

Chaudhary Bansi Lal University, Bhiwani

(A State University established under Haryana Act No. 25 of 2014)

Department of Zoology

Syllabus and Examination Scheme

For

M.Sc. Zoology

In accordance with NEP-2020

w.e.f. 2025-2026



PG BOS & R on 20.05.2026
Faculty of Life sciences on 03.06.2026
(2025-26)

Vijay Kumar
20/05/2026

Approved
May 20th, 2026
L-2
20/5/26

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Chaudhary Bansi Lal University, Bhiwani
(A State University established under Haryana Act No. 25 of 2014)

Evaluation Scheme

of

M.Sc. Zoology

Summary

Programme	: M.Sc. in Zoology
Duration	: Two year (Four Semesters)
Maximum Durations	: Four Years
Minimum Attendance Required	: 75%
Total Credits	: 100
Total Marks	: 2100 (Option I in IV th Sem.) : 2200 (Option II in IV th Sem.)

Medium of Instructions and Examinations: English

Assessment/Evaluation of
Theory examination:

Internal Marks	Major Test (End Semester Exam) Marks	Total Marks
30	70	100
15	35	50

Internal Evaluation:

Minor Test Marks	Attendance Marks	Assignment/ Quiz Marks	Total Marks
15	05	10	30
07	04	04	15

Duration of Examination:

Minor Test (Internal)	Major Test
1 hour for 15 Marks and 30 minutes for 7 marks	3 hours for 70 marks and 2 hours for 35 marks

Passing Criteria: The pass percentage will be 40 percent (Grade 'P'), both for theory and practical and end term examinations. A student has to obtain minimum 40% marks (Grade 'P') in aggregate (Sum of internal assessment and end term examination marks) and in the end term examinations separately to qualify a course.

The IKS is 5% in the syllabus of Zoology including Assignments.

For other details: See Ordinance for PG Programme at CBLU Website

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CREDITS: 24

SEMESTER-I

Sr. No.	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	Total
1	25ZOO101	Diversity of Invertebrates	CC-1	04	-	04	04	-	04	70	30	-	100
2	25ZOO102	Fundamentals of Biochemistry	DEC-1	04	-	04	04	-	04	70	30	-	100
	25ZOO107	Vermiculture & Apiculture	DEC-2	04	-	04	04	-	04	70	30	-	100
3	25ZOO103	Animal Cell Biology	CC-2	04	-	04	04	-	04	70	30	-	100
4	25ZOO104	Advance Physiology	CC-3	04	-	04	04	-	04	70	30	-	100
5	25ZOO105	Lab course I	PC-1	-	08	08	-	04	04	-	-	50	50
6	25ZOO106	Lab course II	PC-2	-	08	08	-	04	04	-	-	50	50
	TOTAL			16	16	32	16	08	24	280	120	100	500

CC=Core Course PC= Practical Course DEC: Discipline Elective Courses

#The Discipline Elective Course (DEC) paper can be offered depending upon the availability of the resources and faculties. Students may Select one out of given two DEC

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SEMESTER-II

CREDITS:26

MARKS: 550

Sr. No	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	Total
1	25ZOO201	Diversity of Vertebrates	CC-4	04	-	04	04	-	04	70	30	-	100
2	25ZOO202	Molecular Biology	CC-5	04	-	04	04	-	04	70	30	-	100
3	25ZOO203	Parasitology	CC-6	04	-	04	04	-	04	70	30	-	100
4	25ZOO204 OR 25ZOO205	Biosystematics and Biosafety OR Genomics and Proteomics	D.E.C.-3 OR D.E.C.-4	04	-	04	04	-	04	70	30	-	100
5	25ZOO206	Lab course I	PC-3	-	08	08	-	04	04	-	-	50	50
6	25ZOO207	Lab course II	PC-4	-	08	08	-	04	04	-	-	50	50
7	25ZOO208	Environmental studies and Sustainable development	VAC/IKS (Opt any one)	02	-	02	02	-	02	-	50	-	50
8	25ZOO209	Indian Knowledge Systems in Biology											
	TOTAL			18	16	34	18	8	26	315	135	100	550

CC =Core Course VAC =Value Added Course IKS= Indian Knowledge System DEC = Discipline Elective Courses PC= Practical Course

*The Discipline Elective Course (DEC) paper can be offered depending upon the availability of the resources and faculties. Students may Select one out of given two DEC

MOOC courses might also be adopted after discussion with the MOOC coordinator of the department.

SEMESTER-III

CREDITS: 26

Sr. No	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	Total
1	25ZOO0301	Molecular Endocrinology and Neural Physiology	CC-7	04	-	04	04	-	04	70	30	-	100
2	25ZOO0302	Genetic and Cytogenetics	CC-8	04	-	04	04	-	04	70	30	-	100
3	25ZOO0303	Developmental Biology	CC-9	04	-	04	04	-	04	70	30	-	100
4	25ZOO0304/ 25ZOO0305/ 25ZOO0309	Discipline Elective Course # OR A MOOC course from Swayam Portal of Equal Credits	D.E.C-5 OR D.E.C.-6 OR D.E.C-7	04	-	04	04	-	04	70	30	-	100
5	25ZOO0306	Lab course I	PC-5	-	08	08	-	04	04	-	-	50	50
6	25ZOO0307	Lab course II	PC-6	-	08	08	-	04	04	-	-	50	50
7	25ZOO0308	Entrepreneurship in Statistical Biology	EEC	02		02	35		02		15		50
TOTAL				18	16	34	16	08	26	315	135	100	550

CC=Core Course

DEC= Discipline Elective Course

PC= Practical Course

EEC= Employability Enhancement Course

#The Discipline Elective Course (DEC) paper can be offered depending upon the availability of the resources and faculties. Students may Select one out of three below given DEC

List of Discipline Elective Courses:

- a) 25ZOO0304 Bioinformatics
b) 25ZOO0305 Environmental Biology and Toxicology
c) 25ZOO0309 IPR and GLP

SEMESTER-IV (Option-I)

CREDITS: 24

MARKS: 500

Sr.No	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			Total
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	
1	25ZOO0401	Molecular Immunology	CC-10	04	-	04	04	-	04	70	30	-	100
2	25ZOO0402	Ecology and Evolution	CC-11	04	-	04	04	-	04	70	30	-	100
3	25ZOO0403	Genetic Engineering	CC-12	04	-	04	04	-	04	70	30	-	100
4	25ZOO0404/ 25ZOO0405/ 25ZOO0406	Discipline Elective Course#	D.E.C.-8 OR D.E.C.-9 OR D.E.C.-10	04	-	04	04	-	04	70	30	-	100
5	25ZOO0407	Lab course I	PC-7	-	08	08	-	04	04	-	-	50	50
6	25ZOO0408	Lab course II	PC-8	-	08	08	-	04	04	-	-	50	50
	TOTAL		-	16	16	32	16	8	24	280	120	100	500

CC=Core Course

DEC=Discipline Elective Course

PC= Practical Course

#The Discipline Elective Course (DEC) paper can be offered depending upon the availability of the resources and faculties. Student may select one out of three below given DEC

List of Discipline Specific Elective Courses:

(a) 25ZOO0404 Aquaculture

(b) 25ZOO0405 Insect Morphology and Physiology

(c) 25ZOO0406 Animal Behavior and Wild Life Conservation

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MARKS: 600

Sr.No	Paper Code	Subjects	Type of Course	Contact hours per week			Credits			Examination Scheme			Total
				Theory	Practical	Total	Theory	Practical	Total	Theory	Internal Assessments	Practical	
1	25ZOO401	Molecular Immunology	DEC 11	04	-	04	04	-	04	70	30	-	100
2	25ZOO402	Ecology and Evolution	DEC 12	04	-	04	04	-	04	70	30	-	100
3	25ZOO403	Genetic Engineering	DEC 13	04	-	04	04	-	04	70	30	-	100
4	25ZOO404	Aquaculture	DEC 8	04	-	04	04	-	04	70	30	-	100
5	25ZOO405	Insect Morphology and Physiology	DEC 9	04	-	04	04	-	04	70	30	-	100
6.	25ZOO406	Animal Behaviors and Wild Life Conservation	DEC 10	04	-	04	04	-	04	70	30	-	100
7	25ZOO410	Dissertation/ Internship		-	-	-		12	12		100	200	300
	TOTAL		-	12	00	12	12	12	24	210	190	200	600

#The Core course of semester fourth (option I) will be treated as Discipline Elective Course (DEC) in semester fourth (option II). The students will opt 3 DEC out of six DEC in semester IV (Option –II)

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Programme Learning Outcomes (PLOs) of the M.Sc. Zoology, Department of Zoology, CBLU

- PLO1 Students will have knowledge and skills and in-depth acquaintance of animal species, their life biology, evolution, interaction with the environment at organismal, cellular and molecular level
- PLO2 Students will understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Reproductive health, Animal Behavior, Cancer Biology, Micro biome and their roles in health and diseases, Bioremediation of pollutants and pesticides.
- PLO3 Students will be trained to identify, review, and analyze complex situations of living forms and develop commitment to professional ethics, responsibilities and norms of the work practice related to biological systems.
- PLO4 Students will be made capable of applying knowledge-based methods with development of problem-solving expertise and robust communication skills.
- PLO5 This Programme will develop personnel who can function effectively as an individual or leader in diverse teams, and in multidisciplinary settings with deep understanding of Zoology.
- PLO6 This Programme will develop students with excellence in Zoology for career in teaching, research, industry, entrepreneurship etc.
- PLO7 Students will develop a strong understanding of Biodiversity Conservation, Ecosystem functioning, Environmental Sustainability, Wild life protection and climate change and Molecular understanding of all subjects.

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M.Sc. Zoology
Semester I
25ZOO101 Diversity of Invertebrates

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. Make students to understand how life evolved from simple to complex organization by division of labor & enhancing efficiency in Invertebrates.
2. In depth knowledge of minor phyla and their organization and relationship with other invertebrate phyla

Outcomes:

- CO1 The study of invertebrates reveal progressive evolutionary history and adaptations together which forms the basis of huge complex and diverse life forms.
- CO2 Students will acquire a clear understanding about organization of minor phyla and their relationship with other animal phyla.
- CO3 Students will be able to know the structure and significance of various systems of Invertebrates.
- CO4 Students will have detailed understanding of adaptations and significance of invertebrates.

Note: There shall be nine questions in all. Question no.1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Introduction to invertebrates with their general characters and classification up to Order Level: Introduction to minor Phyla with their general characters and affinities of Rotifera, Endoprocta, Ectoprocta, Sipunculida and Echiuroidea, Organization and general characters of Acoelomate, Pseudocoelomates and Coelomates, Protostomia and Deuterostomia

Unit-II

Locomotion in Protozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata, Filter-feeding in Polychaeta, Mollusca and Echinodermata, Organs of respiration: Gills, book gills, lungs, tracheal system, book lungs, and trachea, Respiratory pigments, Mechanism of respiration.

Unit-III

Organs of excretion: Coelomoducts, Protonephridia, Renette cells, Nephridia, Green Glands, Coxal Glands and Malpighian tubules, Mechanism of excretion and Osmoregulation, Nervous system: Trends in neural evolution, Mode of reproduction from Protozoa to Helminthes

Unit-IV

Larval forms of Coelentrata, Helminthes, Annelida, Mollusca and Echinodermata, significance of larval forms, Metamorphosis of insects and its Hormonal control, Torsion and Detorsion in Mollusca, Ambulacral system

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Suggested Reading:**Text Books:**

1. Hyman, L.H. Invertebrates Zoology, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London

Reference Books:

1. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
2. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
3. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saunders Co., Philadelphia.
4. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
5. Sedgwick, A.A. Student text book of Zoology. Vol. I, II and III Central Book Depot, Allahabad

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	×	√	√	√	√	√
CO2	√	√	√	×	√	√	√
CO3	√	×	√	√	√	√	√
CO4	√	√	√	×	√	√	√

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M.Sc. Zoology
Semester I
25ZOO102- Fundamentals of Biochemistry

Maximum Marks: 100
Time: 3 hrs

Theory Examination: 70
Internal Assessment: 30

Objective: To develop understanding of chemistry used in biological processes and to perform wide range of analytical techniques to explore biological activities.

Outcomes:

- CO1 It will provide the students a basic appreciation of the underlying principles and practical strategy of the analytical and preparative techniques that are fundamental to study and understanding of life processes.
- CO2 It will make the students to understand the general reactions of various metabolic pathways.
- CO3 Students will be able to explain the principle, working, materials used and applications of various biological techniques that are used to study the basic biological processes.
- CO4 Students will be able to describe the structure and classification of biomolecules.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit 1

General Principles of Biochemistry and chemical composition of life, Glycolysis, Gluconeogenesis, Citric acid cycles its regulation and role as metabolic hub, Pentose/Hexose phosphate pathway, their regulations, and significance, interlinking between different pathways

Unit II

Structure and Classifications of amino acids and proteins, Ramachandran plot, Classification and nomenclature of enzymes, coenzyme, isozymes, enzyme kinetics (Michaelis-Menten equation, K_m , V_{max} , Turnover number, Enzyme inhibition, allosteric enzymes, Immobilized enzymes, coenzymes, in born errors of metabolism

Unit III

Saturated and unsaturated fatty acid and their metabolism, Structure and function of major lipid sub classes- Acyl glycerol, Phospholipids, glycolipids, Sphingolipids, Waxes, Terpenes and Sterols, Fatty acids biosynthesis, degradation and their regulations, Ketone bodies synthesis, biosynthesis of TAG, Phospholipids and Glycolipids, biosynthesis of cholesterol and its metabolism

Unit IV

Structure and properties of nucleic acid bases, nucleosides and nucleotides, Biosynthesis and degradation of purines and pyrimidines, Salvage pathway, Conformation of nucleic acids (A-, B-Z-DNA), t-RNA, micro-RNA), Structure and biochemical roles of vitamins

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Suggested Reading:**Text books:**

1. Principle of biochemistry by Lehninger
2. Illustrated Biochemistry by Harper
3. Principles and Techniques of biochemistry and molecular Biology by Wilson and Walker

Reference Books:

1. A Biologists guide to Principles and Techniques of Practical Biochemistry, K. Wilson and K.H. Goulding, ELBS Edn.
2. D.Voet and J.G. Voet. Biochemistry, John Wiley & Sons
3. I.H. Segal. Biochemical Calculations, John Wiley & Sons
4. T.E. Creighton. Proteins-structure and Molecular Properties, W.H. Freeman & Company.
5. Biochemistry by Satyanarayana and U.Chakarpani

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	√	×	√
CO2	√	√	√	√	×	√	√
CO3	√	×	√	√	×	√	√
CO4	×	×	√	√	×	×	×

Dr. S. K. Kumar
20/05/2026

Dr. S. K. Kumar

Dr. S. K. Kumar
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Dr. S. K. Kumar
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Dr. S. K. Kumar

M.Sc. Zoology
Semester I
25ZOO107 Vermiculture and Apiculture

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objective: To develop understanding of vermiculture and apiculture and its and entrepreneurial applications.

Outcomes:

CO1: Students will understand earthworm taxonomy, morphology, ecology, reproduction, biodiversity, and their role in vermiculture and vermicomposting.

CO2: Students will gain practical knowledge of vermicompost and vermiwash production, waste management, organic farming, and entrepreneurial opportunities through vermiculture.

CO3: Understand honey bee biology, behaviour, social organization, and beekeeping practices.

CO4: Gain knowledge of bee products, pollination, disease management, and entrepreneurial applications of apiculture.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit I

Earthworms - Taxonomic position, external features - shape, size, colour, segmentation, Prostomium, Peristomium, Metamerism, Cuticle, setae and clitellum. Body wall, coelom, locomotion; Reproductive system - Hermaphroditism, copulation, cocoon formation, Cocoon structure, fertilization and development. Incubation period of cocoon in vermicomposting earthworm, Fecundity in surface dwelling (epigeic) and soil dwelling (endogeic and anecic) earthworm. Ecological/habit categories: Epigeic, Endogeic and Anecic earthworms

Unit II

Vermiculture and Vermicomposting: Definition and differences. Selective features of earthworms for vermiculture and vermicomposting. Common species: Native Indian/indigenous earthworms-*Perionyx excavatus*, *Perionyx ceylanensis*; Exotic earthworms- *Eisenia fetida*, *Eisenia andrei*, *Eudrilus eugeniae*, identification of the above species based on morphological characters.

Environmental parameters: moisture, temperature, pH, organic matter etc. Vermicomposting methods: low-cost floor beds, field pits, ground heaps, tank system, roof shed, windrows and bin method. Management, harvesting and storage of vermicompost; Physicochemical features of vermicompost. Role of earthworms and vermicompost in plant growth. Vermiwash preparation and its utility.

Unit III

Introduction to Apiculture. Morphology and biology of honey bees. Honey bee species, classification, life cycle and behavioural patterns. Social organization of bee colony. Bee keeping systems, tools and equipment. Types of beehives including Newton's Bee Hive, structure and functional features. Site selection criteria.

Unit IV

Bee enemies - identification, characteristics and preventive measures. Diseases of honey bees and their control. Colony collapse disorder and management. Bee products - honey, royal jelly, propolis, pollen, bee venom - uses and importance. Harvesting, processing, packaging and marketing of bee products. Importance of bees in crop pollination.

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Suggested and Reference books

1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA)
2. Sharma P.L. and Singh, S.H. Book of Bee keeping.
3. Cherian and Ramanathan, S. Bee keeping in south India.
4. Prospective in Indian Apiculture - R.C. Mishra.
5. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
6. Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi
7. Mary Violet Christy, 2008. Vermitechnology, MJP Publishers, Chennai.
8. Aravind Kumar, 2005. Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
9. Badwaik, V. (2025). *Textbook of Vermiculture and Vermicomposting*. Bhumi Publishing. ISBN: 978-93-48620-26-2.
10. Caron, D. M., & Connor, L. J. (2022). *Honey bee biology and beekeeping* (3rd ed.). Wicwas Press.
11. Sammataro, D., & Avitabile, A. (2021). *The beekeeper's handbook* (5th ed.). Cornell University Press.
12. Graham, J. M. (Ed.). (2015). *The hive and the honey bee* (Revised ed.). Dadant & Sons.
13. Edwards, C. A., Arancon, N. Q., & Sherman, R. L. (Eds.). (2011). *Vermiculture technology: Earthworms, organic wastes, and environmental management*. CRC Press.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
C01	√	√	√	√	√	×	√
C02	√	√	√	√	×	√	√
C03	√	×	√	√	√	√	√
C04	√	√	√	√	×	×	√

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M.Sc. Zoology
Semester I
23ZOO103 Animal Cell Biology

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. To make students learn the deeper aspects of cell structure and function at molecular level.
2. To apprise students about likeness between the physiological processes at the cellular and organismic levels.

Outcomes:

- CO1 This core course will make students able to understand how the cell functions as a unit of life.
- CO2 Through this course, students will be able to appreciate the importance of various cell functions and structures in the evolution of multicellular organisms.
- CO3 The course will make the students understand elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell functions.
- CO4 The students will know about the basic cellular and molecular approaches for cancer development and treatment, cell death and its mechanisms.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Sub cellular organization and interaction between organelles, Biomembranes: Molecular composition and arrangement, functional consequences, membrane transportation, Donnan equilibrium; ion movements and cell function, Maintenance of cellular pH.

Unit-II

Structure and organization of microfilaments and microtubules, Role of kinesin and dynein, cellular movements, Cell matrix adhesion, Integrins, Collagen, Non-collagen components, Protein sorting and transport by ER, Protein uptake into ER, Membrane proteins and Golgi sorting, the Extra Cellular Matrix, Cell-cell interactions: adhesion junctions, tight junctions, gap junctions, plasmodesmata, Ca^{++} dependent and Ca^{++} independent Homophilic cell-cell adhesion

Unit-III

Eukaryotic cell cycle, Regulators of cell cycle progression, the events of M phase, Cell – Cell signaling, Signaling molecules and their receptors, Function of cell surface receptors, Pathways of intracellular signal transduction, Signaling networks

Unit-IV

Cell death and cell renewal: Programmed cell death, Metastasis, Stem cells and the maintenance of adult tissues, Embryonic stem cells and therapeutic cloning, Biology of Cancer, Oncogenes, virus induced cancer, Tumor suppressor genes, Molecular approaches to cancer treatment, Biology of Ageing

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Suggested Readings:**Text Books:**

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Cell Biology by C.B. Panwar, Himalaya Publication Syllabus, Department of Zoology, CBLU

Reference Books:

1. Cell and molecular biology Phillip Sheeler, Donald E. Bianchi Wiley, 1987
2. Cell and Molecular Biology by De Robertis
3. Cell Biology by A.K. Berry, EMKAY Publication
4. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	×	√	√
CO2	√	√	√	√	√	√	√
CO3	√	√	√	√	×	√	√
CO4	√	√	√	√	×	√	√

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M.Sc. Zoology
Semester I
25ZOO104 Advance Physiology

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. The Student will learn advanced knowledge about the physiology of organism and functions of organ systems.
2. This core course will make students understand how an animal works at all levels.

Outcomes:

- CO1 An appropriate understanding of functioning of each organ system of different groups of animals with their comparison will be acquainted.
- CO2 The students will able to explore the mechanism of circulatory and digestive system.
- CO3 The students will able to learn the physiology of respiration and respiratory diseases.
- CO4 The student will learn the mechanism of excretion and physiology of muscles and their regulation.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Digestion and circulation: Physiology of digestion & absorption. Malnutrition, nutritional diseases & under nutrition, Types of minerals and vitamins and its regulation to body functions.

Circulation: Chemistry and composition of blood and their functional significance; biochemistry of hemoglobin and Myoglobin, lymphatic system, Mechanism of blood coagulation and homeostasis. Cardiac cycle and its regulatory mechanisms. Cardiac output and micro circulation, blood pressure and its regulation.

Unit -II

Respiration: Types of respiration, mechanism of breathing; biochemistry of respiratory gaseous exchange; Transport of respiratory gases; Lungs anatomy, Lungs volume and Capacities. Regulatory mechanisms (humoral and neural) of respiration. Respiratory acidosis, alkalosis and regulation of pH, Respiratory Diseases: Chronic bronchitis, Asthma

Unit -III

Excretion: Types of excretion and nitrogenous wastes; functional anatomy of renal unit; biophysical and chemical mechanisms of ultrafiltration, reabsorption and secretion, transport mechanisms, urine formation & regulatory control of sugar, urea, Na^+ K^+ , and H^+ ; Role of kidneys in regulation of acid-base balance and osmoregulation, Counter Current mechanism, Homeostasis.

Unit -IV

Physiology of Muscles: Types of muscles and their components; Molecular organization & interaction of myosin & actin. ATPase activity of myosin, power-stroke, ATP binding and hydrolysis; Role of troponin and tropomyosin and Ca^{++} in regulation of muscle contraction. Sliding filament mechanism, Contraction of smooth & cardiac muscles, role of phosphorylation, Ca^{++} and kinases.

Thermoregulation & Stress Physiology: Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature, physiological adaptation at high altitude and in deep sea environment.

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Suggested Readings:**Text Books:**

1. Sherwood, L., Klandorf, H. and Yancey, P.H., Animal Physiology: From Genes to Organisms, 2005, Thomson Asia Ltd., Singapore
2. Sherwood, L. Human Physiology: From Cells to Systems, 5th Ed., 2004, Thomson Asia Pte. Ltd., Singapore

Reference Books:

1. David Randall, Warren Burggren, Kathleen French: Eckert Animal Physiology
2. Guyton, A.X., Text Book of Medical Physiology, 7th edition, Saunders Company (1986).
3. Best, J.P., Best and Taylor's Physiological basis of medical practice, 11th ed. William and Wilkins (1985).
4. Hoar, W.S., General and Comparative Physiology, Adaptation and Environment, 3rd ed. Cambridge University, Press (1985).
5. Vander, A.J., Sherman, J.H. and Luciana, D.S., Human Physiology, McGraw Hill Publ. Co. (1990).
6. Gillian Pocock and Christopher D. Richards. Human Physiology. The Basis of Medicine Oxford University Press (2001).

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	×	√	√	×	√	√
CO2	√	√	√	√	√	√	√
CO3	√	√	√	√	×	√	×
CO4	√	×	√	√	×	√	×

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M.Sc. Zoology**Semester I****Lab Course I (PC I) (25ZOO105)****(Based on 25ZOO101 & 25ZOO102 OR 25ZOO107)****Total Marks: 50****Time: 4 hours****Evaluation scheme in examination**

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

1. Make students to understand how life evolved from simple to complex organization by division of labor & enhancing efficiency in Invertebrates.
2. To develop understanding of chemistry used in biological processes and to perform wide range of analytical techniques to explore biological activities.

Outcomes:

- CO1 The study of invertebrates reveals progressive evolutionary history and adaptations together which forms the basis of huge complex and diverse life forms.
- CO2 Able to apply the scientific method to the process of experimentation.
- CO3 It will provide the students a basic appreciation of the underlying principles and practical strategy of the analytical and preparative techniques that are fundamental to study and understanding of life processes.
- CO4. This course will make students able to understand the regulation of chemical reactions in living cells as well as understanding of vermiculture and apiculture

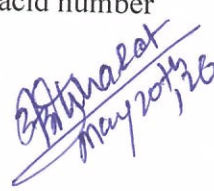
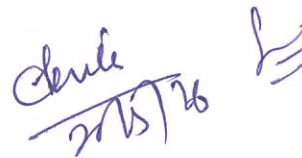
Course contents:

1. Live demonstration of Amoeboidal movements, conjugation in *Paramecium* and flagellar moments in *Euglena*.
2. **Slides and Museum specimens:**
 - a. PROTOZOA: *Gregaria*, *Monocystis*, *Ceratium*, *Didinium*, *Noctiluca*, *Radiolaria*, *Stentor*, *Opalina*.
 - b. PORIFERA: Sectional view of *Sycon* (T.S., L.S.), *Grantia* (T.S.)
 - c. CNIDARIA: *Obelia* polyp and Medusa, *Pennaria*, *Aurelia-Tentaculocysts*, *Virgularia*, *Zoanthus*, *Favia*.
 - d. ANNELIDA: *Ozobranchus*, *Eunice*, *Flava*, *Polynoe*, *Terebella*, *Eurythoe*, *Heteroneresis*
 - e. ARTHROPODA: *Cyclops*, *Daphnia*, *Peripatus*, *Balanus*, *Lepas*, *Palinurus*, *Uca*, *Hippa*, *Gongylus*, *Bellostoma*, *Limulus*, *Squilla*, *Eupagurus*.
 - f. MOLLUSCA: Museum specimens of *Dolabella*, *Pteria*, *Sanguinolaria*, *Ficus*, *Onchidium*, *Murex*, *Turritella*, *Bulla*, *Cardium*, *Area*.
 - g. ECHINODERMATA: Museum specimen of *Echinodiscus*, *Holothuria*, *Antedon*, *Asterias*
3. Study of mouth parts of different insects.
4. Mounting: Trachea, Crustacean Larva, *Cyclops*, *Nauplius*, *Daphnia*, *Zoea*, *Mysis*, *Cercaria*.
5. Demonstration of dissected specimens through chart/Model/CD to expose varioussystem (Loligo/Sepia, Prawn, Cockroach, Earthworm)

Based on fundamental of Biochemistry

1. 6. Reactions of amino acids, sugars and lipids
2. 7. Quantitation of Proteins and Sugars
3. 8. Analysis of oils-iodine number, saponification value, acid number



4. 9. Separation techniques - Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc. and Electrophoresis
5. 10. Mitosis & Meiosis study by onion root tip and grass hopper testis
6. 11. Field Visit to Zoological sites/Parks/ Anthropology/Science museums/ Research Labs/Biosafety Labs/ Wild Life Institutes/ Sanctuaries/ or any site of Zoological Interest.
7. Submission of Project report/presentation by the students.

Based on Vermiculture and Apiculture

1. Key to identify different types of earthworms.
2. Collection of some native and exotic earthworms and identification.
3. Study of life stages of indigenous and Exotic earthworms through video clipping/charts etc.
4. Study of systematic position, habits, habitat and external feature of earthworm
5. Preparation of vermibeds, maintenance of vermicompost and climatic conditions.
6. Field visit of Vermicomposting unit.
7. Identification of different bee species.
8. Study of Honey bee Caste.
9. Study of bee hive structure.
10. Life cycle of Honey Bee through video clipping/charts etc.
11. Study of Bee products, Bee diseases and pests.
12. Demonstration of Modern Bee Keeping Equipment and Methods.
13. Training of methods of Extraction of Honey (Indigenous and Modern)
14. Report of field visit/ Honey Bee farm etc.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	√	√	√
CO2	×	√	×	×	×	×	√
CO3	√	√	√	√	√	√	√
CO4	√	×	√	√	√	√	√

Dr. Kashyap

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Dr. Kashyap
May 20, 26

Dr. Kashyap
20/5/26

Dr. Kashyap

M.Sc. Zoology**Semester I****Lab Course II (PC-2) (25ZOO106) (Based on 25ZOO103 & 25ZOO104)****Total Marks: 50****Time: 4 hours****Evaluation scheme in examination:**

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

1. To make students learn the deeper aspects of cell structure and function at molecular level.
2. This course attempts to bring the awareness to the students of major features of each body system as well as of advanced knowledge about the principles of physiology

Outcomes:

- CO1. The studies will make the students reveal elegance, dynamics and economy in the living cell and a gratifying unity in the principles by which a cell function
- CO2. To understand function and adaptations as related to the survival of organisms in their natural environment
- CO3. To understand appropriate understanding of functioning of each system and its importance in maintain homeostasis.
- CO4. To understand related disease and its cure, will be beneficial to understand the whole-body system.

Course contents:

1. Slide preparations of mitotic and meiotic chromosomes.
 2. Calculation of morphometric data and preparations of terminal.
 3. Determination of chiasma frequency and terminalisation coefficient.
 4. Study of polytene chromosomes and mapping.
 5. Study of different types of cancer and their stages by slides/ photographs/video
 6. To demonstrate that the optimum activity of salivary amylase is Ph dependent.
 7. Estimation of Haemoglobin.
 8. Determination of bleeding time.
 9. Determination of clotting time.
 10. Determination of blood groups.
 11. Measurement of blood pressure.
 12. To study the effect of exercise on cardiovascular and respiratory systems.
 13. To study the effect of insulin on blood glucose level of mammal.
 14. If feasible Field Visit to Zoological sites/Parks/ Anthropology/Science museums/Research Labs/ Biosafety Labs/ Wild Life Institutes/ Sanctuaries/ or any site of Zoological Interest.
- Submission of Project report/presentation by the students.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	√	√	√
CO2	√	√	√	×	√	×	√
CO3	√	×	√	×	√	×	√
CO4	×	√	√	×	√	×	√

N. K. S. Kumar
20/05/2026

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Chaitanya
20/05/2026

M.Sc. Zoology
Semester II
25ZOO201 Diversity of Vertebrates

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. This paper deals with the comparative and evolutionary trends in structure and function of the organ systems of the vertebrate series.
2. To understand what are the general characters and different categories of chordates animal.
3. To understand the level of organization in chordate subphylum.
4. To understand the origin and evolutiona
5. ry relationship in different subphylum of chordates.

Outcomes:

- CO1 Students will be able to understand various biological functions, the evolution of life from most primitive to most advanced form with respect to their habit and habitat.
- CO2 Students will have acquaintance with the basic concepts, external morphology and sexual dimorphism in chordates and understand the various systems, adaptation and dentition in chordates.
- CO3 Students will also Understand the Classification various classes of phylum Chordate i.e., Pisces, Reptiles, Aves and Mammals.
- CO4 This core course will make students familiarise with the vertebrate diversity around them

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Origin of Chordates: introduction with general characters and classification upto orders of phylum Protochordata, hemichordate, urochordata & chordate, General structure and function of vertebrate integument and its derivatives, Glands, scales, horns, claws, feathers and hairs

Unit –II

Comparative account of jaw suspensorium, Digestive system: Comparative account of Dentition, Stomach, Digestive organs & Glands Respiratory system: Internal and External Respiration, Comparative account of respiratory organs in vertebrates

Unit –III

Evolution of heart and aortic arches and Portal systems of vertebrates, Evolution of Urinogenital system in vertebrate, Flight adaptation in birds, Migration in fish and Birds, parental care in all chordates.

Unit –IV

Comparative account structure of brain & spinal cord in vertebrates, Comparative account of hearing and Vision in Vertebrates, Lateral line system, Evolution of Man, Horse, Camel and Elephant.

N. K. Kumar
20/05/2026

Approved
May 2025, 20
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Suggested Readings:**Text Books:**

1. Sedgwick, A. A Students Text Book of Zoology, Vol. II.
2. Kotpal R.L. modern text book of zoology Vertebrates, Rastogi publications

Reference Books:

1. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
3. Kingsley, J.S. Outlines of Comparative Autonomy of Vertebrates. Central Book Depot, Allahabad.
4. Kent, C.G. Comparative anatomy of vertebrates.
5. Milton Hilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
6. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
7. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hall Book Co., New York.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	×	√	√	√
CO2	√	×	√	×	√	√	√
CO3	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√

Alka Kumar

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Pratibha
may 20th, 20
Shruti
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M.Sc. Zoology
Semester II
25ZOO202 Molecular Biology

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objective: To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.

Outcomes:

CO1 Learn the necessary information about the chemistry of life to allow the students to understand the basis of molecules of life.

CO2 Acquire a clear understanding about protein sorting and their mechanisms

CO3 To know about Recombination and repair mechanism in DNA

CO4 Detail understanding of molecular techniques of genomes analysis

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

DNA Replication: Mechanism of DNA replication in Prokaryotic and Eukaryotic cells. Enzymes and accessory proteins involved in DNA replication and DNA repair. Transcription: Prokaryotic & Eukaryotic transcription, RNA polymerase, General and specific transcription factors & their regulation, Transcriptional and post-transcriptional gene silencing, Modifications in RNA: 5'-Cap formation, Transcription termination, 3'-end processing and Polyadenylation, Splicing, Editing, Nuclear export of mRNA & its stability.

Unit -II

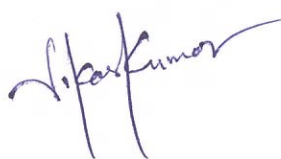
Antisense and Ribozyme Technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping Translation: Prokaryotic and Eukaryotic translation, Regulation of translation, genetic code, co- and post translational modifications of proteins.

Unit -III

Biochemistry of ribozyme; hammer head & their designing strategies, hairpin and other ribozymes, Homologous Recombination: Holliday junction, excision repair, RecA and other recombinases and DNA repair mechanisms. Molecular gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination,

Unit -IV

Genome Sequencing: Genome sizes, organelle genomes, Genomic libraries, YAC, BAC libraries, Packaging, transfection and recovery of clones, Application of Sequencing: sequence information for identification of defective genes



Text Books:

Text Books:

- ### Reference Books:

- ### Teaching-Learning Process

- ## Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	×	×	×	√
CO2	√	×	√	×	√	√	√
CO3	√	√	√	√	×	√	√
CO4	√	√	×	√	√	√	√






M.Sc. Zoology
Semester II
25ZOO203 Parasitology

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objective:

1. To explore in detail the biology of various parasitic diseases and their transmission in human and animal population.
2. To understand modes of infection, life cycles of parasite and vector, host - parasite interactions, infectivity pattern, treatments to parasitic diseases and vector control measures.

Outcomes:

- CO1 To understand about host preference of various disease causing parasites.
- CO2 To understand morphology, life cycles and mode of infection of various parasites.
- CO3 To have detailed knowledge of various insect vectors and their life cycle.
- CO4 To understand ecology and evolution of parasitism.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit-I

Introduction to Parasitology, different types of animal associations: definitions; Parasitism, Mutualism, Hyperparasitism. Hosts: host types, regular hosts, irregular hosts, intermediate hosts. Endoparasite and Ectoparasite, Obligate parasites, Facultative parasites, accidental, or incidental parasite, Oioxenous, Stenoxenous, and Euryxenous Parasite, Host Specificity: Kinds of parasite host specificity, specificity factors related to infection and growth, Host-parasite interaction, parasitic adaptation, Types of Vaccination: duration, doses and health education.

Unit-II

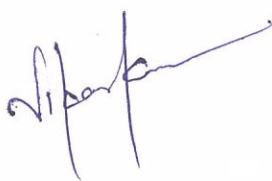
Parasitic Morphology: Protozoa, Helminths, Nematodes and Arthropods. Life cycles of Plasmodium, Parasitic Tapeworm, Dengue, Leishmania, Trypanosoma, Nematodes, Schistosomiasis and Ascariasis. Their mode of Infection

Unit-III

Vectors - Brief account of various insect vectors and their life cycle (Mosquitoes: *Anopheles*, *Aedes* and *Culex*; vectors of *Leishmania*, *Trypanosoma*, Blood fluke, mites, etc.) Parasite Transmission in vector host: Introduction, mechanism, Zoonosis: viral; rabies, *Japanese encephalitis*. Parasitic: Hydatid disease

Unit-IV

Natural parasite habitats: Soil, water, air and animals, clinical and molecular diagnostics of parasite, Host immune response to protozoan and helminthes parasites, Ecology of parasites: Ecological niche, evolution of parasitism: Origin of parasitism, progressive and retrogressive evolution.



Suggested Readings:**Text Books:**

1. Parasitology: The Biology of Animal Parasites, 5th edition by Noble, E.R. and Noble, G.A., Lea & Febiger, Philadelphia; 1982.
2. Physiology of Parasites by Chapell, L.H., Blackie, Glasgow, London; 1979.
3. Human Parasitology by Fatik Baran Mandal, PHI Learning, Private Limited, New Delhi.

Reference Books:

1. Immunology of Infection by Kaufmann, S., Academic Press; 1999.
2. An Introduction to Animal Parasitology by Smyth, J.D., Hodder & Stoughton, London; 1976.
3. TB1: Cox, F. E. G., "Modern Parasitology", 2nd Edition, Blackwell Science, 2004.
4. Bogitsh, B.J., Carter, C.E., Oeltmann, T.N., "Human Parasitology", Elsevier, 3rd Ed., 2005.

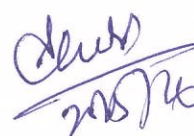
Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
C01	√	√	√	√	×	×	√
C02	√	√	√	√	×	×	√
C03	√	√	√	√	√	×	√
C04	√	√	√	√	√	×	√



M.Sc. Zoology

Semester II

25ZOO204 Biosystematics and Biosafety

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. This paper deals with nomenclature, taxonomy and preservation of organism, assigning names to organisms using nomenclature and classifying species into larger groups that have biological meaning.
2. It imparts understanding about fundamental concepts in biosafety and their application lab safety with focus on biosafety of GMOs and other ethical issues.

Outcomes:

- CO1 Knowledge of Taxonomy helps in classifying and identifying biodiversity and biologist study the well understood relationships by making phylogenetic trees.
- CO2 It will help to understand the overall biodiversity of the world and their application in all the fields of biological sciences.
- CO3 Knowledge of biosafety is essential to work in lab with biological organisms.
- CO4 Able to know the biosafety of GMOs and ethical issues related with GMOs.

Note: Nine questions will be set in all. Question No. 1 will be compulsory consisting of seven short answer type questions covering the entire syllabus. The remaining eight questions will be set with two questions from each unit.

Unit-I

Definitions and perspectives of systematics, classification and taxonomy, goals and importance of taxonomy, Principle and theories of Biological Classification, Hierarchy of classification, Taxonomic Key and its significance

Unit-II

History and theories of classification, International code of Zoological nomenclature-principles, objectives and rules for nomenclature, type system and priority for different taxa, Polytropic species, race, variety, cline, subspecies, Species concepts - Typological species concept, nominalistic species concept, biological species concept, evolutionary species concept, Difficulties in applying biological species concept, Chemotaxonomy, cytotaxonomy and Molecular taxonomy

Unit III

Introduction to bioethics: Bioethical issues related to genetically-modified organisms and gene therapy/gene editing; international bioethics advisory committees and their tasks (IBC, IBA, IBS etc.); ethical issues in human cloning; ethics for using animals in research; social and ethical implications of biological weapons.

Unit IV

Introduction to biosafety; biological safety cabinets; primary containment for biohazards; biosafety levels for microorganisms, infectious agents and infected animals; biosafety guidelines of Government of India; GMOs & LMOs; Indian regulations of GMOs: EPA act and rules, guidelines; regulatory framework RCGM, GEAC, IBSC etc.

Suggested Readings:**Text Books:**

1. Genetics and the origin of species by T. Dobzhansky, Columbia University Press; 1951.
2. Principles of Systematic Zoology by E. Mayr, Tata McGraw Hill Publishing Co. Ltd., New Delhi; 1976
3. IPR, Biosafety and Bioethics by Deepa Goel and Somini Prashar, Pearson.

References Books:

1. Taxonomy by R.E. Blackwelder, John Wiley & Sons, New York; 1967.
2. Organic Evolution by Lull, MacMillan Co., New York; 1947.
3. Time, life and Man by R.A. Stirton, John Wiley and Sons, New York; 1959.
4. Evolution of the Vertebrates by E.H. Colbert, Willy Eastern Ltd., New Delhi; 1969.
5. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nabisan, Elsevier Publishing

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through discussion, surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√
CO3	×	×	√	×	×	√	√
CO4	×	×	√	×	×	√	√

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M.SC Zoology
Semester II
25ZOO205 Genomics and Proteomics

Maximum Marks: 100

Time: 3 hrs

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. The goal of genomics is to study about gene and their products that are focal points of proteomics studies.
2. The goal of proteomics is to identify or compare the proteins expressed in a given genome under specific condition, study the interaction between the proteins and use this information to predict cell behavior and develop drug targets.

Outcomes:

- CO1 To provide the knowledge and practical skills of functional genomics and proteomics
- CO2 To teach the techniques used in functional genomics such as microarrays, NGST, mRNA expression and miRNA expression.
- CO3 To give knowledge on gene manipulation, gene expression, etc which prepares them for further studies in the area of genetic engineering
- CO4 To learn advance understanding of life

Note: Nine questions will be set in all. Question No. 1 will be compulsory consisting of seven short answer type questions covering the entire syllabus. The remaining eight questions will be set with two questions from each unit.

Unit-I

Genomics: Genome sequencing strategies and programs, new technologies for high throughput sequencing, methods for sequence alignment and gene annotation; Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications; gene tagging; gene and promoter trapping; knockout and knock-down mutants; dynamic modulation of protein structure and function

Unit-II

Comparative genomics of model plants and related crop species; Recombination-based cloning techniques; RNAi and gene silencing, genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing, genomic tools to study methylome and histone modifications.

Unit -III

Analysis of proteins by different biochemical and biophysical procedures like CD (Circular Dichroism), NMR, UV/Visible and fluorescent spectroscopy, protein identification and analysis on ExPASy server, other protein related databases, 1-D and 2-D gel electrophoresis for proteome analysis, Sample preparation, gel resolution and staining; Mass spectrometry-based method for protein identification like PMF (protein mass fingerprinting) and LCMS.

Unit-IV

Image analysis of 2D gels: Data acquisition, spot detection & quantitation, gel matching, data analysis, presentation, databases, conclusions; DIGE (Differential In Gel Electrophoresis), alternatives to 2-DE for protein expression analysis; Analysis of post-translational modifications and protein-protein interactions; protein chips and arrays, future directions in proteomics, scope of functional proteomics.

Suggested Readings:**Text Books:**

1. Ruchi Singh, Bioinformatics: Genomics and Proteomics, Vikas Publication House, 2014.
2. Lieber DC (2006) Introduction to Proteomics: Tools for New Biology; Humana Press, NJ.

Reference Books:

1. Buchanan B, Gruissem G, and Jones R (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Physiologists, USA.
2. Hammes GD (2005) Spectroscopy for the Biological Sciences; Wiley Interscience, USA.
3. Harlow and Lane D (Eds.) (1988) Antibodies –A Laboratory Manual; Cold Spring Harbor Laboratory, USA.
4. Pennington SR, Dunn MJ (Eds.) (2002) Proteomics: From Protein Sequence to Function, BIOS Scientific Publishers, United Kingdom.
5. Sambrook J and Russell DW (2001). Molecular Cloning –A Laboratory Manual, Vols I –III, Cold Spring Harbor Laboratory, USA.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	×	√	√	×	√	√
CO2	√	×	√	×	√	√	×
CO3	√	×	√	×	√	√	√
CO4	√	×	√	×	√	√	√

Dr. K. S. Kumar

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Dr. Anurag Kumar

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**M.Sc. Zoology
Semester II**

25ZOO208 Environmental Studies and Sustainable Development

Total credits: 02

Maximum Marks: 50

Note: The course will be evaluated based on the study report (50 marks) and seminars/presentations/viva, etc. (50 marks). The report will be focused on local studies that remain centered on the fieldwork/project work related to soil/air/water pollution/best out of waste theme-based work/bioremediation/or any other relevant topic related to the environment, including those mentioned below. In addition, students will also participate in environment-related activities through debate, declamation, group discussions, poster competition, seminars/conferences/paper/poster presentation, and nuked natak at the university/local/state/national levels. Paper/article publication in state/national/level journals, newspaper/conference/seminar proceedings remains a mandatory part of the curriculum.

Objectives: This course will provide fundamental knowledge about the environment and related issues that have a direct impact on the human population.

Course outcomes (CO): The students will understand the environmental challenges, realize their role, and be motivated to protect the environment. This learning will prepare the students to develop their queries and ideas for a healthy environment.

CO1. Understanding water resource management and the concept of green energy.

CO2. Understanding the different types of waste and their management.

CO3. To develop awareness of environmental laws and policies.

CO4. Understanding wildlife protection and environmental impact assessment.

Unit-I

Water Resources Management: coordinated development and management of water, land, and related resources. Revival of Water Bodies: enumeration, protection, and management of water bodies in their respective States. Energy & Green Technologies: Renewable and Alternative energies such as Solar, Wind, Tidal, etc.

Unit-II

Waste Management: Solid/Liquid/Plastic/C&D/Electronic/Bio-medical/Hazardous wastes. Sanitation & Hygiene: Methods of Garbage collection, industrial/ hazardous waste management, Methods of wastewater treatment and disposal.

Unit-III

Environmental Laws & Policies and Legal Proceedings: Legislation, regulations, policies, and permits related to protecting the environment such as The National Green Tribunal Act, 2010, Water Prevention And Control of Pollution Act, 1974, Cess Act, 1974, Air Prevention And Control Of Pollution Act, 1977, Forest Conservation Act, 1980, Environmental Protection Act, 1986, Public Liability Insurance Act 1991, Government Missions for Environment Protection & Conservation (as per National Environment Policy NEP-2020) and Ministry of Environment and Forests (MoEF).

Unit-IV

Wildlife Protection & Conservation: habitat conservation, endangered and keystone species protection, ex-situ efforts, and poaching prevention. Environmental Impact Assessment: Water Environment, Biological Environment, Land Environment, Air Environment, Noise Environment, Socio-economic and Health Environment. Environment Management Plan.

Suggested readings:

1. Fundamentals of Ecology: E. P. Odum, W.B. Saunders Co
2. Environmental Science. Jr. G. T. Mille R, Wadsworth Pub. Co
3. Fundamentals of Environmental Science: Dhaliwal GS, Sangha GS and Raina PK. Kalyani Publication
4. Environmental Science Systems & solutions, M.L. Mac-Kinney, & RM Schoch, Web-enhanced edition.
5. Environmental Chemistry: A. K. De, Wiley Eastern Ltd.
6. Journal publications

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	×	×	√
CO2	×	×	×	√	√	×	√
CO3	√	√	√	√	×	×	√
CO4	√	√	√	×	×	×	√

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**M.Sc. Zoology
Semester II**

25ZOO209 Indian Knowledge Systems in Biology -

Total credits: 02

Maximum Marks: 50

Note: The course will be evaluated based on the study report (30 marks) and seminars/presentations/viva, etc. (20 marks). The report will be focused on studies that remain centered on the relevant topic related to the IKS, including those mentioned below. In addition, students will also participate in debate, declamation, group discussions, or poster competition.

Objectives: This course introduces students to the integration of Indian Knowledge Systems (IKS) with modern biology, focusing on Ayurvedic medicinal applications and biodiversity conservation. It aims to provide insights into traditional practices and their relevance to contemporary biological advancements.

Course Outcomes:

CO1: Understand the application of Ayurvedic principles in modern biotechnology, particularly in drug discovery and bioprocessing.

CO2: Gain knowledge of traditional ecological practices for biodiversity conservation and environmental biology.

CO3: Students will develop skills to apply IKS-based approaches in sustainable agriculture and ecological management.

CO4: Students will be prepared for research careers integrating traditional and modern biological methods.

Unit I

Ayurveda and Medicinal Biology: Overview of Ayurvedic principles in biology: Insights from ancient texts (Sushruta Samhita, Charaka Samhita) on plant and animal-based healing processes. Use of fermentation for herbal drugs and enzyme-based therapies. Case studies of traditional practices in modern medicinal contexts.

Unit II

Pharmacology and Bioprocessing in IKS: Pharmacology of bio-active compounds: Rasayana formulations and their relevance to drug discovery, bioprocessing, and secondary metabolite production. Integration of traditional fermentation (Asava-Arishta) with modern bioprocess technologies for producing antibiotics, vitamins, and enzymes.

Unit III

Ethno-biology and Biodiversity: Ethno-biology: Vrikshayurveda and its contributions to microbial diversity, biofertilizers (e.g., Rhizobium symbiosis), and sustainable crop improvement. Indigenous methods for genetic diversity in crops (e.g., Vavilov's centers in Indian contexts). Role of ethnozoology and ethnobotany in biodiversity conservation.

Unit IV

Sustainable Practices in Environmental Biology: Traditional ecological knowledge in resource management: Bioremediation using herbs, vermicomposting, and phytoremediation for pollution control. Applications of IKS in sustainable agriculture and ecosystem management. Case studies on traditional practices for environmental sustainability.

Suggested Readings:

1. Sushruta Samhita, translated by Kaviraj Kunjalal Bhishagratna, Chowkhamba Sanskrit Series.
2. Charaka Samhita, translated by P.V. Sharma, Chaukhambha Orientalia.
3. Vrikshayurveda: The Science of Plant Life by Surapala, translated by Nalini Sadhale, Asian Agri-History Foundation.
4. Ethnomedicine and Pharmacognosy by V.K. Singh and J.N. Govil, Studium Press.
5. Biotechnology and Traditional Knowledge by S.K. Jain, Oxford & IBH Publishing.
6. Environmental Biotechnology by Bimal C. Bhattacharyya, Oxford University Press.
7. Indian Ethnobotany: Emerging Trends by A.K. Jain, Scientific Publishers.

Please note: The latest edition of these books is proposed or as recommended by the concerned faculty.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	×	×	√
CO2	×	×	×	√	√	×	√
CO3	√	√	√	√	×	×	√
CO4	√	√	√	×	×	×	√

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**M.Sc. Zoology
Semester II**

Lab Course I (PC-3) (25ZOO206) (based on paper 25ZOO201 & 25ZOO202)

Total Marks: 50**Time: 4 hours****Evaluation scheme in examination:**

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

1. This paper deals with the comparative and evolutionary trends in structure and function of the organ systems of the vertebrate series.
2. To thorough understanding of practice of taxonomic arrangement and classification of animal diversity, and biosafety of GMOs and other ethical issues

Outcomes:

- CO1 To understand various biological functions, the evolution of life from most primitive to most advanced form with respect to their habit and habitat.
- CO2 For understanding the overall biodiversity of the world and their application in all the fields of biological sciences.
- CO3 To understand biosafety while in lab.
- CO4 To identify various species.

Course contents:

Museum specimens and slides:

1. Chondrichthyes: *Zygaena, Pristis, Narcine, Trygon, Rhinobatus, Chimaera*.
2. Actinopterygii: *Polypterus, Acipenser, Lepidosteus, Muraena, Mystus, Catla, Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Tetradon, Echeineis and Solea. Dipneusti (Dipnoi): Protopterus (Lung fish)*
3. Amphibia: *Uraeotyphlus, Necturus, Amphiuma, Ambystoma and its Axolotl larva. Triton, Salamandra, Hyla, Rhacophorus*.
4. Reptilia: *Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera, Crocodilus, Gavialis, Chelone and Testudo*.
5. Aves: *Casuaris, Ardea, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo*.
6. Mammalia: *Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca, Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra, Pteropus*.
- a. Demonstration of dissection of Labeo/Chick/Rat through video clipping/models/charts showing Digestive, arterial, venous and urinogenitalsystems
7. Study of the histology of different organs of frog and rat/rabbit through permanent stained slides.
8. Study of the skeleton of Rana, Gallus & Oryctolagus.
9. Isolation of Genomic and plasmid DNA.
10. Isolation of RNA.
11. Quantitative analysis of DNA.
12. Restriction digestion of DNA.
13. Ligation of DNA fragments.
14. Molecular weight analysis using agarose gel electrophoresis.
15. Preparation of competent cell
16. Blotting techniques.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	√	×	√
CO2	√	√	√	√	√	√	√
CO3	×	×	√	√	×	√	√
CO4	√	√	×	×	√	√	√

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M.Sc. Zoology
Semester II
Lab Course II (PC-4) (25ZOO207)
(Based on Core- 25ZOO203 and any One of DEC-1 or DEC-2)

Total Marks: 50**Time: 4 hours****Evaluation scheme in examination**

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

1. To make students understand the complex molecular mechanisms occurring in cell and the applications of molecular technologies.
2. To explore in detail the biology of various parasitic diseases and their transmission in human and animal population. Modes of infection, life cycles of parasite and vector, host - parasite interactions, infectivity pattern, treatments to parasitic diseases and vector control measures

Outcomes:

- CO1 To know about the chemistry of life to allow the students to understand the basis of life.
- CO2 To discover the complex instruments and elaborate techniques by which scientific discoveries can be made.
- CO3 To understand about diseases caused by Protozoa, Helminths, Nematodes, Arthropods and viruses at molecular level.
- CO4 To understand parasite physiology, life cycle and their mode of infection.

Course contents: Parasitology

1. Identification of parasites through PCR
2. Dissection of mosquitoes and isolation of midgut
3. To study the protozoans and helminth parasites infecting frog, toad and common household insects through slides/charts.
4. Counting of parasites from stained blood smears - *Leishmania*, *Plasmodium* and *Trypanosoma*.
5. Rearing the vectors of different parasitic infections and differentiation of vectors through slide preparation (Mosquitoes/ ticks/ sandfly etc.).

Biosystematics and Biosafety

1. Use of key to identify the fishes of the region, representing different families.
2. Methods of describing common insects representing different orders, with particular reference to the recording of taxonomic characters.
3. Preparation of charts based on biosafety and bioethics.
4. Good lab practices: sterilization, gloves, lab coat use/not use
5. Case study and plagiarism check.
6. Study of molecular identification with reference to insects.
7. Study of insect mouthparts and their use in identification.
8. Submission of a report on insect collection/photograph.
9. Field Visit to Zoological sites/Parks/ Anthropology/Science museums/ Research Labs/Biosafety Labs/ Wild Life Institutes/ Sanctuaries/ or any site of Zoological Interest. Submission of Project report/presentation by the students.

Genomics and Proteomics

1. RNA extraction and preparation of cDNA preparation
2. SDS- PAGE.
3. 2-D Gel electrophoresis
4. Quantification of DNA
5. Southern hybridization of genomic DNA
6. Site-directed mutagenesis.
7. Gateway cloning
8. BLAST Analysis
9. Protein extraction and Quantification
10. If feasible Field Visit to Zoological sites/Parks/ Anthropology/Science museums/Research Labs/Biosafety Labs/ Wild Life Institutes/ Sanctuaries/ or any site of Zoological Interest. Submission of Project report/presentation by the students.

Course mapping

	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7
CO1	√	√	√	√	×	×	√
CO2	×	×	×	√	√	×	√
CO3	√	√	√	√	×	×	√
CO4	√	√	√	×	×	×	√

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**M.Sc. Zoology
Semester III**

25ZOO301 Molecular Endocrinology and Neural Physiology

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objectives: To make students learn the molecular aspects of Hormones & Neurons and their role in physiological processes.

Outcomes:

- CO1 The students will be able to understand types of glands and chemicals nature of hormones.
- CO2 Students will be able to identify the organs involved in the endocrine function and understanding human endocrine disorder & diseases.
- CO3 Develop an in-depth comprehensive knowledge of neurons & its mechanism.
- CO4 This course will make students understand the basic structure and function of brain & whole nervous system.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT- I

Overview: Glands, cellular secretions (autocrine, exocrine, endocrine), Secretory mechanism, types of secretion (Autocrine, merocrine, holocrine) and regulation of glandular secretion.

Hormones: Tropic and non-tropic hormones, Chemical classification of hormones: types, nature, synthesis, release and action. Receptor, molecular mechanism and signal transduction.

UNIT-II

Role of hypothalamus in hormonal control: Anterior and posterior pituitary hormones, pineal gland, suprachiasmatic nucleus and Circadian rhythms; thyroid and parathyroid gland and their hormones, pancreas (insulin and glucagon). Hormonal control of food and fluid intake, Diabetes Mellitus, Hormonal control of calcium metabolism, adrenal gland, Reproductive organs and their hormonal regulation in male and female; estrogen and androgen; Reproductive cycle, parturition and diseases.

UNIT-III

Structure of neuron, membrane potential, Neural Communication: action and graded potential, channels (voltage gated and ligated), Na⁺, K⁺ pump, Na⁺, K⁺ ATPase. Bioelectricity, membrane excitability, nerve conduction. Structure of synapse and synaptic transmission, Excitatory and Inhibitory synapses, Neurohormones and neurotransmitters. Neuroendocrine regulations of physiological functions.

UNIT-IV

Introduction to evolution and development of Nervous system. Structural and functional aspects of nervous system (CNS, PNS & ANS). Protection of CNS: meninges, cerebrospinal fluid, Blood-Brain Barrier; Anatomy of brain, Limbic System, neuronal plasticity and brain cellular composition (types of neurons, glia and their functions). Reflexes and memory, Senses vision, olfaction and touch and their Receptors.

Suggested Reading:**Text Books:**

1. Sherwood, L. Human Physiology: From Cells to Systems, latest edition, Thomson Asia Pte. Ltd., Singapore
2. Campbell and Reece., Biology with Physiology: Latest Edition, Pearson Education
3. General Endocrinology by Turner, C.D. and Bagnars, W.B. Saunders Company
4. Sastry & Shukla: Animal physiology and biochemistry: Rastogi Publication

Reference Books:

1. Endocrinology by Golds -Worthy, G.J. Robinson, J. and Mordue, W. John Wiley and Sons, New York; 1981.
2. Comparative Vertebrate Endocrinology by Bentley, P.J. Cambridge Univ. Press; 1998.
3. Endocrinology (4th ed) by. Hadley, M. E. Prentice Hall; 1996.
4. Williams Text Book of Endocrinology (13th edition by S. Melmed, K. Polonsky), Elsevier, Amsterdam, Netherland, 2015.

Teaching-Learning Process

- **Lectures:** Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	√	×	×	×	×
CO2	√	×	√	×	√	×	×
CO3	√	×	√	×	√	×	×
CO4	√	√	×	×	×	×	×

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M.Sc. Zoology
Semester III
25ZOO302 Genetics and Cytogenetics

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objective: The purpose of this paper is to acquaint the students about basic principles of genetics, concept of linkage, mutation, chromosomal structure, variations and their effects on biological system.

Outcomes:

CO1 To provide students the basic insight about the mechanism of evolution and to make them able to relate different forms of life on our planet earth. It will also provide them in-depth knowledge about the changing frequency and distribution of alleles within the population.

CO2 Acquire a clear understanding about genetic equilibrium in natural populations

CO3 To know about genetics of quantitative traits in populations

CO4 Detail understanding of molecular mechanism of oncogenes along with genetic mutation, basic principles of Mendelian inheritance, concept of linkage.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT I

Mendel's laws, its limitation and their chromosomal basis; extension of Mendel's principles: Morgan principles, allelic variation and gene function-incomplete dominance and co-dominance, allelic series, testing gene mutations for allelism; gene action-from genotype to phenotype-penetrance and expressivity, gene interaction, epistasis, pleiotropy; nature of the gene and its functions: evolution of the concept of the gene, molecular structure of gene (rII locus)

UNIT II

Gene mutation and DNA repair: types of gene mutations, methods for detection of induced mutations, P-element insertional mutagenesis in *Drosophila*, DNA damage and repair; regulation of gene activity in lac and trp operons of *E. coli*, general introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels, organization of a typical eukaryotic gene, transcription factors, enhancers and silencers, non-coding genes.

UNIT III

Sex determination and dosage compensation: sex determination-in humans, *Drosophila* and other animals; dosage compensation of X-linked genes-hyperactivation of X-linked gene in male *Drosophila*, inactivation of X-linked genes in female mammals; human genetics-karyotype and nomenclature of metaphase chromosome bands; chromosomal aberrations and diseases-chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor)

UNIT IV

Genetic analysis of complex traits-complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping, Genetics and cancer: oncogenes-tumor inducing retroviruses and viral oncogenes; chromosome rearrangement and cancer; tumor suppressor genes-cellular roles of tumor suppressor genes, pRB, p53, pAPC, genetic pathways to cancer.

Suggested Reading:**Text books:**

1. Robert J Brooker (2009). Genetics: Analysis and Principles (III Edition). McGraw Hill.
2. Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).
3. William S Klug, Michael R Cumming (1994). Concepts of Genetics, Prentice Hall.

Reference Books:

1. Snustad and Simmons (2005). Principles of Genetics, (4th Ed.), John Wiley & Sons, USA
2. Genetics (2001) J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA.
3. Hartl DL and Jones EW (2007). Genetics –Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers.
4. Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006). Genetics –From Genes to Genomes, 3rd edition, McGraw Hill.
5. Lewin B (2008). Genes IX, Jones and Barlett Publishers.
6. Gardner EJ, Simmons MJ, Snustad DP (1991). Principles of genetics (III edition). John Wiley and Inc.

Teaching-Learning Process

- Lectures : Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	√	√	√
CO2	√	√	×	√	×	×	√
CO3	√	√	√	√	√	√	√
CO4	√	×	×	×	√	√	√

M.Sc. Zoology
Semester III
25ZOO303 Developmental Biology

Maximum Marks: 100
Time: 3 hrs.

Theory Examination: 70
Internal Assessment: 30

Objective: To explain how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult, or more generally throughout a life cycle.

Outcomes:

- CO1 Based on learning contents of embryology, students can have a systematic and organized learning about the knowledge and concepts of growth and development.
- CO2 Developmental biology displays a rich array of material and conceptual practices that can be analyzed to better understand the scientific reasoning exhibited in experimental life sciences
- CO3 To understand biological processes that takes place in and between cells and in and between organisms in nature.
- CO4 This understanding will make the students capable of describing and explaining both biological processes and their importance for living organisms.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT I

Development in unicellular eukaryotes, Molecular basis of spermatogenesis, Oogenesis, fertilization, Cell surface molecules in recognition of animal zygote formation, Genomic equivalence

UNIT II

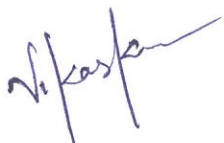
Cell fate and Cell lineages, Stem cells, their characteristics and stem cell therapy, Cleavage types and significance, Blastula, Fate maps, Morphogenetic gradients, Comparative account of Gastrulation (sea urchin, chick) Neurulation and ectoderm, Mesoderm and endoderm, coelom and pseudocoelom formation

UNIT III

Cytoplasmic inheritance and its determinants, Cell commitment, specification, induction, competence, determination and differentiation, Cell specification in nematodes, Germ cell determinants, Germ cell migration, Cell-Cell interaction, Mutants and transgenics in analysis of development, Cell aggregation and differentiation in Dictyostelium

UNIT IV

Caenorhabditis: Vulva formation Genetics of axis specification in Drosophila, chick Eye lens induction, limb development and regeneration in vertebrates, Differentiation of neurons, HOX genes Metamorphosis, Environmental regulation of normal development, Sex determination



Suggested Readings:**Text Books:**

1. S.F. Gilbert. Developmental Biology (2017). 11th Edition Sinauer Associates Inc., Massachusetts.
2. Balinsky and Fabian (2018) An Introduction to Embryology, 5th Edition, Springer

Reference Books:

1. L. Wolpert et. al. Principles of Development; Oxford University Press; 2002
2. Jonathan M. W. Slack. Essential Developmental Biology, 3rd Edition. 2012, WileyBlackwell
3. T. Subramonium. Molecular Developmental Biology, 2nd Edition, 2013. Narosa Publishing House
4. K.V. Sastry and Vineeta Shukla (2010). Developmental Biology, Rastogi publication, Meerut

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	√	√	×	√	×
CO2	√	×	√	√	×	√	√
CO3	√	√	√	√	√	√	√
CO4	√	√	√	√	×	√	×

M.Sc. Zoology
Semester III
25ZOO304 Bioinformatics

Maximum Marks: 100
Time: 3 hrs.

Theory Examination: 70
Internal Assessment: 30

Objectives:

1. It involves the integration of computers, software tools and databases in an effort to address biological questions.
2. It involves different tools to unwrap different biological functions arise during study.

Outcomes:

- CO1 To provides information to the students about database and sequence file formats for data analysis.
- CO2 To understand major biological databases and their uses in data analysis.
- CO3 To know Sequence comparison methods and molecular phylogeny.
- CO4 To know various methods for searching sequence databases like FASTA and BLAST Algorithms and their types.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit I

Introduction to bioinformatics: Branches, scope and research areas of bioinformatics; introduction to various sequence file formats; introduction to PERL: scalar variables, strings and numbers, arrays, hashes, operators, loops, regular expression; applications of PERL in bioinformatics. Introduction to databases: Classification scheme and features of biological databases; overview of various primary and secondary databases dealing with protein and nucleic acid sequences.

Unit II

Major biological databases: Primary databases of nucleic acid and protein: NCBI-Gen bank, EMBL, DDBJ; Swiss Prot, PIR. Other databases: Secondary protein database Prosite and PRINTS; secondary genomic database OMIM and OMIA, literature database Pub Med, metabolic database KEGG, Plasmodium database Plasmo DB, specialized databases including MIPS, TIGR, TAIR.

Unit III

Sequence comparison methods: Methods for the comparison of two sequences viz., dot matrix plots, Needleman Wunsch & Smith Waterman algorithms; analysis of computational complexities and the relative merits and demerits of each method; theory of scoring matrices and their use for sequence comparison; difference between PAM and BLOSUM; sequence similarity tools: CLUSTAL X/W; molecular phylogeny.

Unit IV

Database search algorithms: Methods for searching sequence databases like FASTA and BLAST algorithms; BLAST and its types; PSI-BLAST and RPS-BLAST; concept of position specific weight matrices and their use in sequence analysis; theory of profiles and their use with special reference to PSI BLAST; Markov chains and models; concept of HMMS, Viterbi algorithm; forward algorithm and Baum welch algorithm.

Suggested Readings:**Text Books:**

1. Teresa K., Attwood and David J. Parry-Smith. Introduction to Bioinformatics, Pearson Education, London.
2. Jin Xiong (2006). Essential Bioinformatics, Cambridge publisher.

Reference Books:

1. Bioinformatics: Principles and Applications by Zhumur Ghosh and Bibekanand Mallick (2008), Oxford University Press publisher.
2. Bioinformatics by Orpita Bosu and Simminder Kaur Thukral (2008), Oxford University Press publisher
3. Introduction to Bioinformatics by M Lesk (2014), Oxford University Press publisher.
4. Fundamental Concepts of Bioinformatics by Dan E Krane, Michael L Raymer (2014), Pearson Education.
5. Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug. Discovery by P Rastogi and N Mendiritta (2013), Prentice-Hall of India Pvt. Ltd.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	×	√	×	√	×
CO2	√	×	×	√	×	×	×
CO3	√	√	√	√	×	×	×
CO4	√	√	√	√	×	×	×







**M.Sc. Zoology
Semester III**

25ZOO305 Environmental Biology and Toxicology

**Maximum Marks: 100
Time: 3 hrs.**

**Theory Examination: 70
Internal Assessment: 30**

Objectives:

1. To apprise the students about the toxicants and their effects on human health
2. To identify relationships between chemical exposure and effects on physiological systems

Outcomes:

- CO1 The awareness about toxic agents, their different routes of exposure and their effects on humans and their livestock will be appraised.
- CO2 The students will have the knowledge about mode of transformation of toxicants
- CO3 It will help in creating skilled personnel in the field of environment protection and research.
- CO4 Students will understand ill-health and diseases that are related to exposure to chemicals in human everyday life

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT I

Environmental policies at global and national level. Remote sensing and geographic information system: Basic concepts, procedure and Applications. Concept of sustainable development: utility and significance

UNIT II

Environment impact assessment: environmental monitoring different phases and significance. Solid waste management: Primary waste products-Solid waste, Air, Water and Soil pollutants; hospital landfills.

UNIT III

Basic concept of toxicology, classification and route of absorption of toxicants, Food additives, Effect of pollutant on ecosystem with case study of important Organo-phosphorous and Organo-chlorine pesticides, Nitrates, Polychlorinated biphenyls, Clenbutarol, Xenobiotics

UNIT IV

Bioremediation, Biodetrification, Biomagnification: their role and significance, Applications of toxicology, Human toxicology, Genotoxicology and medicinal ethics. Toxic agents: metals, solvents, radiations, carcinogens, poisons, Biotoxins, petrochemical.

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20/5/26

Suggested Readings:**Text Books:**

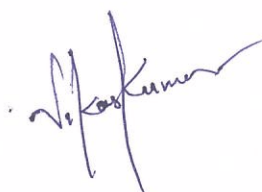
1. Fundamentals of Ecology (5 th Edition) by W.B. Odum, E.P. Saunders, Toppan Co. Ltd., Tokyo, Japan. (1963 1st Edition).
2. Environmental biology and toxicology by P.D. Sharma (2014), Rastogi Publication. Reference Books:
3. Concepts of Ecology by Edward J. Kormondy (4 th Edition) (2017); Prentice Hall of India (Pvt.) Ltd. 2. Ecology: from individuals to ecosystem (4 th Edition) by Michael Begen, Colen R, Harper 2005.
4. Environmental Pollution by H.M Dix. (1981), John Wiley Publications, New York.
5. Handbook of Solid Waste Management by D.G. Wilson (2017).
6. Environmental Studies by D.B. Botkin, & E.A. Keller (1995), Martill Publisng Co., Columbs, Toronto, London.
7. Ecology by Paul Colinvaux; John Wiley & Sons (1976), New York, Chichester, Brisbane, Toronto, Singapore.
8. Applied Ecology and Environmental Management by Edward I. Newman (2000).
9. Principle of Environmental Science by W.P. Cunningham & M.A. Cunningham (2018).
10. Biotranformation: Bioremediation Technology for Health & Environmental Protection by R. D. Stapleton Jr. and V.P. Singh (Ed) (2002), Elsevier.

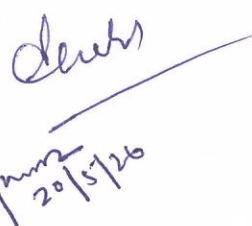
Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	×	√	√	√	×
CO2	×	√	√	√	√	√	×
CO3	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√



9/11/2025

**M.Sc. Zoology
Semester III
25ZOO309 IPR and GLP**

**Maximum Marks: 100
Time: 3 hrs.**

**Theory Examination: 70
Internal Assessment: 30**

Objectives:

1. The course aims to introduce students about the evolution of IP and its importance in the present context. The course also aims to apprise students about the kinds of IP and general principles of IP rights.
2. Familiarize students with biosafety, waste disposal, documentation, and quality assurance procedures. Prepare students for research laboratories, diagnostic laboratories, biotechnology industries, and regulatory environments.

Outcomes:

- CO1 The course would provide a platform to students of different disciplines to learn principles of IP which has become a buzzword in the present times given the im- portance and application of IP in different subjects.
- CO2 The course would add value to the knowledge of students who are desirous of learn- ing IP and making their career in the field of IP.
- CO3 The course would also contribute by creating a task force of IP knowing students who will tomorrow represent the university in different forums and platforms.
- CO4 Students will understand research laboratories, diagnostic laboratories, biotechnology industries, and regulatory environments.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit I

Evolution of Intellectual Property and Kinds of IPRs: Introduction, Historical Perspective of IPR, Analyzing and understanding IP Framework, Need for Protecting IP, Impact of IPR on Business Development. Forms of IPR, Copyright, Trademark, Patents.

Unit II

Nature & Rationale of IPRs: Different theories on concept of property, Nature (territorial, monopolistic, fixed terms etc.), Public Vs. Private – Tangible Vs. Intangible, Protected v/s open source, open innovation, National IPR Policy 2016.

Unit III

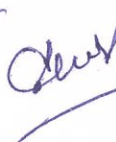
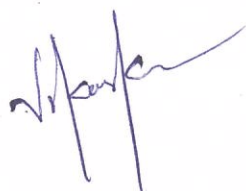
Introduction to Good Laboratory Practices: Definition, concept, and history of GLP, Objectives and significance of GLP in life sciences.

Principles and components of GLP, Organization and management of laboratory facilities.

Roles and responsibilities of laboratory personnel, Laboratory design and infrastructure requirements, Standard Operating Procedures (SOPs).

Unit IV

Handling of Laboratory Equipment and Specimens: Calibration and maintenance of laboratory instruments, Microscopes, centrifuges, incubators, spectrophotometers, PCR machines, Animal handling and ethical considerations, Collection, preservation, labelling, and storage of zoological specimens, Sample preparation and contamination control, Good microbiological and molecular biology practices.



Suggested readings:**Primary Text:**

Textbook on Intellectual Property Rights by N. K. Acharya

Supplementary Reading:

Law Relating to Intellectual Property Rights by V. K. Ahuja

Policy & Current Framework:

National IPR Policy 2016 and WIPO resources

OECD GLP Guidelines

WHO Biosafety Manuals

CPCSEA animal ethics guidelines

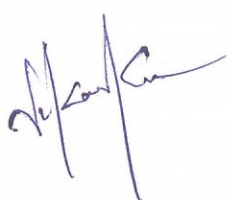
ICMR laboratory and biosafety guidelines

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C01	√	√	×	√	√	√	×
C02	×	√	√	√	√	√	×
C03	√	√	√	√	√	√	√
C04	√	√	√	√	√	√	√







**M.Sc. Zoology
Semester III**

(25ZOO306) Lab Course I (PC 5) (Based on 25ZOO301 & 25ZOO302)

Total Marks: 50**Time: 4 hours**

Evaluation scheme in examination

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

1. To explore the molecular mechanism of action of hormones and nervous system involved in various physiological processes
2. To know basic principles of genetics, concept of linkage, mutation, chromosomal structure, variations and their effects on biological system

Outcomes:

CO1 To explain the connection of two whole body system (endo and neuro) in regulating all functions of the body.

CO2 To understand how the hormones and nervous system help in regulation of physiology.

CO3 For understanding of basic principles of Mendelian inheritance, concept of linkage and mutagenesis.

CO4 To develop the understanding of management of inherited diseases.

Course contents:

1. Identify the stage of oestrous cycle.
2. To show the endocrine glands in human through charts/models/video clipping.
3. To study the histology of endocrine glands through permanent stained slides.
4. To study the corrective measures for myopia, hypermetropia, astigmatism, cataract.
5. To study the structure of eye, ear and different types of neurons through charts/models.
6. Study of mutant phenotypes of Drosophila.
7. Demonstration of law of segregation using Drosophila mutants.
8. Study of law of independent assortment by modals
9. Demonstration of sex- linkage by using mutation of Drosophila.
10. Demonstration of dosage compensation in Drosophila males and females.
11. Demonstration of Green Fluorescence and Red Fluorescence protein for monitoring gene expression.
12. Study of sex chromatin in buccal smear and hair bud cells (Human).
13. Study of Hardy-Weinberg equilibrium in human population by taking the example of blood group system (ABO).
14. If feasible Field Visit to Zoological sites/Parks/ Anthropology/Science museums/Research Labs/ Biosafety Labs/ Wild Life Institutes/ Sanctuaries/ or any site of Zoological Interest. Submission of Project report/presentation by the students.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	√	√	×	×	×
CO2	√	√	√	√	√	×	×
CO3	√	√	√	√	√	√	×
CO4	√	√	√	√	√	√	×

M.Sc. Zoology
Semester III
(25ZOO307) Lab Course II (PC 6)

(Based on 25ZOO303 & 25ZOO304 OR 25ZOO305 OR 25ZOO309)

Total Marks: 50

Time: 4 hours

Evaluation scheme in examination

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objectives:

1. Practical knowledge of important concept and types of development
2. In depth knowledge of Theory and practice of wildlife conservation

Outcomes:

- CO1 It will boost students for keen understanding development pattern of various animals.
 CO2 Students will acquire a clear practical understanding about larvae of different arthropods and their importance in its life cycle.
 CO3 Students will know about the practical approaches of protected area system in India
 CO4 Detail understanding of standard pug marks of large sized wild mammals

Course contents:**25ZOO303 Developmental Biology**

1. To study the different stages of development in frog and chick through permanent slides.
2. To study the spermatogenesis of grasshopper and mammal through slides.
3. To study different larvae in invertebrates from permanent slides.
4. To study the larvae of invertebrates (Redia, Cercaria, Arthropod larvae, Glochidium larva) through permanent slides.
5. Study of salivary gland chromosomes of larvae of chironomus/Drosophila from permanent slides.
6. Study of metaphase karyotypes from photographs/permanent slides of Drosophila, grasshopper and man/rat.
7. Demonstration of monohybrid and dihybrid cross, Co-dominance, Incomplete dominance and Epistasis with the help of beads and photographs.

Discipline Specific Elective # any one out of three given below**25ZOO304 Bioinformatics**

1. Retrieve single nucleotide sequence from NCBI serve.
2. Retrieve multiple nucleotide sequences through Entrez.
3. Retrieve Protein sequences from PDB.
4. Analysis of sequence similarity using BLAST.
5. To predict homology of any nucleotide/ protein sequence against respective database.
6. Perform multiple sequence alignment by using Clustal W.

25ZOO305 Environmental Biology and Toxicology

1. Bioassay to demonstrate toxicological effect.
2. Study of various components of pond ecosystem.

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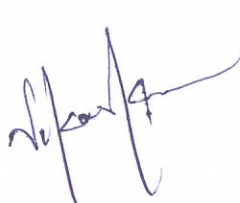
3. Determination of Water quality characteristics viz: Dissolved oxygen, pH, B.O.D and C.O.D. test
4. Determination of phosphate, ammonia and nitrate in water.
5. Determination of sediment chemistry: Moisture, Carbonate, Nitrate, pH, Phosphate, Texture and Organic Carbon
6. Gel electrophoresis

25ZOO309 IPR and GLP

1. Demonstration of laboratory safety procedures.
2. Use and maintenance of microscopes and common laboratory instruments.
3. Proper labelling and storage of biological specimens.
4. Preparation and maintenance of laboratory records/notebooks.
5. Biosafety cabinet handling and sterilization methods.
6. Biomedical waste segregation and disposal practices.
7. Calibration demonstration of laboratory equipment.
8. Patent database search using Indian Patent Office and WIPO databases.
9. Drafting of a provisional patent application.
10. Case study analysis on biopiracy.
11. Identification of plagiarism using software tools.
12. Preparation of trademark/copyright application format.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	×	√	√
CO2	√	√	√	√	√	√	√
CO3	√	√	×	√	√	√	√
CO4	√	√	√	√	√	√	√







M.Sc. Zoology
Semester III
25ZOO308 Entrepreneurship in Statistical Biology

Maximum Marks: 50

Time: 3 hrs.

Theory Examination: 35

Internal Assessment: 15

Note: There shall be nine questions in all. Question no.1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Students will have to attempt one question from each unit. Each question shall carry equal marks.

Objective: The course is designed to train students in basic statistical applications in biology.

Course Outcomes: After completion of the course

CO1: The students will be able to describe theoretical sources of biological data, and its presentation.

CO2: The students will be able to explain the fundamental concepts of biostatistics, as well as their diverse applications in various fields of biological sciences.

CO3: The students will be able to understand the regression analysis, Z-test, t-Test, chi-square test and one- and two-way ANOVA.

CO4: The students will be able to explain the correlation analysis.

Unit I

Preliminary concepts: Variables and constants; random samples; discrete and continuous variables; variables in biology; accuracy and precision.

Presentation of data: Types of graphs; modes of graphical representation of data; line graph; bar diagram; pie, circle and sector chart; histogram; frequency polygon; frequency curve; frequency distribution; relative and cumulative frequency distribution.

Unit II

Measures of central tendency: Mean; median; mode; empirical relationship between mean, median and mode; quartile and percentile.

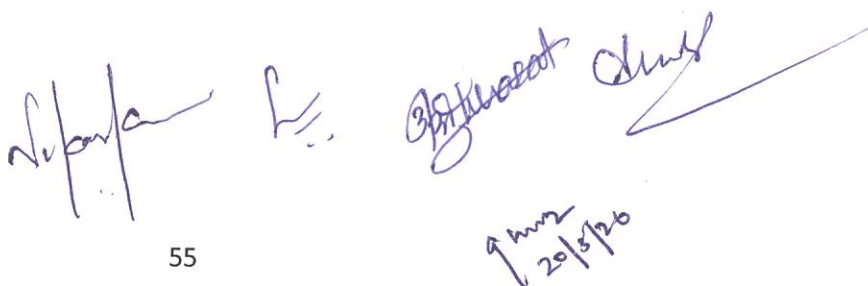
Measures of dispersion: Variability; range; mean deviation; coefficient of mean deviation; standard deviation; merits, demerits and uses of standard deviation; calculation of standard deviation.

Unit III

Regression analysis: Regression coefficients; properties of regression coefficients; student's t-test; chi-square test; f-test; one- and two-way ANOVA.

Unit IV

Correlation analysis: Correlation; co-variance; calculation of co-variance; correlation analysis; correlation coefficient calculated from ungrouped data; Spearson's rank correlation coefficient; estimation of correlation coefficient using scattered diagrams.


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Books Recommended:

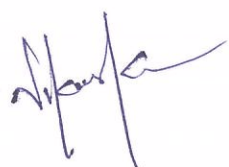
1. Zar, J.H., Biostatistical Analysis, Pearson Education.
2. Bhise, S.B., Textbook of computer applications and biostatistics, Trinity Publishing house.
3. Gupta, S.P., Statistical Methods, S. Chand & Sons, New Delhi.
4. Arora, P.N., and Malhan, P.K., Biostatistics, Himalayan publishing house.
5. Grant, G.R., Ewens, W.J., Statistical methods in bioinformatics: An introduction. Springer Verlag.
6. Jagota, A., Data analysis and classification for bioinformatics. Bioinformatics by the bay.

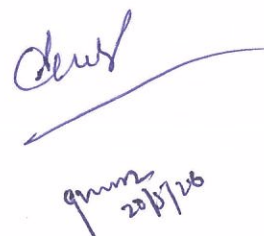
Teaching learning process:

- **Lectures (online and offline mode):** Through white board, notes, power point presentation supported by smart class rooms and other online teaching platforms like Google meet and Google classroom. etc.
- **Doubt session :** once in a week
- **Assignments, seminars and different exercises**
- **Tests:** Learning level of the students will be tested through class tests, quizzes, surprise evaluation, assignments sessional exams and through interactive sessions.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	×	√	×	√	√	√	×
CO2	√	√	×	√	√	√	×
CO3	×	×	×	√	√	√	×
CO4	×	×	×	√	√	√	×



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M.Sc. Zoology
Semester IV
25ZOO401 Molecular Immunology

Maximum Marks: 100
Time: 3 hrs.

Theory Examination: 70
Internal Assessment: 30

Objectives: To provide knowledge of fundamentals of immune system and the immunological basis for treatment of some common diseases.

Outcomes:

- CO1 How the immune system can fight infection and other diseases
- CO2 The strategies to improve existing vaccines and how to approach these
- CO3 Cellular and molecular basis of inflammatory response
- CO4 Mechanisms involved in control of immune response

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT I

1st and 2nd line of defense mechanism, Innate and adaptive immune system, Cells and molecules involved in innate and adaptive immunity, Antigens, antigenicity and immunogenicity, B and T cell epitopes, Structure and function of antibody molecules, Generation of antibody diversity

UNIT II

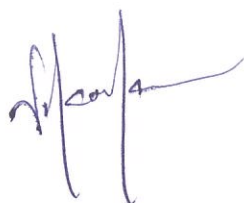
Monoclonal antibodies, Antigen-antibody interactions, MHC haplotypes, Class I and class II molecules, Cellular distribution of MHC, Peptide binding of MHC, Expression and diversity of MHC, Antigen processing and presentation

UNIT III

Activation, maturation and differentiation of B and T cells, B and T cell receptors, Humoral and cell-mediated immune responses, Primary and secondary immune modulation, The complement system, PRR: Toll-like receptors, Opsonization.

UNIT IV

Inflammation, Fever, Hypersensitivity Autoimmunity, Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, Congenital Acquired immune deficiencies.



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Suggested Readings:**Text Books:**

1. Kuby Immunology by Jenni Punt Stranford et al., (8th Edition) (2018), Books Wagan.
2. Microbiology: An Introduction. Tortora by Gerrard J. et al. (2007). Better World Books Ltd UK.

Reference Books:

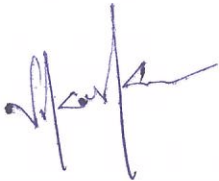
1. W. Paul. (2012). Fundamentals of Immunology. L. Williams and Wilkins.
2. Essential of Immunology by Dr. S.K. Gupta (2nd edition), Arya Publication, 2017.
3. A Text Book of Microbiology by R.C. Dubey, S. Chand Publication, 2013.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	×	×	×	√	×
CO2	×	√	×	×	×	√	×
CO3	√	×	×	×	×	√	×
CO4	×	√	×	×	×	√	×





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M.Sc. Zoology
Semester IV
25ZOO402 Ecology and Evolution

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objective:

1. To expose the students in understanding various types of interactions between biotic and abiotic components of environment, biogeochemistry, energy flow, or biodiversity of ecosystems responds to climate change or another disturbance
2. To understand the origin and progression of life on earth with conventional and novel evidences and techniques, in depth knowledge of process of speciation with concept of ecology & evolution.

Outcomes:

- CO1 Students will be able to understand and explain the need for intra- and interdisciplinary cooperation in researching different ecosystems, the all biotic and abiotic factors that are related to individual, population, community and ecosystem and defines the relationships between them.
- CO2 Information provided will give an insight about the benefits of ecosystem and can be used in the management of natural resources for sustainable development in ways that leave the environment healthy and many specialties within ecology such as marine, vegetation and statistical ecology provides students information to better understand the environment around them
- CO3 To provide students the basic insight about the mechanism of evolution and to make them able to relate different forms of life on our planet earth. It will also provide them in-depth knowledge about the changing frequency and distribution of alleles within the population.
- CO4 Detail understanding of molecular phylogenetics and methods of construction of phylogenetic tree

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT- I

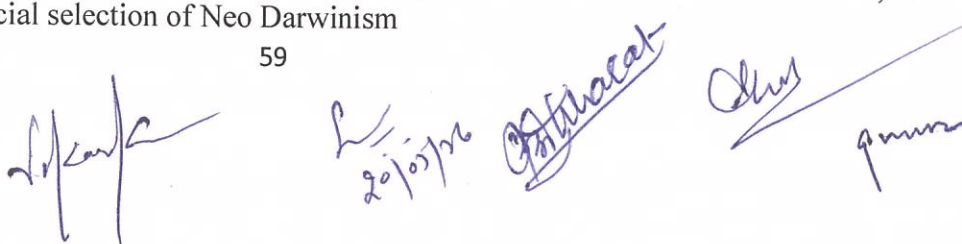
Physical environment, Concept of habitat and niche, resource partitioning, Characteristics of a population, population growth curves, population regulation, life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations, Types of species interactions and relationships.

UNIT- II

Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones, Ecological Succession, its Types and mechanisms, changes involved in succession, concept of climax, Ecosystem structure and function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine), Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

UNIT- III

Emergence of Evolutionary Thought and Mechanism, Lamarck, Darwin, Concept of variation, adaptation, struggle, fitness and natural selection, The evolutionary synthesis, Convergent and Divergent evolution, RNA World and Molecular evolution, Molecular tools in phylogeny, classification and identification; Gene duplication and divergence; artificial selection of Neo Darwinism



UNIT IV

Evolutionary time scale: eras, periods and epoch, Major events in evolutionary time scale: Concepts of Oparin and Haldane, Experiments of Miller, Origins of cells, unicellular, multicellular organisms, Anaerobic metabolism, photosynthesis and aerobic metabolism. Concept of Speciation and its methods, Evolution of *Homo sapiens*

Suggested Readings:**Text Books:**

1. Organic Evolution by Veer Bala Rastogi, Published by MEDTECH (2016).
2. Principles of Systematic Zoology by E. Mayr and P. D. Ashlock, Tata McGraw Hill Publishing Co. Ltd., New Delhi; 1991.

References Books:

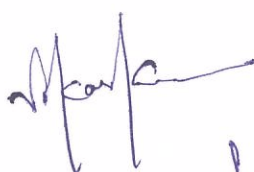
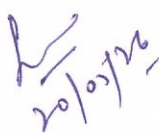
1. Genetics and the origin of species by T. Dobzhansky, Columbia University Press; 1951.
2. Taxonomy by R.E. Blackwelder, John Wiley & Sons, New York; 1967.
3. Organic Evolution by Lull, MacMillan Co., New York; 1947.
4. Time, life and Man by R.A. Stirton, John Wiley and Sons, New York; 1959.
5. Evolution of the Vertebrates by E.H. Colbert, Willy Eastern Ltd., New Delhi; 1969

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	√
CO3	√	√	√	√	√	√	√
CO4	√	√	√	√	√	√	√




M.Sc. Zoology
Semester IV
25ZOO403 Genetic Engineering

Maximum Marks: 100
Time: 3 hrs.

Theory Examination: 70
Internal Assessment: 30

Objective:

1. To understand the basic principles of various techniques and their utilization in analysis of biological samples.
2. To teach students the common laboratory techniques that are frequently used in research, medical/clinical, and bio industry fields.

Outcomes:

- CO1 To understand the scope of genetic engineering techniques for the welfare of mankind
- CO2 Student may able to handle various sophisticated analytical instruments and a get hands-on experience on various molecular biology techniques
- CO3 To understand the importance of genome and techniques for its analysis, storage and modification.
- CO4 To recognise the potential of genetic recombination and gene therapy.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

Unit I

Scope in genetic engineering techniques for the welfare of mankind, Basic cloning method: Cloning vectors, steps involved in gene cloning, Different enzymes and their Applications: DNA and RNA polymerase, reverse transcriptase, alkaline phosphatase, kinase, ligase, RNase, DNase, topoisomerase, Restriction endonucleases: R-M system, nomenclature of RE, Types and recognition, cleavage sites and application of endonucleases.

Unit II

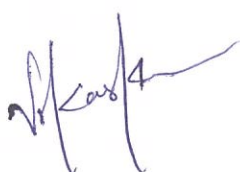
Nucleic Acid Purification, cDNA Synthesis, Yield Analysis, agarose gel electrophoresis, PCR (DNA Amplification, primer designing and its Applications), Gene Cloning Vectors: Plasmids, lambda bacteriophage, yeast cloning vector, Artificial chromosome (YAC, BAC), Shuttle vector, expression vector. Cloning and expression of DNA in Plant, yeast, insect cells, mammalian cells.

Unit -III

Nucleic Acid Sequencing (Chain termination, chemical degradation, automated, pyrosequencing), Nucleic acid blotting and hybridization (Southern, Northern and dot blot hybridizations), Introduction to Microarray, molecular markers: RFLP, RAPD, AFLP, SNP

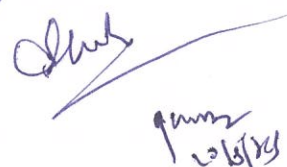
Unit -IV

Recombinant proteins: Purification of proteins and folding, characterization and stabilization. Protein analysis: SDS Page and Western blotting, T-DNA and Transposon Tagging, Zinc finger nucleases (ZFN), Transcription activator-like effector nucleases (TALEN) and clustered regularly interspaced short palindromic repeats (CRISPR), Gene therapy, Gene knockout and gene silencing.



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Suggested Readings:**Text Books:**

1. Genetic Engineering: Rastogi and Pathak, Oxford University Press.
2. Metzenberg, Stan. Working with DNA. Oxford: Taylor and Francis.

Reference books:

1. Brown, T.A. Gene Cloning and DNA Analysis: An Introduction. United Kingdom: WileyBlackwell.
2. Sambrook J., MacCallum P. and David Russell. Molecular Cloning: A Laboratory Manual (3rd edition, three-book set). New York, USA: CSHL Press.
3. Primrose S. B., Twyman R. M., Old R. W. Principles of Gene Manipulation. WileyBlackwell, 2001.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	√	√	√
CO2	×	×	√	√	√	√	×
CO3	×	×	√	√	√	√	√
CO4	×	×	×	√	√	√	×

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**M.Sc. Zoology
Semester IV
25ZOO404 Aquaculture**

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. To acquaint the students about the huge diversity of fishes
2. To develop ability for different type of aquaculture practices.
3. To acquaint about biology of fish and methods of aquaculture, which are important contributors to food security.

Outcomes:

- CO1 Through this core elective paper student/s will learn identification of fish species and culture techniques of aquatic organisms
- CO2 This core elective paper will generate knowledge about various methods and significance of aquaculture
- CO3 It will create awareness about food security, significance of protein in diet and importance of fish in fighting protein deficiency
- CO4 It will also be helpful in acquainting with methods of conserving fish diversity.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Types of aquaculture: pond culture, cage culture, raceway culture; Sustainable Aquaculture: scope and its types: traditional, extensive, intensive, semi-intensive. Integrated Aquaculture and waste water aquaculture, Poly culture, Pearl culture, Shrimp culture, Prawn culture-Fresh and brackish water

Unit-II

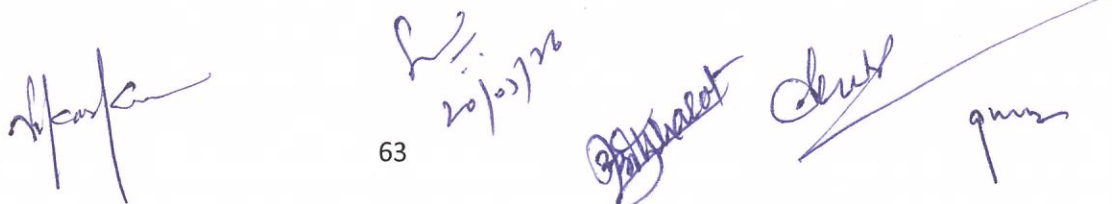
- Impact of Aquaculture on Environment, Nutrition in Aquaculture, Preparation and processing of feed, feed formulae, Natural and supplementary feed and their utilization; Culture of important fish species (Indian Major carps and common carps). Composite fish culture of endemic and exotic fishes in India. Ecology of fish pond ecosystem: Physico-chemical conditions of pond water and soil

UNIT-III

Induced breeding: Definition, different kinds of hatcheries and advantages of induced breeding in fishes. Use of synthetic chemicals for induced breeding; Fish diseases: Fungal, bacterial, protozoan, worm and crustacean diseases of fishes; Methods of fishing: Crafts and Gear technology, Osmoregulation in fishes, Migration in fishes

UNIT-IV

Rigor Mortis, Fish processing and preservation: (drying, salting and smoking), Chilling and freezing of fish, canning of fish and fish products. Fish transportation and marketing. Concept of Transgenic organisms, GMO's and bio safety regulations, fish-biotech, androgenesis, gynogenesis, polyploidy

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Suggested Readings:**Text Books:**

1. Fish and Fisheries of India by Jhingran, V.G., Hindustan Publishing Corporation, New Delhi; 1991.
2. A Text Book of Fisheries Science and Indian Fisheries, by CBL Srivastav (2006), Kitab Mahal.
3. Experimental ichthyology by Garg et al., 2008, CBS

Reference Books:

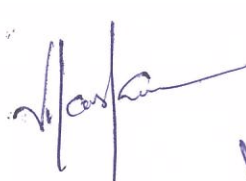
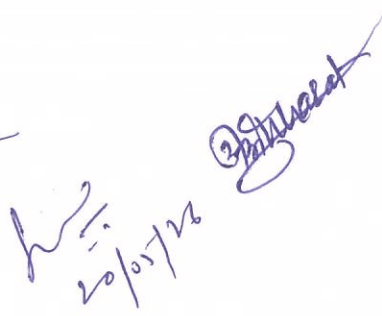
1. Inland Fisheries of India, Vol. I & II by Talwar P.K. and Jhingran A.G., Oxford & IBH, New Delhi; 1991.
2. Methods for Assessment of Fish Production in Freshwaters by Bagenal, T.B., IBP Handbook No. 3, Blackwell Scientific Publications Ltd., Oxford; 1970.
3. Fishery Development by Agarwal, S.C. and Johal, M.S., Narendra Publishing House, Delhi; 2004.
4. History of Fishes by Norman, J., Ernst Brown, London; 1999.
5. Biology of fishes by Kyle H.M., Biotech. Books, New Delhi; 2007.
6. Freshwater Ecology: Concepts and environmental applications by Dodds, Walter K. Academic Press, USA; 2002.
7. The Biology of fishes: New Introduction by Dr. Vijay Dev Singh by M. Hary. Kyle. Biotech. Books, New Delhi; 2007.
8. Aquaculture Principles and Practices, Pillay, T. V.R., Blackwell Publishing, USA
9. Aquaculture and Fisheries Biotechnology Genetic Approaches, Dunham, R.A., CAB International, USA

Teaching-Learning Process

- Lectures : Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through classroom discussion, surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	×	√	√	√	√
CO2	×	√	×	√	√	√	√
CO3	×	√	×	√	√	√	√
CO4	×	√	×	√	√	√	√



**M.Sc. Zoology
Semester IV**

25ZOO405 Insect Morphology and Physiology

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objectives:

1. To provide intimacy between insects and environment as insects are the most abundant animals on earth and have huge economic value.
2. To understand the scope and importance of insect morphology and physiology: their principles, utility and relevance

Outcomes:

- CO1 Description of head- origin, structure and modification; types of mouthparts and antennae and Description of Thorax- Areas and sutures. Wings: structure and modifications, wing coupling apparatus and mechanism of flight. Legs: structure and modifications
- CO2 Biology, adaptation, host seeking behaviour of eusocial, predatory and parasitic groups of insects, their metamorphosis and moulting.
- CO3 Described structure, modification and physiology of different systems.
- CO4 Understanding of reproduction in insects, their sense organs and insect hormones.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT -I

Classification and diagnostic features of insects and their orders. Classification of Orthoptera, Hemiptera, Lepidoptera, Diptera and Coleoptera up to families (important ones only). Structure and evolution of wings and its variation.

UNIT II

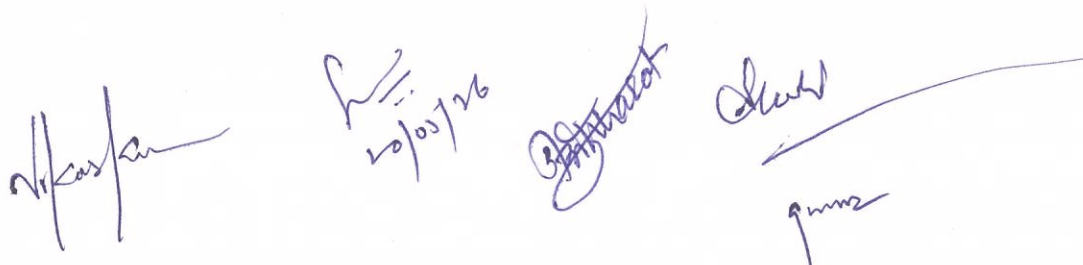
Pollination and Myrmacochory. Insect societies: Subsociality in insect; Eusociality in insect (Colony and Castes in Hymenoptera and Isoptera). Insect metamorphosis, moulting and diapause. Insect Predation and parasitism

UNIT-III

Structure and function of following systems in insects: digestive system, respiratory system, circulatory system, immune system and excretory system of periplanta, Apis and grass hopper

UNIT-IV

Anatomy and physiology of following systems in insects: Reproductive system, Nervous system of periplanta, Apis and grass hopper, Types of Receptors, sound reception and sound production, insect vision (structure and function of compound eye), Pheromones, Kairomones and allomones.



Suggested Reading:

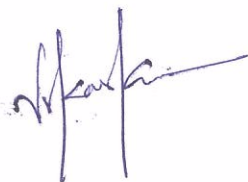
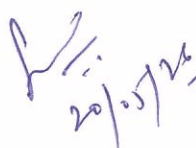
1. The Insect-Structure and Function. - by R.F. Chapman (5 th Edition) 2012. Cambridge University Press.
2. Imm's General Text Book of Entomology –by O.W. Richards and R.G. Davies (10th Edition) Springer (1977).
3. The Insect an outline of Entomology- by P.G. Gullan and P.S. Cranston (5 th Edition) (2014), Willey Blackwell.

Teaching-Learning Process

- Lectures : Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	√	√	√	√	√
CO2	√	√	√	√	×	√	√
CO3	√	√	×	√	√	√	√
CO4	√	√	×	√	√	√	√




**M.Sc. Zoology
Semester IV**

25ZOO406 Animal Behaviour and Wild Life Conservation

Maximum Marks: 100

Time: 3 hrs.

Theory Examination: 70

Internal Assessment: 30

Objectives: To explore the important concept of animal behaviour and conservation.

Course Outcomes:

- CO1 Understand animal behaviour and its evolutionary basis by explaining innate and learned behaviour, proximate and ultimate causation, altruism, learning, memory, cognition, and biological rhythms.
- CO2 Analyze behavioural adaptations in animals including communication, territoriality, dominance, migration, reproductive behaviour, parental care, aggression, orientation, and navigation.
- CO3 Develop knowledge of wildlife ecology and management practices through understanding wildlife zones of India, protected area systems, and wildlife census techniques.
- CO4 Evaluate wildlife conservation strategies and human-wildlife conflict management with reference to endangered species categories, conservation organizations, and national wildlife projects such as Project Tiger, Project Elephant, Project Rhinoceros, and Project Crocodile.

Note: There shall be nine questions in all. Question no. 1 shall be compulsory, consisting of seven short answer type questions covering the entire syllabus. Two questions will be asked from each unit. Student will have to attempt one question from each unit. Each question shall carry equal marks.

UNIT-I

Approaches and Methods in Study of Behaviour; Innate and Learned Behaviour; Proximate and Ultimate Causations; Altruism and Evolution-Group Selection, Kin Selection, Reciprocal Altruism, Concept of Learning, Memory, Cognition, Biological clock and rhythms

UNIT-II

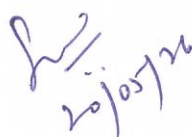
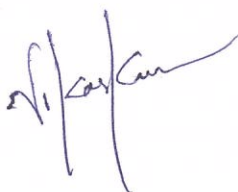
Development of Behaviour, Social communication, Pheromones, Social Dominance; Territoriality; Reproductive Behaviour, Parental Care, Aggressive Behaviour, Migration, Orientation and Navigation;

UNIT-III

Wildlife: Definition, significance and wildlife zones of India. Protected Area Systems (PAS): Concept and management. Wild life census: its planning, understanding of sample counts, block counts, road side counts, dung counts, pugmark census, water-hole census

UNIT-IV

Wild life damage, its nature and definition, various methods to control wild life damage. Wildlife conservation techniques, role of WWF, IUCN, Red Data Book; Categories of Endangered Wildlife Species. National projects: Project tiger, Project elephant, Project rhinoceros, Project crocodile.



Suggested Readings:**Text Books:**

1. Mohan P. Arora 1995. Animal Behaviour, Himalaya Publishing House
2. V.K. Aggarwal, 2010 Animal Behaviour (ethology) , S.Chand
3. S. K. Singh, 2015. Text book of Wild Life Management, CBS.

Reference Books:

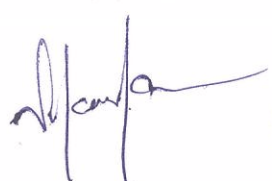
1. Techniques for wildlife Census in India by W.A. Rogers (A field manual) (1991); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majupuria (1986) Tecpress Services, L.P., 487/42 SOL Wattenslip, Pratunam Bangkok, 10400, Thailand.
3. Ali, S. Ripley S.D (2002). Handbook of Birds of India, Pakistan 10-Vols. Oxford University.
4. The Book of Indian Animals by S.H. Prater (1990), BNHS-Publication, Bombay.

Teaching-Learning Process

- Lectures: Supported by power point presentations and related videos
- Assignments and exercises
- Test: Knowledge of the students is tested through surprise tests, quiz & session tests.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	×	√	√
CO2	√	√	√	√	√	√	√
CO3	×	×	√	×	√	√	√
CO4	×	×	√	√	√	√	√







M.Sc. Zoology
Semester IV
(25ZOO407) Lab Course I (PC-7) (Based on 25ZOO401 & 25ZOO402)

Total Marks: 50**Time: 4 hours****Evaluation scheme in examination:**

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objective:

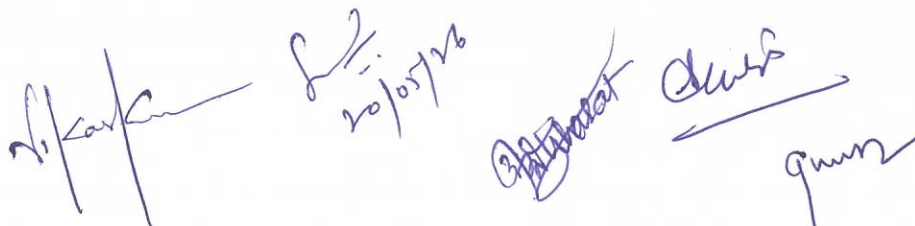
1. To provide the students with the knowledge about the blood cells, antigen, antibody.
2. To understand the ecology and evolution.

Outcomes

- CO1 Students will know the principle and various techniques.
 CO2 Students will able to prepare the blood film and identify the different blood cells.
 CO3 Students will understand various physical factors of the environment.
 CO4 Students understand the evolution of various mammals.

Course contents:

1. Blood film preparation and identification of cells
2. To identify blood group antigens
3. Lymphoid organs and their microscopic organization
4. Immunization, Collection of Serum
5. Transfection of Hela Cells
6. Separation of mononuclear cells by Ficoll-Hypaque
7. ELISA
8. Hapten Conjugation and quantitation
9. Immunodiagnosics (demonstration using commercial kits)
10. Calculation of population density in natural/hypothetical community and calculation of its Shannon Weiner Diversity by Quadrat method
11. Study of life tables, Survivorship curves and Fecundity tables of Hypothetical Population.
12. Determination of pH of soil sample.
13. Study of ecological pyramids in hypothetical community.
14. Study of ancestry of man, horse, camel and elephant through charts/models.
15. Study of origin of invertebrate and vertebrate groups through charts.
16. IfffeasibleFieldVisittoZoologicalsites/Parks/Anthropology/Sciencemuseums/ResearchLabs/BiosafetyLabs/WildLifeInstitutes/Sanctuaries/oranysiteofZoologicalInterest. Submission of Project report/presentation by the students.



 20/05/20

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	×	×	×	√	√	×
CO2	√	×	×	×	√	√	×
CO3	×	×	√	√	√	√	√
CO4	√	√	√	√	√	√	√

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**M.Sc. Zoology
Semester IV**

Lab Course II (PC-8) (25ZOO408)

(Based on 25ZOO403 & 25ZOO404 OR 25ZOO405 OR 25ZOO406)

Total Marks: 50

Time: 4 hours

Evaluation scheme in examination:

Practical Performance & Evaluation	Viva-voce	Practical Record/File
35	10	05

Objectives :

1. To develop capability of identifying different species of fishes, their taxonomic status and their anatomy
2. To train students for analysis of physico-chemical and biological conditions of water

Outcomes:

- CO1 Student/s will be able to identify of fish species using classical morphological methods
- CO2 This will develop students capable of using different fish nets and gears for capturing fishes and also of conducting small projects
- CO3 Students will be able to conduct qualitative and quantitative analysis of phyto and Zooplanktons
- CO4 This practical course will also be helpful to develop personnel to develop career in organizations where water quality analysis and fish diversity studies are carried out

Course contents:

25ZOO403 Genetic Engineering

1. Media preparation, LB plate with and without antibiotic preparation and sterilization.
2. Inoculation of bacteria E-coli and growth monitoring using spectrophotometer
3. Isolation of genomic and plasmid DNA from E-coli Bacteria
4. Quantification of DNA using UV spectrophotometer
5. Separation of DNA through agarose gel electrophoresis
6. Restriction Digestion DNA using EcoRI, BamHI or other restriction enzymes
7. Amplification of Plasmid DNA using PCR
8. Cloning of DNA fragment using TA cloning vector.

Discipline Specific Elective # any one out of three given below

25ZOO404 Aquaculture

1. To estimate the dissolved oxygen in water.
2. To estimate the pH of water.
3. To estimate the phosphate of water.
4. To determine the BOD, chloride and hardness of water.
5. To study the benthic organisms.
6. To study the different types of fishing gears.
7. To study the Indian culturable fishes.
8. To study the Exotic culturable fishes.
9. qualitative and quantitative analysis of planktons
10. Determine approx. Composition of feed

25ZOO405: Insect Morphology and Physiology

1. Study of insect biodiversity in natural environment and preparation of project based on

the observation.

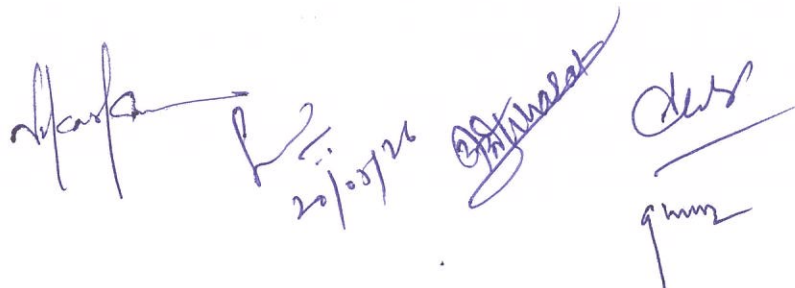
2. Identification marks and taxonomic status of insect pests of crops vegetables, fruits and stored products mentioned in theory syllabus.
3. Demonstration of dissection of insects for the study of following systems through charts/models/video clippings.
 - a. Digestive System
 - b. Nervous System
 - c. Reproductive System.
4. Systematic position upto family and ecology of the following medical and veterinary pests : Anopheles, Culex, Aedes, sandfly
5. Systematic position upto family and ecology of the following medical and agricultural pests : a. pyrillapurpusila, b. aulacophora, c. Plutella, d. Pinkboll worm, e. Dysdercus f. Gandhi bug, h. Blister beetle
6. Introduction to apiculture practices and handling of Beehives.
7. Study of male and female external genitalia of insects through permanent slides.
8. Study of different types of larvae and pupae with the help of charts/ photographs/ diagrams.
9. Study of mouth parts of insects

25ZOO406 Animal Behavior and Wild life conservation

1. To prepare charts of wildlife zones of India
2. To study mobbing response of birds in field.
3. Demonstration of food preferences in *tribolium/Rhizopertha/Callosbruchus*.
4. To study the effect of temperature on gill movement in fishes.
5. Communication in ants by pheromones.
6. Preparation of charts of endangered amphibians, reptiles and mammals with ecological remarks.
7. Animal behaviour patterns using photostat sheets.
8. Analysis of standard pugmarks of large sized wild mammals
9. Field visit to a zoo or wildlife part/sanctuary and preparation of field report.

Course mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	√	√	√	√	√	√	√
CO2	√	√	√	√	√	√	×
CO3	×	×	√	√	√	√	√
CO4	×	×	×	√	√	√	√



 20/05/22