Opercular bones, Pharyngeal bones, etc. in fishes.
CO4	Analyze the various permanent slides of different tissues/organs/ developmental stages, etc. in fishes.
CO5	Summarize accessory respiratory organs/ Weberian ossicle, Electric organs, etc.in fishes.
CO6	Explain the diversity and distribution, Behavioral aspects, and economic importance of freshwater Ichthyofauna thorough field trips/case study/experimental setup, etc.

Course code : MZOL310	L	T	P	C
Course Name : Lab Course II Based on MZOE 304& 307	0	0	4	4
Semester : IIIrdsem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about diversity of insect group.
2. To understand the histology of insect specimens.
3. To know about the parameters essential for the Insects survival

List of Practical's:

1. Collection, preservation and identification of insects.
2. To study the permanent slides of different parts of insects.
3. To identify the insects up to class.
4. Mounting and display of mouthparts of honey bee, butterfly and mosquito.
5. Wings and their venation. Different types of antennae and legs of insects.
6. Collection of various types of social insects.
7. Dissection of alimentary canal of honey bee, butterfly and grasshopper.
8. Filter chamber of Homopteran; salivary glands of mosquito and honeybee.
9. Circulation; haemocyte count.
10. Nervous system; dissection of butterfly, honey bee, and grasshopper.
11. Study of life history of arthropods, dipteran, anoplura, siphonoptera.
12. Field visit.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Collection, identification, classification and preservation of different class of insects.
CO2	Identification, classification, and general study of the various specimens of insects.
CO3	Compile different types of wings, legs, stings, mouthparts etc. in insects.
CO4	To examine various permanent slides of different organs and developmental stages, etc. in insects.
CO5	To evaluate the life history of various insects.
CO6	To assemble the diversity and distribution, behavioral aspects, and economic importance of insects through field trips/case study/experimental setup, etc.

Course code : MZOL310	L	T	P	C
Course Name : Lab Course II Based on MZOE 305 & 308	0	0	4	4
Semester : IIIrdsem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about ecological parameters.
2. To understand the conservation measures.
3. To know about the parameters of soil and water.

List of Practical's:

1. To determine the Density, distribution of the given sites.
2. To study the Important National parks, wildlife Sanctuaries, Biosphere reserves of India & Uttarakhand
3. To study the Aquatic biomes.
4. To study the different components of an Environment.
5. To study soil profile & different soil types of India.
6. To study the biological indicators.
7. To study the seismic zones of India
8. Preparation of an Inventory of IUCN categories of animal and plant species of any National park
9. To estimate the pH, temperature, and electrical conductivity in a given soil/water sample
10. To study the pollution and its types.

Course Outcomes (COs):
Upon successful completion of the course students will be able to:

CO1	Study about basics of environment.
CO2	Discuss the techniques importance in experimentation.
CO3	Illustrate the knowledge about the various environmental parameters.
CO4	Analyze the Biodiversity & pollution levels in various ecosystems
CO5	Summarize the various characteristics of soil and water (pH, temperature, and electrical conductivity)
CO6	Explain the diversity and distribution behavioral aspects and economic importance of environment through field trips/case study/ experimental setup etc..

Course code : MZOS311 (Self-study, any one)	L	T	P	C
Course Name : Aquatic Biodiversity	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about aquatic biodiversity of animals and its conservation.
2. To understand about endemic species.
3. To know the impact of different hydroelectric project.

Course Contents

Unit I

Biodiversity: Definition, Concept, Scope and measurement of biodiversity. Types of Biodiversity: Species, Genetic, Community, Ecosystem. Factors governing biodiversity: Historical & Proximate Endemic species: Definition, Concept, Scope, Hot spots

UNIT II

Types of aquatic ecosystem & biomes and their characteristics. Freshwater biodiversity. Marine biodiversity. Biodiversity databases of CMFRI, CIFRI, NBFGR.

UNIT III

Threats to habitats and biological diversity in Freshwater and marine ecosystems. Endangered species: Definition, Concept, Scope. Conservation; Definition, Concept, Scope. Physical and chemical characteristics of freshwater rivers, lakes, reservoirs and wetlands. Over view of freshwater biodiversity in important Rivers, Lakes Reservoirs and Wetlands of India with emphasis on Himalaya.

UNIT IV

Impact of Hydroelectric Projects (HEP) on aquatic biodiversity. Environmental Impact Assessment (EIA): Case studies. Environmental flows: Importance for the aquatic flora & fauna. Environmental flows assessment methodology: Hydrological, hydraulics rating, habitat simulation & holistic.

Reference Books:

1. KJ Gaston & JI Spicer: Biodiversity: An Introduction
2. WT Edmondson: Freshwater Biology
3. HBN Hynes: Freshwater Ecology
4. WK Dodds: Freshwater Ecology
5. Rivers for Life: Managing water for people and nature, Sandra Postel, Brain D. Richter.

Text Books:

1. VG Jhingran: Fish & Fisheries of India
2. EP Odum: Ecology

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify scope, concept of aquatic biodiversity and aquatic ecosystem and reservoirs.
CO2	Discuss Biodiversity definition, species concept, community & environmental projects.
CO3	Illustrate Biodiversity scope and endemic species, hydrological projects.
CO4	Analyze the type of ecosystem, biomes and their characteristics
CO5	Summarize the threats to habitats and biological diversity in Freshwater and marine ecosystems
CO6	Explain Impact of Hydroelectric Projects (HEP) on aquatic biodiversity, EIA, Environmental flaws.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	2	2	2	1	1	1	2	1	2	2	1	1	2
CO2	1	2	1	2	2	2	1	1	2	2	1	2	1	1	1	2
CO3	1	1	2	2	2	1	2	1	1	2	1	1	1	2	1	1
CO4	1	2	1	2	2	1	2	2	1	2	1	1	2	1	2	1
CO5	1	1	2	2	1	2	2	1	2	2	2	2	2	1	2	2
CO6	1	1	2	2	1	1	2	1	1	2	2	1	1	2	2	1

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOS312 (Self-study, any one)	L	T	P	C
Course Name : Economic Zoology & Parasitology	3	0	0	3
Semester : IIIrd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To know about apiculture, sericulture and lac culture.
2. To know about parasites and their causing diseases.
3. To understand the process of integrated pest management.

Course Contents

UNIT I

Economic Zoology

Elementary knowledge of sericulture, Life cycle of Silk worm, Apiculture, Life cycle of Honey bee, Honey bee culture and tool used in honey bee culture, lac culture.

UNIT II

Fish culture System in India, Major Fresh water Fishes, Poultry keeping.
Elementary knowledge of Animal Husbandry. Integrated Pest Management (IPM).

Parasitology

UNIT III

Parasitism and evolution of parasitism. Protozoan parasites: Biology, life cycle and diseases caused by selected pathogenic protozoans of man their preventive and control measures (*Entamoeba histolytica, Trypanosomes, Leishmania donovani, Trichomonas vaginalis, Giardia intestinalis & Plasmodium).*

UNIT IV

Parasitic adaptations in Platyhelminthes and Aschelminthes. Common trematode, cestode and nematode parasites. Biology, life history and preventive measures of economically important helminth parasites of man and domesticated animals (*Ascaris, Schistosoma, Fasciola, Wuchereria) Taenia*. Introduction to arthropods and vectors of human diseases (mosquitoes, lice, flies & ticks). Parasitism in Crustacea.

Reference Books:

1. A general text book of entomology, Imms, A.D., Champman & Hall, UK
2. 2. Sobti, R.C.: Medical Zoology. Sobhan Lal Nagin Chand & Co. Jallendhar.
3. Kotpal, Agrawal &Khetrapal: Modern Text-book of Zoology, Invertebrates. Rastogi, 1976.
4. Foundation of Parasitology, Roberts L.S. and Janovy j., McGraw-Hill Publishers, New York, USA.

Text Book

1. Shukla, G.S. & Upadhyay, V.B.: Economic Zoology. 4th Ed. 2005-06. Rastogi Publ., Meerut.
2. Modern Parasitology; A Text book of Parasitology, FEG Cox., Willey-Blackwell, U.K.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify culture techniques, animal husbandry, IPM, parasitic protozoans and helminthes
CO2	Describe the behaviour of fishes, insects and other parasitic protozoans and
CO3	Analyze about the sericulture and life cycle of silk worm, Apiculture and fish culture system in India
CO4	Illustrate poultry farming & IPM
CO5	Evaluate parasitism and evolution of parasitism, protozoan parasite.
CO6	Explain the knowledge about parasitic adaptation in Platyhelminthes and Aschelminthes

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO2	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO3	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO4	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2
CO5	3	3	2	3	2	2	1	1	2	3	3	3	2	2	3	2
CO6	2	2	2	2	2	2	1	1	2	3	2	2	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOS313 (Self-study, any one)	L	T	P	C
Course Name : IPR, Patenting and Bioethics	4	0	0	4
Semester : III				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To acquire sound knowledge of IPR, Patenting & Bioethics.
2. To study the structure, format and applications of bioethics. Social and ethical issues in Biology.
3. To comprehend concepts and issues of Intellectual property rights and assess the application of it in licensing of bio-product, marketing of biological inventions along with associated trade regulations.
4. To compare and contrast types of patents, treaties, amendments, drafting patent applications along with aspects of international patenting.
5. To study social and ethical issues in biology.

Course Contents

Unit 1

Unit 1

Introduction to Intellectual Property: Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs.

Unit 2

Agreements and Treaties: History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments.

Unit 3

Patents: Basics of Patents and Concept of Prior Art. Introduction to Patents: Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications:

Provisional and complete; Forms and fees Invention in context of "prior art"; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet (EPO), PATENTScope (WIPO), IPO, etc.).

Unit 4

Patent filing procedures: National & PCT filing procedure; Period and cost; Status of the patent applications filed; Precautions while patenting– disclosure/non-disclosure; Financial assistance for patenting- introduction to existing schemes. Patent licensing and agreement. Patent infringement-meaning, scope, litigation, case studies

Unit 5

Introduction to Bioethics. Social and ethical issues in Biology, causes of unethical acts, ignorance of laws, codes, policies, and Procedures, recognition, friendship, and personal gains.

Professional ethics - professional conduct, Ethical decision-making, ethical dilemmas, good laboratory practices, good manufacturing practices, laboratory accreditation.

Suggested Reading and Text Books

1. BARE ACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra Information Solution Pvt. Ltd., 2007.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the objectives, concept, applications and prospects of IPR, Patenting & Bioethics.
CO2	Describe ability to utilize IPR, Patenting & Bioethics.
CO3	Exhibit an understanding of the concept and types of intellectual property rights and implementation of IPR in protecting biological inventions.
CO4	Differentiate various aspects of drafting of the patent application, types and specifications of the patent application, and various treaties and amendments made with exposure to the concept of international patenting.
CO5	Summarize Social & ethical issues.
CO6	Explain new patent ideas, Industrial design and protection of GMOs.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO2	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	2	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC 401	L	T	P	C
Course Name : Ecology and wild Life	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Ecology and wildlife
2. To understand ecological principles.
3. To understand concepts of wildlife and different conservation measures

Course Contents

UNIT-I

Definition, Scope, Importance, Application. Limiting Factors: Liebig's law of the minimum, Shelford's law of tolerance.Combined concept of limiting factor, Factor interaction. Homeostasis. Biogeochemical cycle (nitrogen, phosphorus, carbon & water cycle). Ecosystem. Concept; Energy flow; Food chains & Ecological pyramids. Habitat Ecology: Concept of habitats & ecological niche**.**

UNIT- II

Population: Concept & attributes: Biotic potential, Density, Natality, Mortality; Intrinsic rate of natural increase, survivorship curves. Population growth forms; Carrying capacity; Population regulation (Density-dependent and independent). Community: Concept & characteristics: Density, Dominance, Diversity & Stratification. Succession of communities; Key stone species.

UNIT – III

Biodiversity: Endemism, Genetic, Species and ecosystems diversity; Factors influencing biodiversity. Economic valuation of biodiversity: Concepts & Importance. Environmental pollution (Air, water, solid waste, Radioactive); Environmental Impact Assessment. Cumulative Impact Assessment of hydropower development; Environmental flows: need, methodologies, DRIFT, BBM.

UNIT - IV

Techniques in wildlife: Identification by natural marking, pugmarks, calls, etc.

Marking passive marking (collars, tags, branding, rings etc.) and Dynamic marking (radio telemetry, satellite telemetry, radio isotopic tracers).

Population estimation techniques: Absolute versus relative density, total count versus estimates. Census methods (Drive count, aerial count, point count).

Indices (pug marks, droppings, nests, burrows, dens, calls).

UNIT - V

General introduction to Sanctuaries, National Parks and Biosphere Reserves of India, Endangered species: endangered fauna of Himalaya. Brief Account of Wildlife Acts and Their Amendments in India and World. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Tiger conservation: Tiger reserves in India; Management challenges in Tiger reserve.

Reference Books

1. Krebs: Ecology (4th ed.) Harper Collins College Publisher
2. Negi: An Introduction to Wildlife Management, 1983.
3. Majupuria T C: Wildlife Wealth of India Tecprress Service, Bangkok, 1986.
4. Saharia: Wildlife of India Nataraj Publishers, Dehradun.
5. Negi: Handbook of National Parks, Sanctuaries and Biosphere Reserves in India, 1995.
6. Negi: Himalayan Wildlife: Habitat and Conservation, 1992. Indus Publishing Company, New Delhi.
11. Sharma: High Altitude Wildlife of India Oxford & IBH Publishing Co. Pvt. Ltd.1994.

Text Books:

1. Odum: Fundamentals of ecology, Saunders Co. Publ., 1993 Indian ed.
2. Odum: Basic ecology, Saunders Co. Publ., 1993 Indian ed.
3. N Arumugham Ecology,Concepts of : environmental biology

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify ecological laws, Biogeochemical cycle, Ecosystem, Food chains and food web, Biosphere reserves, pollution, population, biodiversity and national park.
CO2	Discuss the concept of population, Community, and succession
CO3	Illustrate knowledge about biodiversity & its importance
CO4	Analyze economic valuation of biodiversity, environmental pollution, wild life conservation.
CO5	Justify the techniques in wildlife, Population estimation.
CO6	Explain knowledge about Sanctuaries, National Parks, and Biosphere Reserves

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO2	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	-	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	1	2	2	2	2	1	2	-	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOC 402	L	T	P	C
Course Name : Immunology & Biochemistry	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Immunology and Biochemistry
2. To understand Immunological principles and their role in Human Physiology.
3. To understand metabolism of Carbohydrate, Proteins, Fatty acids, etc.

Course Contents

UNIT-I

Enzymes: Classification, concept of E-S complex, Lock and Key Hypothesis, Induced –Fit Hypothesis, Michaelis- Menten equation and its derivation,

Carbohydrate Metabolism I: Pathway and regulation of Glycolysis, Gluconeogenesis, Glycogenolysis, Glycogenesis.

UNIT-II

Carbohydrate Metabolism II: Citric acid cycle and its regulation and pentose phosphate pathway and its regulation.

Urea cycle (conversion of ammonia into urea), linkage between urea cycle and citric acid cycle) and its regulation. Conversion of nitrogen to ammonia by microorganisms, overview of amino acid biosynthesis.

UNIT-III

Fatty Acid Metabolism: β Oxidation and its regulation, Fatty Acid Biosynthesis and Regulation. Nucleic Acid Metabolism: Purine biosynthesis and its regulation, pyrimidine biosynthesis and its regulation. Salvage pathway for purine & pyramid in nucleotides.

UNIT - IV

Overview of the Immune System. Cells and Organs of the Immune System. Antigens, Antigenicity versus Immunogenicity. Haptens & Epitopes Immunoglobulins: Structure and Function. Major Histocompatibility Complex. Antigen processing and presentation. Structure and functions of BCR & TCR.

UNIT-V

Cytokines. The Complement System. Cell mediated cytotoxicity: Mechanism of T cell & NK cell mediated lysis. Ab-dependent cell mediated cytotoxicity (ADCC) Overview of Hypersensitivity and Autoimmunity. Introduction to Transplantation. Vaccines: Active and Passive Immunization Introduction to Monoclonal Antibodies and Hybridoma technology. Antigen-Antibody Interactions: Precipitation Reaction, Agglutination Reactions, RIA, ELISA, Western Blotting, Immuno precipitation, Immuno-fluorescence.

Reference Books

1. Lehninger: Principles of Biochemistry, 4th ed., Nelson & Cox, WH Freeman and Company, 2007
2. Voet&Voet: Biochemistry, 2nd ed., Wiley & Sons.
3. Berg, Tymoczko, Stryer: Biochemistry, 5th ed., WH Freeman and Company, 2003.
4. Garett & Grisham: Biochemistry, 4th ed., Brooks/Cole Cengage learning, 2010.
5. Roitt, Male &Brostof : Immunology (3rd ed).
6. Deb A C:,Fundamentals of Biochemistry
7. Wilson & Walker: Practical Biochemistry (4th ed.).

Text Books :

1. Kuby : Immunology (6th ed.).
2. HR Singh and Neeraj Kumar: Animal physiology and Biochemistry: Vishal Publishing House.
3. SS Lal : Immunology : Rastogi Publication
4. Abbas Abdul K: Cellular and molecular immunology

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify basic Biochemical & Immunological theories
CO2	Describe the concept immunity, antibody, antigen, and synthesis of biomolecules
CO3	Analyze the biochemical & immunological concepts.
CO4	Classify the immune system, immunity, immunoglobulins, biomolecules and enzymes
CO5	Summarize and distinguish the immune system, types and biomolecules (metabolism)
CO6	Explain the immunological & biomolecular techniques

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO2	2	2	1	1	2	2	1	-	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	-	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE 403 (Elective-I Any One)	L	T	P	C
Course Name : Fisheries Science	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Fisheries Science and its aspects.
2. To learn various culture methods in fisheries
3. To understand Fish preservation, processing & economic aspects of fisheries.
4. To study recreational fishery and cooperative movements.

Course Contents

UNIT - I

Aquaculture: Scope, importance and present status. Role of fertilizers,

water quality and its maintenance.

Control of aquatic weeds, insects and predatory fishes.

UNIT – II

Fish nutrition: Development of natural food and supplementary feeding.

Fish Transportation and its types, Transport of fish seed.

Nutritive value of fish, biochemistry of fish flesh of Indian major carps.

UNIT – III

Harvesting and Post harvesting.

Fish preservation and processing techniques and marketing of fishes Fish by-products and their uses.

UNIT -IV

Capture and Ornamental Fishery: Rivers, Lakes, Dams / Reservoir fishery- Problems and perspectives in Capture fisheries. Estuarine fishery. Characteristics and species dynamics. Marine fishery: Coastal, Off shore and deep sea fishery.

Exclusive Economic Zone. (Hilsa, Oil sardine, mackerel, Bombay duck, Sole, Ribbon, Shark and Rays).

UNIT- V

Recreational fishery and Cooperative movements. Fish Farmers Development Agencies (FFDA). Climate change and fishery. Gov participation in Aquaculture.

Text Books

1.C.B.L. Srivastava: Fish Biology, Narendra Publication House, 2008.

2. SS Khanna & H.R. Singh: Fish & Fisheries

Reference Books

1. Dr. J. Ojha: Biology of Hill Stream Fish, Narendra Publication House, 2002.
2. Kyle: The Biology of Fishes, 2007.
3. H.R. Singh: Advances in Fish Biology, Hindustan Publishing Corp., 1994.
4. J.D. Munshi& J.S.D. Munsi: Fundamental of Freshwater Biology, Narendra Publ. House,1995.
5. Carlander: Handbook of Freshwater Fishery Biology, vol. 2, Iowa State Univ. Press,1977.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify aquaculture, its scope, importance, and various culture systems including fish culture in ponds, reservoirs, rice fields, bheries, cages, pens, monoculture, and polyculture.
CO2	Describe the preparation and maintenance procedures of a fish farm.
CO3	Apply the principles of induced breeding and explain its uses, including implications for fish biodiversity.
CO4	Analyze different aquaculture practices, including recreational fisheries and cooperative movements.
CO5	Summarize the characteristics of various fisheries such as Mahseer, Schizothorax, capture fisheries, and ornamental fisheries.
CO6	Explain fish preservation and processing techniques, and describe the nutritive value of fish

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	1	2	1	2	2
CO2	2	2	1	1	2	2	1	-	2	1	2	2	2	1	2	2
CO3	2	2	1	1	-	2	1	2	2	1	1	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	-	2	2	2	2	1	2	-	1	1	2
CO6	2	2	1	1	-	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE 404 (Elective-I, Any One)	L	T	P	C
Course Name : Applied Entomology	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Applied Entomology
2. To know various insects of household, vegetable, store grain and fruit pests
3. To understand IPM

Course Contents

UNIT - I

Insects in relation to man: sericulture, apiculture and lac culture and its parasites, predators and diseases. Insect of veterinary importance; sand fly, horse fly, sucking louse, fleas.

UNIT - II

Brief knowledge of important household, vegetable, store grain and fruit pests with special reference to distribution, habits, habitat, nature of damage, life history and control.

UNIT-III

Cut worm (*Agrotis ipsilon)* Cabbage cateripillar (*Pieris brassicae*) Rice weevil (*Sitophilus oryzae*) Mustard aphid (*Lipaphis erysimi*) Red cotton bug (*Dysdercus cingulatus*) Woolly apply aphid (*Eriosoma lanigerum*) Termite: important termites of Fam. *Termatidae (Odontotermis sp.)*

UNIT IV

Origin of pests, Insect pest control; mechanical, physical, culture, biological. Chemical control: chemosteril ants, radiation.

UNIT V

Integrated Pest Management (IPM), Role of pheromones and hormones in insect pest management. Legislative control of insect pests and quarantine law. Nomenclature and classification of insecticides on the basis of mode of action, chemical nature. Environmental factors influencing effectiveness of insecticides, persistence, biodegradability, hazards of insecticides, precaution and antidotes.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the role of insects in relation to humans, with reference to sericulture, apiculture, and lac culture
CO2	Describe the major household pests (vegetable, stored grain, fruit pests) with reference to their distribution, habits, habitat, nature of damage, life cycle, and control methods.
CO3	Apply various Integrated Pest Management (IPM) techniques in pest control scenarios
CO4	Analyze the origin of insect pests and differentiate among various pest control and culture techniques
CO5	Evaluate the effectiveness of Integrated Pest Management (IPM) strategies, including the role of pheromones and hormones in insect pest control
CO6	Design strategies to optimize insecticide effectiveness based on environmental factors

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	1	2	1	2	2
CO2	2	2	1	1	2	2	1	2	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	1	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE 405 (Elective-I, Any One)	L	T	P	C
Course Name : Applied Environmental Biology	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Applied Environmental Biology
2. To understand tests its importance and effects of various environmental parameters
3. To understand EIA, IPM and Biological Pests control

Course Contents

UNIT - I

Air: Air pollutants (chemistry, sources & control); Air Quality standards, carbon credits, carbon footprint, Thermal pollution sources and effect. Water: Biochemical aspects of water pollutants (domestic, industrial & agricultural waste). Waste water treatment (Aerobic & anaerobic treatment processes); Water quality standards. Case study-Ganga Action Plan. Noise Pollution: Effects of noise and its control.

UNIT - II

Radioactive fallouts its effects & safe disposal. Solid waste management: Sources & control methods (composting, Vermi Culture, Biogas). Hazardous waste & their management. Bioremediation (herbicides, pesticides, hydrocarbons, oil spills). Ecological Restoration: wasteland & its reclamation & restoration.

UNIT - III

Environmental Impact Assessment (EIA): Case study of River valley projects & Mining. Bioassay: Dose-response relationships; Frequency; Response & cumulative response; statistical concepts (LD50-potency v/s Toxicity). Concept of hyper & hypo sensitivity factors affecting Toxicity.

UNIT- IV

Ecological experimentation & models: Theories & hypothesis; experimentation; Inductive & deductive methods.

UNIT-V

Models: Analytical & simulation models; Validation & verification. Biological pest control: Use of predators; Parasites, parasitoids & pathogens, Integrated Pest Management.

Reference books :

1. **Applied Ecology & Environmental Management** (2nd Edition), Edward I. Newman.
2. **Environmental Biology** — *P. C. Das* (2020)
3. **Environmental Biology and Toxicology** — *P. D. Sharma* (2005)

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the major air pollutants and recall the biochemical aspects of water pollution, wastewater treatment processes, and water quality standards
CO2	Explain the causes and effects of radioactive fallout and describe methods for its safe disposal.
CO3	Apply Environmental Impact Assessment (EIA) and Integrated Pest Management (IPM) techniques in environmental decision-making.
CO4	Analyze ecological experiments and models to understand environmental interactions and processes
CO5	Evaluate the effectiveness of analytical and simulation models in predicting environmental outcomes
CO6	Design techniques and propose parameters to assess and mitigate environmental hazards

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	2	2	1	2	2	1	2	1	2	1	2	2
CO2	2	2	1	1	2	2	1	1	2	1	2	2	2	1	2	2
CO3	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2	2
CO4	1	2	2	2	1	2	2	1	1	2	1	1	2	2	2	1
CO5	2	1	2	2	1	1	2	2	2	2	1	2	2	1	1	2
CO6	2	2	1	1	2	2	2	1	1	2	1	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE 406 (Elective-II, Any One)	L	T	P	C
Course Name : Research Methodology in fishery science	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about research methodology in fisheries science.

2. To estimate water quality parameters for the survival of fishes

3. To understand Morphometric & meristic analysis of important hill stream carps and catfishes

Course Contents

UNIT I

Research and scientific methods, Criteria of good research, Compilation of research paper, Presentation of the research paper, Preparation of research proposal, Compiling bibliography, Samplings

UNIT II

Water Chemistry and substrate conditions: Dissolved Oxygen, Free Carbon di oxide, Total alkalinity, Total hardness, pH, BOD, Chlorides, SO4- S, PO4-P and NO3-N and rated in instrumentation (probes, meters) Qualitative and quantitative estimation of plankton & periphyton. Fish sampling and preservation. Morphometric & meristic analysis of important hill stream carps and catfishes. Stream order wise study of distribution and diversity of fish fauna from Garhwal Himalaya (Bahuguna method).Truss analysis. Use of Keys and Monographs for fish identification.

UNIT III

Importance of statistics in biological research. Calculation of mean, median and mode, range, variance, standard deviation. Students-t test. Chi-square and F–test of significance, Analysis of variance (ANOVA), Introduction to statistical software's.

UNIT IV

Calculation and importance of Shannon Wiener Diversity Index, species richness and Margalef diversity index. Dobriyal Bahuguna drifting index (DBDI). Regression analysis and coefficient of correlation. Cluster analysis, Factor analysis and Discriminate analysis.

Reference books :

1. Practical Manual of Fisheries, Author: K. P. Biswas (2018)

2. *S. Felix & J. Rujan, 2025Fisheries Statistical Methods: Theory and Practical Manual,*

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify Research and scientific methods, fish sampling & preservation, diversity of fish fauna, statistical method & analytical methods
CO2	Discuss Water Chemistry and substrate conditions
CO3	Applying Importance of statistics in biological research & in fisheries.
CO4	Analyze Calculation and importance of Shannon Wiener Diversity Index & other statistical methods
CO5	Evaluate Cluster analysis, Factor analysis, Discriminate analysis. Calculation and importance of Shannon Wiener Diversity Index.
CO6	Create new technological techniques in biological research.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	2	1	2	1	2	2	2	1	2	2	1
CO2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	1	2
CO3	1	2	2	1	2	1	2	2	1	2	1	1	2	1	2	2
CO4	1	3	1	2	2	1	2	2	2	2	1	1	2	2	1	1
CO5	2	1	2	2	2	2	1	1	2	2	1	2	1	2	1	2
CO6	2	2	1	1	1	-	2	1	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOE 407 (Elective-II, Any One)	L	T	P	C
Course Name : Research Methodology in Entomology	3	0	0	3
Semester/Year : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Research Methods in Entomology.
2. To understand Entomological techniques.
3. To understand Application of Statistics in Entomology.

Course Contents

UNIT I

Introductory Entomology Research methodology in entomology in introduction. Role of entomology in agriculture (Beneficial and Harmful insects). Medical entomology: Disease vectors (Mosquito, Sand fly, tsetse fly, pathogens, lifecycle and diseases). Veterinary entomology: Vector insect (Ticks, Mites, Flies, pathogens, lifecycle and diseases). Forensic. Entomology: Principle, Forensic entomological flies, use of human lice in forensic entomology, Importance.

UNIT II

Entomological techniques –I Type of sampling survey, Different Collection Methods, Collection of wild flies and Domestic insects. Collecting Insect in the wild area-Tools and Equipment's, Preparing and using baits, collecting from natural substances, Collection permission from govt. agency like forest department State Biodiversity Board (SBB), National Biodiversity Authority (NAB), Transporting live adults or larvae. Preservation of insects, classification of insects up to the level of families with hands-on experience in identifying the families of insects and Catalogues.

Insect Laboratory and rearing equipment, Experimental designs in field and Laboratory Observation techniques and Molecular techniques in insect taxonomy. Mortality correction, Bioassay: Principles, Importance, Factor affecting, Procedures apparatus used.

UNIT III

Entomological Techniques –II Trophic relationships. Use of ecological data, insect diversity: Indices, richness, rarity. Population estimates. Coexistence and Competition. Distribution patterns. Study of terrestrial/aquatic insect biodiversity, physic-chemical parameters of water (turbidity/transparency, velocity, pH, temperature, estimation of CO_2, O_2 hardness).

UNIT IV

Application of Statistics Descriptive statistics, Chi-Square test, Student t-test. Analysis of variance.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify research methodologies in entomology and recognize the role of entomology in agriculture.
CO2	Describe entomological techniques, sampling survey types, collection methods for wild and domestic insects, and the use of laboratory and rearing equipment
CO3	Apply entomological techniques and ecological data to study trophic relationships, insect diversity, species richness, population estimates, coexistence, and competition.
CO4	Analyze the application of statistical methods in entomology and evaluate the role of entomology across various fields and in understanding insect diversity.
CO5	Evaluate the effectiveness of entomological and statistical techniques in insect research
CO6	Create innovative techniques for population estimation and develop new statistical methods in entomological research.

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	2	1	2	1	2	2	2	1	-	2	1
CO2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	1	2
CO3	1	2	2	1	2	1	2	2	1	2	1	1	2	1	2	2
CO4	1	3	1	2	2	1	2	2	2	2	1	1	2	2	1	1
CO5	2	1	2	2	2	1	1	1	2	2	1	2	1	2	-	2
CO6	2	2	1	1	1	2	2	1	1	2	2	2	1	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

	L	T	P	C
Course code : MZOE 408 (Elective-II, Any One)				
Course Name : Research Methodology in Environmental Biology	3	**0**	**0**	**3**
Semester/Year : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are

1. To know about Research methods in Environmental Biology
2. To understand measurement of environmental parameters.
3. To understand Parametric and Nonparametric Tests.

Course Contents

UNIT - I

Importance and need of environmental research. Problem identification, objectives, significance, scope and limitations. Literature survey. Importance and designing of the problem to be undertaken. Field survey: Site selection, source selection for data acquisition. Sampling strategies, Sample size, Frequency, Bias, Error. Project Report Preparation.

UNIT - II

Measurement of solar radiation, wind velocity, air quality-monitoring, measurement of oxides of nitrogen, carbon, sulphur, lead, tropospheric ozone, methane, aerosol, pesticide. Stack sampling, sample collection for particulate matters (Dustfall collection, High volume sampler), indoor air pollutants (radon) measurement.

UNIT -III

Water quality analysis: Measurement of water temperature, velocity, depth, transparency, dissolved oxygen, free carbon dioxide, pH, turbidity, hardness, alkalinity, BOD, COD, dissolved nutrients (Nitrates, phosphates, sodium, potassium, chloride, etc.), heavy metals. Sampling methods for terrestrial flora and fauna (quadrate method).

UNIT - IV

Sampling methods for aquatic fauna and flora (plankton, periphyton, micro and macroinvertebrates, nekton, etc.). Soil types, measurement of soil pH, water holding capacity, organic matter, soil nutrients (nitrate, nitrite, calcium and magnesium), Sampling of soil fauna. Sampling of soil for microbial diversity. Application of statistical Descriptive and regression analysis in Environmental Science: Parametric and Nonparametric Tests, Hypothesis testing, t-test, Z-test, F-test, multivariate test chi square test, Kruskal Wallis test. Statistical Software's: Excel, Statistical, SPSS, etc.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Explain the importance of environmental research and the process of problem identification, objective formulation, and field survey planning including sampling strategies and data acquisition
CO2	Design a project proposal with defined objectives, scope, sampling methodology, and report structure for environmental research
CO3	Apply field techniques for monitoring air quality parameters including solar radiation, wind velocity, atmospheric gases, particulate matter, and indoor air pollutants.
CO4	Apply standard procedures for analyzing water quality and sampling terrestrial flora and fauna using relevant physical, chemical, and biological indicators.
CO5	Analyze the diversity and abundance of aquatic and soil organisms using ecological and chemical sampling techniques.
CO6	Evaluate environmental data using statistical methods including parametric and non-parametric tests, and statistical software tools like Excel and SPSS

CO-PO Mapping

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	2	1	2	1	2	1	2	2	2	1	2	2	1
CO2	1	2	1	2	2	1	2	2	2	2	2	2	2	2	1	2
CO3	1	2	2	1	2	1	2	2	1	2	1	1	2	1	2	2
CO4	1	3	1	2	2	1	2	2	2	2	1	1	2	2	1	1
CO5	2	1	2	2	2	2	1	1	2	2	1	2	1	2	1	2
CO6	2	2	1	1	1	2	2	1	1	2	2	1	2	2	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code : MZOL 409	L	T	P	C
Course Name : Lab course I based on MZOC 401 & MZOC 402	3	0	0	3
Semester : IVth Sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are:

1. To know about different laws of Ecology.
2. To understand Identification of biomolecules.
3. To know about the immunology and its principles

List of Practical's:

1. To study different laws of Ecology (law of the minimum, Shelford's law of tolerance)
2. To study the different ecosystems and differentiation of various ecosystem biota.
3. To study pond ecosystem and thermal stratification in water body.
4. To study the biogeochemical cycle and different food chains and their trophic levels.
5. To study community, species and its types.
6. To study the population ecology, Natality mortality and different curves.
7. Study of Biodiversity, pollution type, National parks, biosphere reserve etc.
8. Identification of biomolecules, (Carbohydrate, protein, lipids):
9. To study hypothesis in Enzymes functioning.
10. Immunity and its types.
11. To study physical, biochemical factors in immunity.
12. Lymphoid organs, (Primary and secondary lymphoid organs)
13. Antigen Antibody structure and its type
14. Antigen-antibody interaction and different reaction types in it.
15. To study western blotting technique.
16. To study vaccines and its types

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify and observe the ecosystems ecology biodiversity biomolecules and immune system.
CO2	Describe the ecosystem and immunological aspects
CO3	Illustrate the ecosystem and its trophic levels, biomolecules & immunoglobulins, antigen, antibody presence
CO4	Distinguish food chain food web, lymphoid organs etc
CO5	Summarize Biomolecular, immunological and bio stat tests in ecology
CO6	Recognize the presence of ecological biodiversity, and tests of antigen antibodies, biomolecules and blotting techniques

Course code : MZOL410	L	T	P	C
Course Name : Lab Course II Based on MZOE 403 & 406	3	0	0	3
Semester : IV rd sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are:

1. To know about Water chemistry.
2. To understand biostatistics and its application in fishery science.
3. To know about Shannon Wiener Diversity Index.

List of Practical's:

1. To examine the water quality parameters of different water bodies and their analysis.
2. Aquatic weeds and their types
3. Fish feed formulation calculation
4. To study fish transportation models.
5. To study fish byproducts.
6. To study fishery and their types
7. To study the water chemistry
8. To study Quantitative and Qualitative estimation of planktons.
9. To apply biostatistics in fishery science.
10. Application of Dobriyal Bahuguna drifting index (DBDI)
11. Application of different diversity indexes including Shannon Wiener Diversity Index

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify the ichthyology, fisheries, and research methodology terms
CO2	Describe the application of basics of ichthyology, fisheries, and research methodology in experiments
CO3	Illustrate the techniques for the fresh water ecology examination
CO4	Analyze the various techniques and their effects for fresh water ecology and animals.
CO5	Evaluate the fish experimentation techniques and their importance
CO6	Write about diversity and distribution behavioral aspects and economic importance of fishes through field trips/case study experimental setup etc.

Course code : MZOL410	L	T	P	C
Course Name : Lab Course II Based on MZOE 404 & 407	3	0	0	3
Semester : IV rd sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are:

1. To know about important insects to man.
2. To understand collection methods of insects pest.
3. To know about application of biostatistics in entomology.

List of Practicals:

1. To study important insects to man (sericulture, apiculture and lac culture)
2. To study important insects in veterinary science sand fly, horse fly, sucking louse, fleas
3. To study important household, vegetable, store grain and fruit pests
4. To study Cut worm (*Agrotis ipsilon)* Cabbage cateripillar (*Pieris brassicae*) Rice weevil (*Sitophilus oryzae*) Mustard aphid (*Lipaphis erysimi*) Red cotton bug (*Dysdercus cingulatus*) Woolly apply aphid (*Eriosoma lanigerum*)
5. To study various termites
6. To study mechanical physical and chemical control of insects.
7. To study Environmental factors influencing effectiveness of insecticides, persistence, biodegradability, hazards ofinsecticides, precaution and antidotes.
8. To study medical entomology (Mosquito, Sand fly, tsetse fly, pathogens, lifecycle and diseases Ticks, Mites, Flies, pathogens, lifecycle and diseases)
9. To study collection methods of insects pest etc.
10. To study the apparatus used in entomology
11. To study physio chemical parameters of water in relation to insects.
12. To study application of biostatistics in entomology

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify classification and preservation of different economically important insects.
CO2	Describe classification and general study of the various specimens of insects
CO3	Illustrate the different type of pest harmful for crops and stored grains.
CO4	Summarize preparation and study of the various permanent slides of insects
CO5	Evaluate the insect's techniques and their importance
CO6	Create and develop the diversity and distribution behavioral aspects and economic importance of insects through field trips/case/ study experimental setup etc.

Course code : MZOL410	L	T	P	C
Course Name : Lab Course I Based on MZOE 405 & 408	3	0	0	3
Semester : IV rd sem				

L - Lecture T – Tutorial P – Practical C – Credit

COURSE OBJECTIVES: The objectives of this course are:

1. To study water quality parameters.
2. To study sampling methods for aquatic fauna and flora.
3. To know about application of biostatistics in environmental biology.

List of Practical's:

1. To study air pollution pollutants of area.
2. To study air quality standard.
3. To study water quality parameters (water temperature, velocity, depth, transparency, dissolved oxygen, free carbon dioxide, pH, turbidity, hardness, alkalinity, BOD, COD, dissolved nutrients Nitrates, phosphates, sodium, potassium, chloride, etc.)
4. To study Ecological experimentation & models
5. To study biological pests.
6. To study measurement of oxidesof nitrogen, carbon, Sulphur, lead, tropospheric ozone, methane, aerosol, pesticide.
7. To study sampling methods for aquatic fauna and flora (plankton, periphyton, micro and macroinvertebrates, nekton, etc.)
8. To study application of biostatistics in environmental biology.
9. To study soil quality and its analysis.

Course Outcomes (COs):

Upon successful completion of the course students will be able to:

CO1	Identify about basics of environment.
CO2	Describe the techniques importance in experimentation.
CO3	Illustrate the knowledge about the various environmental parameters.
CO4	Analyze the pollution levels in various ecosystems.
CO5	Evaluate the various parameters.
CO6	Create and develop the diversity and distribution behavioral aspects and economic importance of environment through field trips/case study/ experimental setup etc..

Course code : MZOE411	L	T	P	C
Course Name : Dissertation	0	0	9	9
Semester : IV rd sem				

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are
1. The main objective of this course to develop awareness and interest towards research.
2. The main objective of this course to development of scientific temperament.

Course Content:

The area of dissertation shall be assigned to the students at the end of second semester based on the expertise available in the Department. The project-oriented dissertation must be submitted by the end of fourth semester. During the course of completion of dissertation work the students will be required to complete various assignments given to them by their respective supervisors or the Head of Department for the purpose of their evaluation.
Beside classroom seminars, the students will have to present their dissertation work in the form of seminar before the board of examiners including the supervisors which will be followed by viva voce examination

Course Outcomes (COs):
Upon successful completion of the course students will be able to:

CO1	Explain the research problem in zoology, including its significance, scope, and literature background.
CO2	Apply appropriate research methodologies, experimental designs, and data collection techniques relevant to zoological studies
CO3	Analyze collected data using suitable statistical and analytical tools to derive meaningful conclusions
CO4	Critically evaluate research findings in the context of existing zoological knowledge and scientific literature
CO5	Develop a well-structured dissertation report, demonstrating originality, scientific rigor, and adherence to ethical standards.
CO6	Present research outcomes effectively through oral presentations and scientific writing

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