

University of Ladakh



COURSE STRUCTURE AND SYLLABI FOR M.Sc. ZOOLOGY

(Effective from Academic Year 2023)

**DEPARTMENT OF ZOOLOGY, LEH CAMPUS,
TARUTHANG LEH LADAKH-194101**

DEPARTMENT OF ZOOLOGY, LEH CAMPUS, UNIVERSITY OF LADAKH.

Course Structure and Syllabi for M.Sc. Zoology

(Effective from Academic Year 2023)

OBJECTIVE OF THE PROGRAMME:

M.Sc. program of this department, will specifically sensitize, students to carryout research work in different fields of pure and applied Zoology, particularly to explore extensive wetlands and fauna of Ladakh. The academic training imparted to the M.Sc. students, aim at increasing their understanding in the field of Entomology, Fish Biology, Animal Physiology, Immunology, Developmental Biology, Cell Signaling, Cell Biology, Reproductive Biology and Endocrinology. The department will prove to be a leading institution, to study cold-resistant strategies, adopted by various animal taxa to survive in the sub-zero conditions during the extended winter.

OUTCOME OF THE PROGRAMME:

After completion of M.Sc. Zoology, the students will be able to:

- Appreciate the interplay of molecules to constitute a cell and then different levels of cellular arrangements in innumerable life forms in the biosphere.
- Workout the fundamentals of chemical processes underlying life process like nutrition, reproduction, energy transformation, growth and development.
- Work in the interdisciplinary and multidisciplinary areas of biological sciences and also, they will be able to objectively apply their subject knowledge.
- Mitigate the environment and ecosystem related issues. Through their knowledge of the subject students will be able to identify root causes of these issues and also as biologist they can suggest best possible solutions to environmental and ecosystem issues.
- Accept any zoology related assignments in government as well as in private institutions/organizations.

COURS STRUCTURE FOR M.SC ZOOLOGY AS PER NEP GUIDELINES:

Academic credit bank and entry exit system is the essence of New Education Policy 2020. It is one of the important policy measures recommended by the University Grants Commission (UGC) to enhance academic standards and quality in higher education includes innovation and improvements in curriculum, teaching-learning process, and examination and evaluation systems.

The performance of students in examinations will be evaluated following the Grading system, which provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations. The grading system will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students.

The post-graduate level course of the Department of Zoology has been designed to strength, in-depth understanding of Zoological Science and knowledge of natural history. It consists of a 2-year course with two semesters in a year (2 odd semesters and 2 even semesters). Total marks of 2000 (1000 per year and 500 per semester).

1. Entry/Exit Policy:

S.no	Course	Entry	Exit	Outcome
1	Semester I (6 months)	B.Sc. (3-year course)	Certificate	To cater basic need of zoology as a major subject of life science.
2	Semester II (6 months)	Certificate/Semester I	PG Diploma	Leading to M.Sc. Zoology
3	Semester III & IV (12 months)	B.Sc. (4-year course)/ PG Diploma	M. Sc. Zoology	Teaching/ Expertise in Zoology/ Leading to research.

2. Course Detail:

Sem	Core Courses			Discipline Specific Elective Courses		Multidisciplinary Course		(Skill-Based Course) Project/ Dissertation	Total credits
	No. of Papers (T+P)	Credits (T+P)	Total credits	No. of Papers (T)	Total credits	No. of Papers (T)	Total credits	Total credits	
I	3+1	12+4	16	-	-	1	2	2	20
II	3+1	12+4	16	-	-	1	2	2	20
III	2+1	8+4	12	1	4	1	2	2	20
IV	2	8	8	1	4	-	-	8	20
Total credits for the course			52		8		6	14	80

3. Course Structure:

Course Structure for M.Sc. Zoology Under NEP-2020 (2023 onward)				
S. No	Course code	Title	Credit	Marks
SEMSTER-I				
Core Courses				
1	PGZO-C101	Animal Structure and Function (Invertebrate)	4	100
2	PGZO-C102	Molecular Cytogenetics	4	100
3	PGZO-C103	Developmental Biology	4	100
Multidisciplinary Course/Interdisciplinary Course				
4	PGZO-M104	Life style diseases and Management	2	50
Practical Course (Skill Based Course)				
5	PGZO-L105	Laboratory Course Based on the Three cores	4	100
6	PGZO-P106	Skill Based Project Work	2	50
Total			20	500

SEMSTER-II				
Core Courses				
1	PGZO-C201	Animal Structure and Function (Vertebrate)	4	100
2	PGZO-C202	Endocrinology	4	100
3	PGZO-C203	Cell and Molecular Biology	4	100
Multidisciplinary Course/Interdisciplinary Course				
4	PGZO-M204	Environmental Biology	2	50
Practical Course (Skill Based Course)				
5	PGZO-L205	Laboratory Course based on the three cores	4	100
6	PGZO-P206	Skill Based Project Work	2	50
Total			20	500
SEMSTER-III				
Core Courses				
1	PGZO-C301	Immunology	4	100
2	PGZO-C302	Evolution and Ethology	4	100
Multidisciplinary Course/Interdisciplinary Course				
4	PGZO-M303	Fauna of Ladakh	2	50
Discipline Specific Elective Courses (DSEs) (Choose any One)				
3	PGZO-E304	Entomology-I	4	100
	PGZO- E305	Animal Physiology-I	4	100
	PGZO- E306	Wildlife-I	4	100
	PGZO- E307	Fisheries-I	4	100
Practical Course (Skill Based)				
5	PGZO-L308	Laboratory Course Based on the two Cores and DSE	4	100
6	PGZO-P309	Skill Based Project Work	2	50
Total			20	500
SEMSTER-IV				
Core Courses				
1	PGZO-C401	Enzymology and Biostatistics	4	75
2	PGZO-C402	Fundamentals of Biochemistry	4	75
Discipline Specific Elective Courses (DSEs) (Choose any One)				
3	PGZO-E403	Entomology-II	4	100
	PGZO-E404	Animal Physiology-II	4	100
	PGZO-E405	Wildlife-II	4	100
	PGZO-E406	Fisheries-II	4	100
Practical Course (Skill Based Course)				
4	PGZO-P408	Project/Dissertation	8	200
Total			20	500
Grand total				2000

Note: A student is required to complete 80 credits for the completion of the course and the award of degree. In general, one-hour theory lecture per week equals 01 Credit and 2 hours practical class per Week equals 01 credit.

4. **Brief description of the course:** Courses/Papers offered in the M.Sc. are divided into four categories:
- (i) **‘Core Course’** means a course that is Compulsory for a particular programme and offered by the Department, where the student is admitted.
 - (ii) **“Discipline Specific Electives”** means a course that represents a sub domain within Zoology and students can choose any one of these electives in 3rd semester as part-I, to be continued in 4th semester as part-II.
 - (iii) **‘Multidisciplinary /Interdisciplinary Course’** means a course of 2 credit which can be selected by the students from any sister department or from MOOCS or within the department in 1st to 3rd semesters.
 - (iv) **‘Skill Based Project Work’** means a minor project to be performed by the students from semester 1st to 3rd.
 - (v) **“Project/Dissertation”** means a scientific project work of 8 credits, to be carried out either in the department or in any other industry, institute or organization located anywhere in India. The project/dissertation is to be initiated in 3rd semester but will be assessed in 4th semester.

5. EVALUATION PATTERN:

Minimum teaching days: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days.

Attendance: Students must earn at least 75% of attendance in each course for appearing in the semester end examinations. The condonation case of students with less than 75% attendances shall be considered as per the direction of the University.

Marks Distribution: Each theory course shall be divided into 70% marks for term end examination (external exam) and 30% marks for continuous internal assessment. In Multidisciplinary/interdisciplinary courses (2 credits) the assessment shall be entirely based on End-semester examination.

Continuous Internal Assessment will be done in four components: (i) Presentations (ii) Tests (iii) Assignments and (iv) On the basis of grading in day-to-day activities. Grading of day-to-day activity will be done by marking the attendance as α (Alpha), β (Beta), and γ (Gamma) with 100%, 75%, and 50% weightage on the marking scale respectively. The weightage given to each of these components shall be decided and announced at the beginning of the semester by the individual teacher responsible for the course or by the department. Any student who fails to qualify continuous internal assessment will be debarred from appearing in the end-semester examination in the specific course and no Internal Assessment marks will be awarded. His/her Internal Assessment marks will be awarded as and when he/she attends regular classes in the course in the next applicable semester. No special classes will be conducted for him/her during other semesters. The practical course in each semester (up to 3rd) carries 100 marks in full. The assessment of the practical course will be done in two parts with 50% marks for external exams and 50% marks for Continuous Internal Assessment.

Skill Based Project Work/ Two weeks Internship: 1st to 3rd Semester, a 2 credits course (50 marks), Skill Based Project work shall be conducted to inculcate research aptitude. The student can also earn the same credits by participating in a two weeks’ internship program from any recognised institute.

Pattern of end-semester question paper

- (i) There will be two sections A and B.
- (ii) There will be 9 questions in all.
- (iii) **Section A** will carry one compulsory question (question no 1) with four sub-parts (consisting of short answer type questions). Each sub-part (short answer type question) will be from each unit and a student will have to attempt all the four sub-parts.

- (iv) **Section B** will comprise of four long answer type questions (question number 2 to 5); each question will have an option. Thus, there will be two questions from each unit. In total, there will be eight questions in the section; two from each unit and a candidate will be asked to attempt four questions.
- (v) All short answer type questions will carry 3½ marks each. Thus, question No 1 will carry weightage of 14 marks. Whereas, each question from no 2 to 5 will carry equal marks of 14 marks.
- (vi) Students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question of Section A

Project work:

Project/Dissertation work will begin in third/fourth semester. The weightage will be of 200 marks. At the end of semester, students will submit project work in the form of a report. There will be a presentation before a panel of teachers from the department.

6. Detailed syllabi:

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
1st Semester (Core)

Course Title: Animal Structure and Function (Invertebrate)

Credits: 4

Course Code: PGZO-C101

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To impart knowledge about the basic structure and functions in Invertebrates and their comparison across the Phyla. The course is designed to help students understand the diversity in invertebrate, their classification, morphological characteristics, and ecological significance. Economic importance of invertebrate species will also be highlighted.

Course Outcomes: after the completion of the course the students will be able:

- To identify and classify major invertebrate groups, such as arthropods, mollusks, annelids, and others.
- To gain a deep understanding of the physiological processes and behavioral adaptations specific to invertebrate animals. They will be able to explain how invertebrates carry out essential functions like feeding, locomotion, reproduction, and sensory perception in diverse environments.
- To apply their knowledge of invertebrate structure and function to practical scenarios, such as biodiversity conservation and pest management. They will understand the significance of invertebrates in agriculture, medicine, and ecological restoration efforts.

UNIT- I (15 hours)

- 1.1 Feeding and Digestion: Nutrition in protozoa, Types and mode of feeding; Feeding diversity in insects.
- 1.2 Functional mechanism of Filter feeding in Crustacean and Mollusca; Feeding & digestion in Echinodermata.
- 1.3 Hydrostatic evasive movements in Ctenophores; hydrostatic skeleton in annelids; Insect flight mechanism.
- 1.4 Organs of respiration: Body surface, Gills, Book-lungs, Tracheal system, Respiratory pigments in invertebrates. Mechanisms of gill respiration in Mollusca.

UNIT- II (15 hours)

- 2.1 Excretory organs and excretion: Excretion in Protozoa.
- 2.2 Excretory structures and functions in Helminthes; Excretory structures and functions in Annelids; Structure and functions of Malpighian tubules in insects.
- 2.3 General organization of Nervous system in Cnidaria, Annelida, Arthropoda (Crustaceans and Insects), Mollusca (Cephalopod), Echinodermata.
- 2.4 Mechanoreceptor in Non-chordates, Chemoreception & chemotaxis in insects.

UNIT- III (15 hours)

- 3.1 Reproductive mechanisms in Non-chordates, Asexual, Sexual, Parthenogenesis, Hermaphroditism.
- 3.2 Functional variations of reproductive structures in Porifera, Coelenterate and Helminthes.
- 3.3 Reproductive system in Annelida, Mollusca, Arthropoda and Echinodermata.
- 3.4 Larval forms in Porifera, Cnidaria, Helminths, Annelida, and Crustacea.

UNIT- IV (15 hours)

- 4.1 Endocrine glands and their sections and functions in insects.
- 4.2 Water circulatory systems in Porifera and polymorphism in coelenterate.
- 4.3 Blood circulatory system of arthropods (cockroach) and Annelids (earthworm).
- 4.4 Circulatory system in Mollusca and Echinodermata.

Practical (30 hours)

1. Study of representative museum specimens of each invertebrate phylum through available specimens/ audio visual charts and models.
2. Study of stained slides from the culture of *Amoeba*, *Euglena* *Paramecium* and *Vorticella*.
3. Permanent stained preparations of *Sycon* (T.S and L.S) gemmules and spicules, *Hydra* (W.M.), T.S. through regions of testis and ovary, *Obelia* (colony, medusa and polyp), *Fasciola* (miracidium, sporocyst, redia and cercaria), scolex and proglottids of *Taenia* (Mature and gravid L.S. & T.S.), Amphistome, proglottid of a cestode, *Ascaris* (T.S. of male and female gravid).
4. Micrographs of Larval forms: Planula, Radia, Cercaria, Cysticercus, bladder worm, Trochophore, Nauplius, Zoea, Mysis Phyllosoma, Antilon, Veliger, Bipinnaria, Ophio and Echinopluteus, Auricularia, Tornaria.
5. To study the reproductive system of representatives of major invertebrate phylum through charts/photographs/videos.

Books recommended.

A. Essential Books:

1. L.H. Hyman (1940- 51). Invertebrates Vols.I, II, III, IV & V. McGraw Hill, New York.
2. E.J.W. Barrington (1969). Invertebrates Structure and function. English Language Book Society & Nelson.
3. International Code of Zoological Nomenclature official publication.

B. Further Readings:

4. Kudo, R.R (1986). Protozoology, Books and Periodicals Corp. (India) New Delhi.
5. J.D. Smyth (1976). Introduction to Animal Parasitology. Hodder & Stoughton, London
6. Nelson K. S., Animal Physiology: Adaptation and Environmental, Cambridge University Press, Cambridge, UK.
7. Dantzler, W.H., Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Oxford University Press, New York, USA.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
1st Semester (Core)

Course Title: Molecular Cytogenetics.

Credits: 4

Course Code: PGZ0-C102

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To impart the knowledge of fundamentals of prokaryotic and eukaryotic genetics including genome organization of bacteria and bacteriophages. To impart knowledge about genetic and chromosomal aberrations and to study various techniques of genetic analysis for genetic counselling.

Course Outcomes: after the completion of the course, students will be able:

- To understand the organization of genomes in various organisms, including viruses, prokaryotes, and eukaryotes, with a special focus on the human genome, mitochondria, and chloroplasts.
- To gain in-depth knowledge of the molecular aspects of genetics, including the chemistry behind DNA replication and RNA transcription. They will also become familiar with post-transcriptional modifications. Furthermore, students will.
- To comprehend chromosomal alterations, gene mutations, and their associations with genetic diseases. Students will be able to understand the concepts such as maternal inheritance and pedigree analysis.

UNIT- I (15 hours)

- 1.1 Organization and structure of genome in prokaryotes- size, complexity, gene-complexity of viral genome. Types of bacteriophages, Structure of T4 phage and its morphogenesis.
- 1.2 Size, complexity, of Bacterial genome, Bacterial transformation. Bacteria as a model for prokaryotic gene regulation, principles of transcriptional regulation; Operon model, Lac operon.
- 1.3 Bacterial conjugation and transduction; Generalized transduction and specialized transduction.
- 1.4 Organelle genome, architecture of mitochondrial genome, conserved chloroplast DNA.

UNIT- II (15 hours)

- 2.1 Basic organization of a eukaryotic genome: Chromatin structure; histone - structure and function; nucleosome as the fundamental particle; 30 nm chromatin fibers, higher order structure of chromatin.
- 2.2 Organization of human genome; nuclear genome, coding and non-coding DNA, transposable elements, retro-teaspoons, SINE, LINE, Alu and other repeat elements, pseudogenes.
- 2.3 Chemistry of DNA synthesis; Significance of anti-parallel arrangement of DNA strands, role of primer, exonuclease activity of DNA polymerase III, End replication problem.
- 2.4 Transcription and post-transcriptional modifications, self-splicing.

UNIT- III (15 hours)

- 3.1 Numerical abnormalities of human chromosomes and related syndromes: Nondisjunction, Aneuploidy, Patau syndrome, Edwards, Down's, Turner's and Klinefelter syndromes.
- 3.2 Structural abnormalities of human chromosomes and related syndromes: Deletion, Robertsonian translocation, Cri-du-chat syndrome, Prader -Willi syndrome, Williams syndrome.

- 3.3 Gene mutation and Human metabolic disorders: Phenylketonuria, Lesch-Nyhan syndrome, Tay-Sachs disease, Alkaptonuria, Albinism, Glucose-6-phosphate Dehydrogenase deficiency.
- 3.4 Other Genetic Diseases: Sickle cell anemia, Hemophilia, Thalassemia, Cystic Fibrosis.

UNIT- IV (15 hours)

- 4.1 Epigenetics and genome imprinting - DNA methylation in mammals, epigenetic regulation of chromosome inheritance.
- 4.2 Inheritance of mitochondrial genes, Sensorineural Hearing Loss; Maternal inheritance of kappa particles in Paramecium and shell coiling in Limnaea.
- 4.3 Genetic Counselling, Eugenics and Euphenics. Fetal analysis (amniocentesis and chorionic villus sampling).
- 4.4 Pedigree analysis. Chromosomal banding techniques

Practical (30 hours)

1. Study of permanent slides of testis and ovaries of insects/ mice/rat.
2. Basis of reaction and demonstration of the sites of proteins, nucleic acids, lipids & carbohydrates in ovaries of insects/rat/mice through slides and photographs.
3. Study of stages of mitosis and meiosis from permanent slides from animal and plant materials through slides/charts/photographs.
4. Preparation of human karyotypes by using photograph/picture.
5. Identification of wing and eye mutants in Drosophila from picture.
6. Study of sex-chromatin Bars body from human buccal mucosa.
7. Study of various human genetic traits.
8. Study of mtDNA disorders through Photographic slides.
9. Problems in genetics based on dihybrid crosses, sex-linked, Inheritance and blood Groups.

Books recommended.

A. Essential Books:

1. Atherly, A.G., J.R. Girton and J.F. McDonald; The Science of Genetics, Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Benjamin Cummings; Genetics: Analysis and Principles.
3. Lewin, B., Genes. VI, Oxford University Press, Oxford, New York, Tokyo

B. Further Readings:

4. Griffiths, A. J. F., *et al.*, An Introduction to genetic analysis, W.H. Freeman Co.
5. W. R. Anderson; Genetics – The continuity of Life, D, Brooks/Cole Publishing Company.
6. Gardner, E.J., M.J. Simmons and D.P. Snustad; Principles of Genetics, John Wiley.
1. Mange E. J. and A. P. Mange; Basic Human Genetics, 2nd edition. Sinauer Associates.
2. Molecular Biology of Gene, Watson et al., (5th Ed. 2004), Pearson Education, Delhi, INDIA

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
1st Semester (Core)

Course Title: Developmental Biology.

Credits: 4

Course Code: PGZ0-C103

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To study heterogamy and process of gonadal differentiation. To study oocyte development, ovulation and transport of gametes. To study the process and events in fertilization and embryonic development. To study the assisted reproductive techniques.

Course Outcomes: after the completion of the course, students will be able:

- To have a solid understanding of the fundamental processes and mechanisms involved in the development of organisms.
- To analyze and apply concepts from developmental genetics. They will understand how genes and regulatory elements control various aspects of development, including pattern formation, cell fate determination, and morphogenesis.
- To apply their knowledge of developmental biology to practical scenarios like developmental disorders, applications of regenerative medicine etc.

UNIT- I (15 hours)

- 1.1 Principal of developmental Biology: Potency, Commitment, Specification, Induction and Determination, Cell differentiation, Signaling, Patterning.
- 1.2 Gametogenesis: Spermatogenesis and Oogenesis. structure of the gametes– the sperm, the egg
- 1.3 Mechanism of fertilization, post fertilization events and Biochemistry of fertilization, block to polyspermy.
- 1.4 Early embryonic development of vertebrates and invertebrates; types of eggs and cleavage.

UNIT- II (15 hours)

- 2.1 Morphogenesis– gastrulation, neural tube formation and lens formation in vertebrates.
- 2.2 Axis specification in *Drosophila*; origin of anterior-posterior and dorsal- ventral patterning.
- 2.3 Vulva formation in *C. elegans*, sex determination in *drosophila*, environmental sex determination,
- 2.4 General concepts of organogenesis: Dorsoventral axis formation in mammals, development and patterning of vertebrate limb.

UNIT- III (15 hours)

- 3.1 Regeneration: Epimorphic regeneration in reptile (salamander), requirement of nerves for the proliferation of blastema cells; embryonic stem cells and their applications;
- 3.2 Medical implications of developmental biology: genetic errors of human development: pleiotropy, genetic heterogeneity, phenotypic variability.
- 3.3 Gene expression and human disease– inborn errors of nuclear RNA processing, inborn errors of translation.
- 3.4 Teratogenesis- environmental assaults on human development- teratogenic agents (xenobiotics) like alcohol, retinoic acid etc.

UNIT- IV (15 hours)

- 4.1 Scope of reproductive technologies. Induced release of gametes; multiple ovulations, superovulation.
- 4.2 *In vitro* oocyte maturation; Biochemistry of semen composition; Assessment of sperm functions.
- 4.3 *In vitro* fertilization, embryo transfer. Gamete intrafallopian transfer (GIFT); Zygote intrafallopian transfer (ZIFT); Intracytoplasmic sperm injection.
- 4.4 Contraception; immunocontraception, antibody mediated fertilization block and termination of gestation; other contraceptive technologies.

Practical (30 hours)

1. Study of life cycle of an insect through charts/models/video clips.
2. Study of different developmental stages in chick and frog through permanent slides/ audio visuals/ charts.
3. To prepare the permanent stained slides of developing stages from fertilized egg of hen.
4. Study of different types of eggs on the basis of their yolk content through chart/ micrographs.
5. Study of normal and abnormal sperm of man and rat through charts and micrographs.
6. *In vivo* study of life cycles any one locally available insect and to submit the report.
7. Study of artificial insemination technique in farm animals.
8. One day poultry farm visit to observe different stages of development of chick.

Books recommended.

A. Essential Books:

1. Gilbert (2010); *Developmental Biology*, Sinauer Associates Inc., Massachusetts, USA.
2. A.K Berry; *Introduction to embryology*.
3. Kalthoff (2000); *Analysis of Biological Development*, McGraw-Hill Science.

B. Further readings:

4. Slack, J. M. W. (2013); *Essentials of Developmental Biology*.
5. Wolpert *et al.*, (2006); *Principles of Development*. Oxford University Press, New Delhi, India
6. Balinsky (1981); *An introduction to Embryology*, Saunder publication.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
1st Semester (MD/ID)

Course Title: Life Style Diseases and Management

Credits: 2

Course Code: PGZO-M104

No. of Contact Hrs: 30

Max. Marks: 50 (External=35 Continuous Internal Assessment= 15)

Course Objectives: To create awareness among students about various diseases which originate from and which could be prevented by controlling one's life style. The course also covers the general aspects of diagnosis, prevention and management strategies.

Course Outcomes: after completing this course, students will be able:

- To understand the importance of life style for individual as well as for the community health. To distinguish many life style diseases and to be able to device a management regime for these life style diseases.
- To inculcate a healthy life style. Students shall encourage to promote a healthy life style in the community.

UNIT- I (15 hours)

- 1.1 Concept of Lifestyle diseases, Types of Lifestyle diseases.
- 1.2 Overview of Lifestyle Diseases and its Implications in India and the World.
- 1.3 Major Risk Factors: Environmental, Dietary, Psychological, Occupational.
- 1.4 Body Mass Index: Determination and Significance; Obesity; Causes, Prevention, Management

UNIT- II (15 hours)

- 2.1 Atherosclerosis, Arteriosclerosis: Causes, Prevention, Management.
- 2.2 Hypertension and Hypotension: Causes, Prevention, Management.
- 2.3 Stress and Mental Illness; Causes, Prevention and Management.
- 2.4 Diabetes; Types, Characteristics, Causes, Diagnosis, Prevention and Management

Books Recommended:

A. Essentials books

1. M.N Kumar, R. Kumar. Guide to prevention of lifestyle diseases.
2. Gary Eggar et al. Lifestyle Medicine.

B. Further readings

3. Akira et al. New Frontiers in Lifestyle Related Diseases.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
2nd Semester (Core)

Course Title: Animal Structure and Function (Vertebrates).

Credits: 4

Course Code: PGZO-C201

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To acquaint the students with the classification and general organization of vertebrates. To make the students know various morphological and anatomical structures of vertebrates. To introduce the diversity in form, structure and functions within vertebrates.

Course Outcomes: after the completion of the course, students will be able:

- To have a comprehensive understanding of the anatomical structures and physiological processes specific to vertebrate. They will be able to describe, analyze, and explain the form and function of various organ systems in vertebrates.
- To appreciate the evolutionary history of vertebrates and the adaptations that have allowed them to thrive in diverse environments.
- To apply their knowledge of vertebrate structure and function to various fields, including research, medicine, and health sciences. The expertise will prove to be valuable for careers in biology, veterinary science, and medical professions.

UNIT- I (15 hours)

1.1 Vertebrate integument: General structure of mammalian skin. Functions of skin.

1.2 Endoskeleton: Endoskeleton in Protochordates, Visceral skeleton in Fishes. Jaw suspensorium in vertebrates.

1.3 Structural and functional organization of digestive system in protochordate.

1.4 Structural and functional organization of Alimentary canal and digestive glands in vertebrates, with reference to Mammalian type.

UNIT- II (15 hours)

2.1 Characteristics of Respiratory surface; Gills in fishes and mechanisms of gill respiration.

2.2 Functional organization of Mammalian lungs, Larynx and Vocalization.

2.3 Organization of mammalian blood-vascular system, Lymph and lymphatic system.

2.4 Flight adaptations in mammals, Aquatic adaptations in mammals. Migration in birds, and fishes.

UNIT- III (15 hours)

3.1 Excretion: General nature of kidneys; Kidney structure in relation to Osmoregulation; Osmoregulation in freshwater and marine water fishes.

3.2 Functional organization of vertebrate nervous system: Brain and spinal cord;

3.3 Sense organs: Physiology of Vision and Physiology of Hearing.

3.4 Types of Muscles and Physiology of muscle contraction.

UNIT-IV (15 hours)

4.1 Reproductive structure and its physiology in fish (carps).

4.2 Reproductive structure and its physiology in Amphibians (frog).

4.3 Reproductive structure and its physiology in reptiles (lizards) and birds.

4.4 Reproductive structure and its physiology in Mammals; Estrous cycle and Menstrual cycle in Mammals.

Practical (30 hours)

1. Museum Study: Taxonomy of animal specimens/charts representing different orders of Protochordates and vertebrates available in the laboratory
2. Comparative Osteology of Amphibia, Reptilia; Aves, mammals (through models/charts/audio-visuals).
3. Digestive, Arterial systems and Cranial nerves of a given fish through charts/video clips.
4. Digestive, Reproductive, portal Systems and CNS of rat/ mouse through charts/video clips.
5. Study of available permanent slides of T.S. stomach, intestines, testis, ovary of any vertebrate representative.
6. To demonstrate that the optimum activity of human salivary amylase is pH dependent.
7. Demonstration of estimation of Hemoglobin & determination of blood groups in human.
8. Demonstration of measurement of blood pressure in human.
9. One long study tour, preferably to a sea-shore/biodiversity hot spot for study and Observations on animals in their natural habitat.

Books recommended.**A. Essential Books:**

- 1 J. Z. Young (2004); The Life of Vertebrates.
- 2 Seth M Kisia (2011); Vertebrates- structure and function.
- 3 Dantzler, W.H., Comparative Physiology (Handbook of Physiology): Vol. 1, 2, Oxford University Press, New York, USA.

B. Further readings:

4. International Code of Zoological Nomenclature official publication
5. Animal Taxonomy by H. E. Goto.
6. Kudo, R.R (1986). Protozoology, Books and Periodicals Corp. (India) New Delhi.
7. Hoar W. S., General and Comparative Animal Physiology, Prentice Hall, India.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
2nd Semester (Core)

Course Title: Endocrinology

Credits: 4

Course Code: PGZO-C202

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To provide knowledge about the histophysiology of neuroendocrine system of vertebrates. To inculcate the awareness and impart in depth knowledge about the control and regulation of body functions and maintenance of homeostasis involving the endocrine and neuro-endocrine system.

Course Outcomes: after the completion of the course, students will be able:

- To explain how hormones play a central role in regulating homeostasis and coordinating the functions of different organ systems. They will understand how hormonal feedback loops maintain stability in the body while responding to changing environmental conditions.
- To apply their knowledge of endocrinology to clinical scenarios. They will be able to diagnose and understand the underlying hormonal imbalances in endocrine disorders, as well as recommend appropriate treatments and interventions.
- To critically evaluate current research in the field of endocrinology and also to appreciate the role of endocrinology in areas such as hormone therapies, reproductive health, and metabolic disorders.

UNIT- I (15 hours)

1.1 Hormones; Classification of Hormones as Peptides, Steroids and amino acid derived.

1.2 Mechanism of hormone action; Hormone action at cellular level; Hormone action at genetic level.

1.3 Neuroendocrine system; Comparative morphology and anatomy of adeno- and neurohypophysis, Adenohypophyseal and Neurohypophyseal hormones; Regulation of hypophyseal hormones.

1.4 Comparative morphology and anatomy of pineal gland in vertebrates; biological role of Melatonin; role in biological clock.

UNIT- II (15 hours)

2.1 Histology of Thyroid gland, Thyroid hormones: synthesis, secretion and transport. Physiological and metabolic functions of thyroid hormones, Thyroid hormone related disorders.

2.2 Parathyroid gland: anatomy and hormones, Structure and function of parathyroid hormone. hormonal regulation of calcium and phosphate homeostasis.

2.3 Endocrine Pancreas: Histology and hormones; structure, biosynthesis and secretion of insulin and its functions.

2.4 Glucagon: structure, biosynthesis and function, Diabetes mellitus; Diabetes Type I, Diabetes Type II

UNIT- III

(15 hours)

3.1 Adrenal gland: Gross comparative anatomy, corticosteroids and catecholamine: structure, synthesis, nomenclature and function.

3.2 Histophysiology of endocrine placenta, testis and ovary in vertebrates; Male and female sex steroids: structure and functions.

3.3 GI tract hormones – types and functions; role of hormones in digestion.

3.4 Renin Angiotensin System Prostaglandins, cytokines, ANF, Erythropoietin.

UNIT- IV**(15 hours)**

- 4.1 Principal invertebrate hormones. Ultimobranchial body, Corpuscles of stannius, Urophysis and Thymus glands.
- 4.2 Neuroendocrine mechanism in insects and crustacean metamorphosis; Neuroendocrine mechanism in Amphibian metamorphosis.
- 4.3 Hormonal regulation of Growth. Ectohormones in insects and mammals
- 4.4 Hormone replacement therapy; Risks and benefits of Hormone replacement therapy.

Practical (30 hours)

1. To show the endocrine glands in frog through charts/models/video clipping
2. To show the endocrine glands in rat through charts/models/video clipping.
3. Preparation of permanent histology slides from testis, pancreas and adrenal of goat/sheep obtained from slaughter house.
4. Anatomy and Histology of various vertebrates' endocrine glands and insect neuroendocrine structures through prepared slides.

Books recommended.**A. Essential Books:**

1. Gorbman *et al.*, (1983). Comparative Endocrinology, John Wiley & Sons.
2. H. M. Kronenberg, S. Melmed, William's text book of Endocrinology (XI edition)
3. Schreibman & Pang (1985) Vertebrate Endocrinology: Fundamentals & Biomedical Implications, Vol. I-IV Academic Press,

B. Further readings:

4. Brooks and Marshall (1995) Essentials of Endocrinology, Blackwell Science.
5. Turner and Bagnara (1984). General Endocrinology. W. B. Saunders Company Philadelphia.
6. R. Larson, (2002), Williams Text Book of Endocrinology, 10th edition. Saunders Company,
7. K.S. Polonsky and P. R. Larsen. Publisher - Saunders, Elsevier Inc (2009).
8. Norris, Vertebrate Endocrinology, (Lea and Febigar)
9. Bentley (1998). Comparative Vertebrate Endocrinology, Cambridge University Press.
10. Hadley (2000). Endocrinology, Prentice Hall. International Edition

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
2nd Semester (Core)

Course Title: Cell and Molecular Biology

Credits: 4

Course Code: PGZO-C203

No. of Contact Hrs:60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objective: the course has been designed to help the learner to work out the organization and function of cell, its organelles and cell membranes. It will also strengthen the understanding about cell signaling, transport across membrane, secretory pathways and cell cycle.

Course Outcomes: after the completion of the course, students will be able:

- To describe the structure and function of bio-membranes, cytoskeleton and extracellular components. to explain cellular processes at organelle as well as at molecular levels.
- To have a comprehensive understanding of cell signaling processes such as cell to cells communicate through signaling molecules and receptors.
- Students will be able to explain the molecular events that control cell cycle progression and the signaling pathways that lead to programmed cell death.
- Proficiently understand the transport of proteins within the cell, including the mechanisms of protein import and export.

UNIT- I **(15 hours)**

- 1.1 Bio membranes; Biochemical Composition of bio membranes; structural components of basement membrane and basal lamina; Membrane potential.
- 1.2 Transport across cell membrane & transporters; Transport across epithelia.
- 1.3 Cross-linking Components; Collagens & other proteins of extracellular matrix; Cell-cell adhesion molecules; Cell-matrix adhesion; Gap junctions and connexins.
- 1.4 Cytoskeleton, Microfilaments & microtubules: structure and dynamics; membrane binding proteins & their function

UNIT- II **(15 hours)**

- 2.1 Modes of cell signaling (autocrine, juxtacrine, paracrine and endocrine); Signaling molecules.
- 2.2 Cell Surface Receptors, Properties of cell surface receptors; G protein-coupled receptors that activate or inhibit adenylyl cyclase.
- 2.3 G protein-coupled receptors that regulate ion channels. G protein-coupled receptors that activate phospholipase C.
- 2.4 Receptor protein-Tyrosine kinases; Receptor Protein-Tyrosine phosphatases; Receptor protein-guanlyl cyclases; Receptor protein-serine/threonine kinase; Cytokine receptors.

UNIT-III **(15 hours)**

- 3.1 Cell Signaling: Pathways of Intracellular signal transduction; Features of signal transducing systems.
- 3.2 Second messengers; Ion channels and electrical signaling, Signal transduction by G Protein-coupled receptors.
- 3.3 Signal transduction by receptor enzymes; JAK-STAT pathway, Smad pathway, Wnt pathway, Hedgehog pathway.
- 3.4 Signal Transduction in vision, Gustation and Olfaction,

UNIT- IV**(15 hours)**

- 4.1 Cell cycle control, Cyclins & cyclin dependent kinases (CDKs), Role of MPF.
- 4.2 DNA replication block & its removal; Cell cycle checkpoints & feedback control, Regulation of CDK-Cyclic activity.
- 4.3 Programmed cell death (Apoptosis) - Definition, mechanism & significance
- 4.4 Secretory pathways, Protein synthesis in eukaryotes, Uptake into ER, Co- & Post translational modifications in ER, Protein sorting in Golgi apparatus,

Practical (30 hours)

3. Light microscopic demonstration of Plasma membrane. (Oil red O, Sudan black B).
4. Demonstration of mitochondria by vital staining.
5. Histochemical demonstration of extracellular matrix. (Alcan blue pH 1,2.5, PAS).
6. Histochemical demonstration of Lysosomes by demonstrating acid phosphatase activity.
7. Histochemical demonstration of DNA & RNA by Feulgen & MGPY technique 8.
8. Study of metaphase chromosomes in onion root tip.
9. To prepare chemicals required for DNA extraction from the blood sample.
10. Extraction of DNA from blood samples.
11. Determination of molecular size of DNA.

Books recommended.**A. Essential Books:**

1. J. Darnell, H. Lodish & D. Baltimore; Molecular cell Biology. Scientific American Book Inc.
2. B Alberts *et al.*, Molecular cell Biology of the cell. Garland Publishing Inc.
3. Cooper; The cell a molecular approach.
4. Gerald Karp; Molecular cell biology.

B. Further readings:

5. James D. Watson *et al.*, Molecular Biology of the Gene. Benjamin Cummings (2003).
6. Alberts (1983.); Molecular Biology of the Cell.
7. Maniatis (1983); Molecular cloning.
8. Garland A. (1983). Molecular Biology of the cell. Garland Pub. Inc. New York.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
2nd Semester (Multidisciplinary Course/Inter disciplinary)

Course Title: Environmental Biology

Credits: 2

Course Code: PGZO-M204

No. of Contact Hrs: 30

Max. Marks: 50 (External=35 Continuous Internal Assessment= 15)

Course Objectives: The course will provide an account of various abiotic/climatic factors prevailing in ecosystems. The course will also give an insight into the ecosystem functioning, the food web, the flow of energy and cycling of nutrients.

Course Outcomes: after the completion of the course, the students will be able:

- To understand ecosystem dynamics, including ecological principles, species interaction, and the interactions between living organisms and their environment.
- To comprehend how human activities impact the ecosystem and thus students may be able to plan conservation, restoration, and biodiversity management.
- To understand the characteristics of Population, Population Dynamics and will have a comprehensive understanding of the ecological and population dynamics concepts, models, and their real-world applications, enabling them to analyze and address complex ecological and demographic challenges.

UNIT- I (15 hours)

- 1.1 Introduction to ecology and ecosystem, biotic and abiotic interaction, Environmental concepts – laws and limiting factors.
- 1.2 Productivity: Definition, Types and Measurement, food chain and food web.
- 1.3 Major classes of contaminants; bioaccumulation and biomagnification; Factors influencing bioaccumulation from food and trophic transfer.
- 1.4 Resilience of ecosystem, Stable and unstable ecosystem. Sampling methods in ecological studies

UNIT- II (15 hours)

- 2.1 Characteristics of population, population dynamics, Intrinsic rate of natural increase, Population fluctuations and cyclic oscillation, r- and k- selections and carrying capacity, fertility rate and age structure.
- 2.2 Competition and coexistence, intra-specific and inter-specific interactions, mutualism and commensalism, prey-predator interactions, niche overlap and segregation, Lotka- Volterra competition theory.
- 2.3 Patterns of survival and life tables, reproductive effort, offspring size and cost-benefit ratio.
- 2.4 Human population and carrying capacity. Changing relations of human and environment since prehistoric times.

Books recommended.

A. Essential Books:

1. Conklin, A.R. Jr, (2004), Principles and Practices in Environmental Analysis.
2. Wilkinson, D.M., (2007), Fundamental Processes in Ecology: An Earth system Approach,
3. Turk and Turk (1993), Environmental Science., (4th ed. Saunders,).

B. Further Readings:

4. Chapman and Reiss (1995), Ecology - Principles and applications, Cambridge University Press.
5. Odum E. P., (1983), Basic Ecology., Saunders College Publishing
6. Stiling, P. 2002, Ecology: Theories and Applications., Prentice Hall of India Pvt.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (Core)

Course Title: Immunology.

Credits: 4

Course Code: PGZ0-C301

No. of Contact Hrs:60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To acquaint the students with the basic concepts of immunology and the immune effector mechanisms. To make the student understand the role of immunity in controlling the pathogenic infections. To give in depth knowledge of working of vertebrate immune system.

Course Outcomes: after completion of this course, students will be able to answer key questions in immunology as:

- How vertebrate immune system defends against pathogens and how body coup up with emergencies.
- How antigens and immunoglobulins interact during specific immune responses.
- How hypersensitivities, disfunctions of immune system can be managed. They will also know how vaccines are developed and how they work.

UNIT- I (16 hours)

- 1.1 Principles of innate, adaptive/acquired immunity. Organs and cells of the immune system and their functions: primary and secondary lymphoid organs, lymphocytes.
- 1.2 Antigens: Factors affecting immunogenicity, B and T cell epitopes, haptens and adjuvants. Superantigens.
- 1.3 Immunoglobulins: Basic and fine structure of Immunoglobulins, Different classes of immunoglobins, biological activities of different classes of Immunoglobulins.
- 1.4 Cellular and Humoral immune response -Role of T and B lymphocytes, Primary and secondary immune response. Antigenic determinants of immunoglobulins

UNIT- II (16 hours)

- 2.1 Major histocompatibility complex (MHC): Organization, structure and functions.
- 2.2 Exogenous and endogenous pathways of antigen presentation and processing.
- 2.3 Complement System: Complement activation pathway, regulation and biological effects mediated by complement components.
- 2.4 Cytokines: Basic properties, Cytokines that mediate and regulate innate immunity, Cytokines that mediate and regulate adaptive immunity. Cytokine receptors and Cytokine Receptor Mediated Signal Transduction

UNIT- III (15 hours)

- 3.1 B-cell generation, maturation, activation, proliferation and differentiation, B-cell receptors, Selection of immature self-reactive B-cells, T-B cell interactions, Humoral immune response, Signal Transduction by the BCR Complex, Mechanisms of action of CTL and NK cells
- 3.2 T-cell generation, maturation, activation, proliferation and differentiation, T cell Receptor Complex, T cell Co receptors, Generation of T cell Receptor Diversity, T Cell death and T-cell population, Cell mediated effector functions, Signal Transduction by the TCR Complex
- 3.3 Antigen Antibody Interactions: Precipitation & agglutination reactions, radioimmunoassay, ELISA, Immunofluorescence and Immunoprecipitation.
- 3.4 Immunological memory and Immunologic tolerance.

UNIT- IV (13 hours)

- 4.1 Hypersensitivity, types and hypersensitivity diseases.
- 4.2 Autoimmunity and autoimmune diseases, Transplantation.
- 4.3 Immunodeficiency and immunodeficiency diseases
- 4.4 Immunization and its type (active and passive). Types of vaccines.

Practical (45 hours)

1. To demonstrate the agglutination reaction by typing of human blood into A, B, AB, O and Rh factor.
2. Preparation of stained blood film to study various types of blood cells.
3. To study the sections of different lymphoid organs, thymus, spleen, lymph node, intestine etc. from prepared slides or photographs.
4. To demonstrate Ouchterlony diffusion assay.
5. To demonstrate dot ELISA, Immunoblot analysis and Immuno-electrophoresis.

Books recommended.

A. Essential Books:

1. Abul K. Abbas, Andrew H. Lichtman, Basic Immunology; Elsevier Health Sciences.
2. David A. Goldsby, Janis Kuby, Thomas J. Kindt, Barbara A. Osborne., Immunology; W. H. Freeman Company.
3. Glodsy, Kindt and Osborn (2007)., Kuby Immunology (VI edition); W.H. Freeman Publishers.
4. Roitt, I.M, Mosby (2001)., Essential Immunology; Harcourt Publishers.

B. Further Readings:

5. Ivan Roitt, Jonathan Brostoff, David Male, David K. Male., Immunology; Elsevier Health Sciene.
6. Arthur G. Johnson, HighYield Immunology; Lippincott Williams & Wilkins.
7. E. Benjamini, R. Coico and G. Sunshine (2000)., Immunology: A short course; Wiley Liss Publishers.
8. W.E. Paul, (1998)., Fundamental Immunology; Lippincott Raven Publishers
9. I.R.T. Zard (1998)., Immunology an Introduction; Thomson Publishers.
10. Jameway, Charles (2006)., Immunobiology – 6th ed. Academic Press U.S.A

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (Core)

Course Title: Evolution and Ethology.

Credits: 4

Course Code: PGZ0-C302

No. of Contact Hrs:60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To study the physical and molecular basis of organic evolution. To study modes and mechanism of speciation. To study the biological basis of behavior in animals. To explain the biochemical basis of instinct and learning in animals.

Course Outcomes: After completion of this course, students will be able:

- To appreciate theories and evidences of organic evolution. Students will be able to resolve the process of evolution to inducible and spontaneous changes within genetic material.
- To understand origin and diversification of important eukaryotic and prokaryotic taxa.
- Students will be able explore animal behavior as an interplay of stimuli-response webs working at cellular and molecular levels.

UNIT- I (15 hours)

- 1.1 Overview of evolutionary thoughts, concept of organic evolution, development and concept of synthetic theory.
- 1.2 Population genetics, Gene frequencies in Mendelian population, Hardy-Weinberg law; Elemental forces of evolution: Mutation, Selection, Random genetic drift, Migration, Isolating mechanisms.
- 1.3 Models of speciation; tempo of evolution; human evolution- human evolutionary history.
- 1.4 Phylogenetic relationship, Molecular phylogenies, Neutral theory, Molecular clock.

UNIT- II (15 hours)

- 2.1 Evolution and molecular biology- a new synthesis; from molecules to life; The universal common ancestor and tree of life, three domain concept of living kingdom.
- 2.2 Molecular phylogeny– history, terms, definition and limitations, construction of phylogenetic trees using molecular data, molecular divergence.
- 2.3 Origin and diversification of bacteria, the nature of bacterial and archaeal genomes; origin of genomes by horizontal gene transfer; role of plasmid, transposons, etc. in DNA transfer.
- 2.4 Origin and diversification of eukaryotes; early fossilized cells; Evolution of eukaryotic genomes; gene duplication and divergence.

UNIT- III (15 hours)

- 3.1 Definition and patterns of behavior, objectives of behavior, Development of reflex actions, types of reflexes, Characteristics of reflexes and complex behavior.
- 3.2 Genetic basis of behavior, neural basis of behavior, Hormone-brain relationship; Stimulus filtering.
- 3.3 Biological rhythms, Decision making, Predator-prey relationship. Communication and animal signals, Reproductive strategies: infanticide, mates guarding.
- 3.4 Sexual selection: intra sexual selection (male rivalry), inter-sexual selection (female choice) Sexual selection in human, consequences of mate choice for female fitness.

UNIT- IV**(15 hours)**

- 4.1 Parental care, social organization, social organization in honey bee, polyphenism and its neural control, flower recognition.
- 4.2 Altruism – reciprocal altruism, group selection, kin selection and inclusive fitness, cooperation, alarm call, Evolution of helpful behavior, Evolution of eusocial behavior.
- 4.3 Fixed action pattern: mechanism, deprivation experiment, controversies. FAP- characteristics and evolutionary features.
- 4.4 Learning and instincts: conditioning, habituation, sensitization, reasoning; motivational system, physiological basis of motivation, control of hunger drive in blow fly and thirst drive in goat;

Practical (45 hours)

1. To study the phototactic behavior of an insect.
2. To study the geotactic behavior of an insect.
3. To study nesting behavior in birds.
4. Study of ancestry of man, horse, camel and elephant through charts/models.
5. Visit to a fossil park/Geology and Anthropology museums.
6. Study of origin of invertebrate and vertebrate groups through charts.

Books recommended.**A. Essential Books:**

1. Mayr, E., (2001), What Evolution Is, Basic Books, New York, USA
2. Paul W. Sherman & John Alcock, An Introduction to Animal Behavior
3. A. Manning and M.S Dawkins, An Introduction to Animal Behavior, Cambridge University Press

B. Further Readings:

4. Dobzhansky Th. et al. (1976), Evolution. B., Jones and Bartlett Publisher
5. Alcock (2001)., Animal Behavior- An Evolutionary Approach, Sinaur Associates, Inc.
6. Peter Marler and J. Hamilton, Mechanism of Animal Behavior, John Wiley & Sons, USA.
7. David McFarland, Animal Behavior, Pitman Publishing Limited, London, UK.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (MD/ID)

Course Title: Fauna of Ladakh

Credits: 2

Course Code: PGZO-M303

No. of Contact Hrs: 30

Max. Marks: 50 (External=35 Continuous Internal Assessment= 15)

Course Objectives: To introduce local fauna and to arouse ecological consciousness among the students. To work for management and conservation of wetlands of Ladakh.

Course Outcome: After completion of this course, students will be able to:

- Recognize and identify the wild life species of Ladakh region. Students will know and propagate the conservation status of important wildlife species.
- Understand the ecology and distribution of important elements of the local wild life fauna.

UNIT- I (15 hours)

- 1.1 Protected areas of Ladakh: biosphere reserves, national park and wild life sanctuaries.
- 1.2 Ecology and distribution of mammals of Ladakh: Snow leopard, Brown bear, Lynx, Himalayan marmot.
- 1.3 Ecology and distribution of Yak, *Kiang*, *Asiatic ibex*.
- 1.4 Ecology and distribution of Ladakhi *Urrial* (Shapu), *Tibetan Gazella*, Chagra (*Capra aegagrus hircus*).

UNIT- II 15 hours)

- 2.1 Herpetofauna of Ladakh: Ecology and distribution of toad headed agama (*Phrynocephalus theobaldi*), Himalayan agama (*Laudakia himalayana*), Ladakh cliff racer (*Platyceps ladacensis*), toad (*Bufo stomaticus*).
- 2.2 Avifauna of Ladakh: migration of birds, ecology and distribution of Black necked crane, Magpie, *Chukar partridge* and Himalayan snowcock.
- 2.3 Ecology and distribution of Himalayan vulture, Golden eagle.
- 2.4 Ichthyofauna of Ladakh: Ecology and distribution of *Schizothorax sp.*, *Diptychus maculatus* and *Triplophysa ladacensis*; Adaptation in hill stream fish.

Books recommended.

A. Essential Books:

1. Wildlife of India, V.B. Saharia, Natraj Publishers, Dehradun.
2. Mammals of India by Vivek Menon, Princeton University Press, 20093.
3. Threatened Birds of India, Asad A. Rahmani, BNHS-Oxford University Press Publication.
4. Fish and fisheries of Leh region, Rajeev Kapila et al.

B. Further Readings:

5. A text book of Fish biology & Fisheries, 3rd edition, S. S. Khanna & H. R. Singh.
6. Inland Fishes of India, Talwar, P. K. & Jhingran, A. G. Oxford & IBH, New Delhi.
7. Fundamentals of limnology, Jayashree Datta Munshi & Jyotiswarup Datta Munshi.
8. Herpetology 4th edition, F. Harvey Pough
9. Reptiles of India, Indraneil Das & Abhijit Das, Prakash Books India Private Limited.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (DSE)

Course Title: Entomology-I

Course Code: PGZO-E304

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Credits: 4

No. of Contact Hrs: 60

Course Objectives: the main objective of the course is to provide the learner, a platform to explore and understand the vast and divers structural and functional characteristics of insects. The course will expose students to the morphology, anatomy, physiology and ecology of insects. The course will also deal with insect groups of medical, agricultural and economical importance.

Course Outcomes: after the completion of the course the students will be able:

- To understand the morphology, taxonomy, anatomy and physiology of entognathus and ectognathus hexapods. Students.
- To explore the adaptive diversity in several major groups of insects. To identify and diagnose the destructive and useful group of insects and important families of medical and agricultural importance.
- With through knowledge of the subject, the learner shall be able to design and executed research in the field of entomology more successfully.

Unit- I General characters, classification and Bionomics of insect orders (15 hours)

- 1.1 General character and classification of insect order Thysanura and Collembola with economic important families.
- 1.2 General character and Classification up to family level of the orders, viz. Isoptera, Hemiptera, Anoplura, Mallophaga and Siphonaptera.
- 1.3 General character and Classification of Insect orders, viz. Diptera and Coleoptera, with economically important families.
- 1.4 General character and Classification of Insect orders, viz. Lepidoptera and Hymenoptera, with economically important families.

UNIT-II Insect Morphology (15 hours)

- 2.1 Integument - structure, composition and modification.
- 2.2 Head -structure, region/sulci/suture and appendages – antennae.
- 2.3 Thorax -structure, modifications and appendages: Wing - origin, development, structure and modifications and Leg-structure and modifications.
- 2.4 Abdomen and its modification, with special reference to genitalia

UNIT-III Insect Physiology-I (15 hours)

- 3.1 Digestive System and physiology of digestion in insect with special reference to cockroach.
- 3.2 Respiratory System and Physiology of respiration in insects; nervous system in insect with special reference to the nervous system in cockroach.
- 3.3 Excretory system; Malpighian tubules and formation of uric acid in insects; Reproductive system in insets, types of ovaries in insect.
- 3.4 Circulatory System, composition of haemolymph, types haemocytes and their function in insects

UNIT-IV Insect Physiology-II (15 hours)

- 4.1 Insect nervous system with special reference to cockroach.
- 4.2 Insect endocrine system.

- 4.3 Insect reproductive system, male and female reproductive system, type of ovaries in insect.
- 4.4 insect immune system; adaptive and acquired immunity in insect, haemolymph and haemocytes and their role in insect immunity.

Practical (45 Hours)

1. Study of available museum specimen of insects.
2. Study of insect's-stained histological slides through audio-visual charts of
 - 2.1 Alimentary canal of any available insect (fore gut, mid gut and hind gut).
 - 2.2 Salivary apparatus of any available insect.
 - 2.3 Malpighian tubules of any available insect.
 - 2.4 Blood cells of any available insect.
 - 2.5 Reproductive organs of hemi and holometabolous insects
 - 2.6 L.S. telotrophic and polytrophic ovarioles and Testes
3. Demonstration of amylase and proteinase activities of salivary gland of cockroach/grass hopper.
4. Study of the types of antennae in insects through audio-visual charts.
5. Study of different types of mouth parts in insect through audio-visual charts or dissecting of any available insects.
6. Rearing of any available insect.

Recommended Books

A. Essential Readings:

1. Chapman: The Insects: Structure and Function (4th ed.), ELBS, 1998
2. Imms: A General Text Book of Entomology (2 vols.), Asia Publishing House, 1997.
3. D. B. Tembhare: Modern Entomology, Himalaya Publishing House
4. Byrd and Castner: Forensic Entomology, CRC Press, 2001

B. Suggested Readings:

5. Srivastava: A Text Book of Applied Entomology (Vol. I & II, 2nd ed.) Kalyani Publ., 2001.
6. Dhaliwal and Arora: Principles of Insect pest management, National Agricultural Technology Information Centre, Ludhiana, 1996.
7. Pruthi: A Text Book of Agricultural Entomology, ICAR, New Delhi, 1969
8. Richard J. Elizinga: Fundamentals of Entomology.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (DSE)

Course Title: Animal Physiology-I

Credits: 4

Course Code: PGZO- E305

No. of Contact Hrs: 60Hrs

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.

Course Outcomes: After completion of the course the:

- Students will be Able understand animal physiology as the manifest of both relatively simple cellular mechanisms as well as more complex interactions between whole organ systems.
- Students will be able understand various biological processes, include excitable tissues, muscle, blood, the cardiovascular system and neurophysiology.
- Learners will be able to think critically about issues in animal physiology and carryout research in an effective manner.

Unit-I: Muscle Physiology (15 hours)

- 1.1 Ultra structure of skeletal muscle, Types of contraction, isotonic and isometric contraction.
- 1.2 Muscle proteins, Physical and Chemical Properties skeletal muscles, Chemical changes during muscular contraction.
- 1.3 Sliding filament theory of muscle contraction and Molecular basis of muscle contraction Role of Ca^{++} , Calcium receptors, Calmodulin and calcium pump.
- 1.4 Ultra Structure of neuromuscular junction (motor end plate) Synthesis and Release of acetylcholine, Events at the neuromuscular junction (chemical and Electrical) Presynaptic Events during muscle contraction. Myasthenia gravis.

Unit-II: Nerve Physiology (15 hours)

- 2.1 Ultra structure of neuron, Electrical properties of nerve: Conductivity, Summation, In fatiguability, All or none law. Ionic concentration in the cytoplasm (Donnan equilibrium system).
- 2.2 Action potential, Resting potential, Depolarization and Repolarization, Local circuit theory and Saltatory conduction, Ionic theory and nerve conduction.
- 2.3 Ultra structure of synapse, Biosynthesis, storage and release of acetylcholine, Electrical events in post synaptic neurons, Acetylcholine receptor and role of acetylcholine esterase.
- 2.4 Role of calcium, sodium and potassium channels, Types of neurotransmitters, their synthesis and storage (Epinephrine, nor epinephrine, serotonin and GABA).

Unit-III: Physiology of Excretion

(15 hours)

- 3.1 Ultra-structure of excretory organ, Physiology of Excretion: (Urine formation, Ultra filtration, Reabsorption, and Secretion).
- 3.2 Significance of Henley's loop in production of hyper osmotic urine.
- 3.3 Function of aldosterone, antidiuretic hormone and renninangiotensin system in renal physiology.
- 3.4 Role of kidney in pH regulation and water salt regulation.

Unit-IV: Physiology of Digestion.

(15 hours)

- 4.1 Digestion, Absorption, Utilization of Protein, Carbohydrate and Lipid.
- 4.2 Histophysiology of gastric gland, Secretory Functions of the Alimentary Tract.

4.3 Gastrointestinal Function—Motility, Nervous Control, Gastrointestinal peptides.

4.4 Gastrointestinal disorders (Achalasia, gastritis, pancreatitis and colitis)

Practical (45 hours)

1. Simple muscle curve Effects of temperature and calcium.
2. Estimation of serum creatinine.
3. Estimation of serum urea.
4. Qualitative analysis of urea.
5. Quantities estimation of calcium, phosphorus sodium and potassium.
6. Simple muscle curve-effect of temperature on calcium.
7. 3-D viewing of Acetylcholine, ion channel proteins using RasMol/ Deepview softwares.
8. Properties of saliva. Isolation and identification of rumen microorganisms.
9. Microscopic examination of urine.
10. Qualitative analysis of ketone bodies and salts.

Recommended Books

A. Essential Readings:

1. Eckert, Marsall: Animal physiology mechanism and Adaptations, 1983.
2. Hall, J. E., & Hall, M. E. Guyton and Hall textbook of medical physiology e-Book. Elsevier Health Sciences, 2020.
3. Tortora, G. J., & Derrickson, B. H. Principles of anatomy and physiology. John Wiley & Sons, 2018.
4. Randall DJ, Burggren W, French K, Eckert R. Eckert animal physiology. Macmillan; 2002.
5. Rastogi SC. Essentials of animal physiology. New Age International; 2007.

B. Suggested Readings:

1. Garden M.S.: Animal physiology principal and Adaptations. 4th Edition, Macmillan, 1992.
2. Hill RW. Comparative physiology of animals: an environmental approach. (No Title). 1976 Jan.
3. Sherwood, L. Human physiology: from cells to systems. Cengage learning, 2015
4. Hoar WS. General and comparative physiology. (No Title). 1966.
5. Houssa: Human physiology (McGraw Hill Books Company).
6. Keil J.B., Samson Wrightsa, Applied Physiology.
7. Heil E. Joets N (1982). Physiology (Oxford Uni press)
8. Moyes, C. D., & Schulte, P. M. Animal Physiology (p. 21). San Francisco, CA: Benjamin Cummings, 2005.
9. Kay, I. Introduction to animal physiology. Garland Science, 2020.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (DSE)

Course Title: Wildlife-I

Credits: 4

Course Code: PGZO- E305

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: This course deals with diversity, ecology and ethology of wild fauna. The learners will get basic information on biogeographic zones, food, cover, space, wet lands, sanctuary and national park. The learner will also know the tools and techniques in wild life studies. They will also be acquainted with need of wild-life conservation, conservation strategies being adapted at global level and legislations in this regard.

Course Outcomes: after the completion of the course the students will be able:

- To thoroughly understand primers of local and national wild life fauna, their habits and habitat, their social organization, and their conservation status.
- To handle various tools and techniques in wildlife and their application during field studies.
- With thorough knowledge of the subject, students will be able to design and execute research in wild life more successfully.

UNIT-I (15 hours)

- 1.1 Concept of biogeography, bio-geographical realms and bio-geographic classification with special reference to India, bio-geographical barriers, faunal interchange.
- 1.2 Mammalian characteristics, Classification of mammal with detailed treatment of different orders represented in Indian sub-continent.
- 1.3 Morphological and physiological adaptations in mammals, social organization in carnivores, herbivores and omnivores, Concept of altruism in mammals.
- 1.4 Current status, distribution and ecology of important Indian mammalian species.

UNIT-II (15 hours)

- 2.1 Avian classification with special reference to Indian species; morphological adaptations in bills and claws.
- 2.2 Social organization in birds; flocking and aggregation, foraging behaviours, solitary and colonial feeding, mixed hunting parties, food competition and selection.
- 2.3 Amphibians and reptiles, Classification with special reference to Indian fauna.
- 2.4 Areas of high herpetofauna diversity, foraging modes and food habits, predator avoidance, Field identification of poisonous and non-poisonous snakes, snake bites.

UNIT-III (15 hours)

- 3.1 Wildlife ecology, Concept of community; vertical stratification, horizontal heterogeneity, edge and ecotone.
- 3.2 Animal-habitat interactions. Effects of inter and intra-specific competition, mechanism of competition within community; exclusion and co-existence.
- 3.3 Concept of the niche, parameters of niche and factors affecting it, measures of niche width, separation and overlap.
- 3.4 Feeding ecology; review of optimal foraging theory, concept of herbivore, frugivory and predation. Food selection and pattern of habitat utilization.

UNIT-IV (15 hours)

- 4.1 Conservation biology; minimum viable populations, inbreeding and out-breeding depression, population vulnerability analysis and its components.
- 4.2 Stochastic and deterministic extinction process, demographic, genetic and environmental stochastic ties.
- 4.3 Inbreeding in natural populations of birds and mammals, heterozygosity, and fitness in natural populations.
- 4.4 Co-adaptation and out-breeding depression, concept of diversity, rarity, endemism, impact of habitat fragmentation on diversity.

Practical (45 hours)

A. Exercises to be carried out in Ladakh:

1. Identification of mammalian fauna of Ladakh region.
2. Identification of avian fauna of Ladakh region using various field techniques.
3. Identification of herpeto-fauna of Ladakh region.
4. Demonstration of basic equipment needed in wildlife studies (Compass, Binoculars, Spotting scope, Range Finders, GPS, Various types of Cameras and lenses, Camping gear)
5. Preparation of plaster cast and tracing of pugmarks.

B. Familiarization and study of wildlife evidences in field:

1. Identification of animals through indirect evidences: pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
2. Demonstration of different field techniques for flora and fauna.
 - a. PCQ, ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
 - b. Line transect method for abundance estimation of mammals and bird (direct and indirect evidences).
 - c. Call counts, point counts and Species Richness Counting methods for bird species abundance.

Recommended Books:

A. Essential Reading:

1. V.B. Saharia, Wildlife of India, Natraj Publishers, Dehradun.
2. Vivek Menon, Mammals of India. Princeton University Press, 20093.
3. Asad A. Rahmani, Threatened Birds of India, BNHS-Oxford University Press Publication.
4. F. Harvey Pough Herpetology 4th edition,
5. Johnsingh, A.J.T. (ed.). 2009. The Mammals of South Asia: Ecology, Behaviour and Conservation. Permanent Black.

B. Recommended Reading:

6. Wallace, J.G.1975. An Introduction to Ornithology. Macmillan Publishing Co. New York.
7. Grimmet R, Inskipp C and Inskipp T. 1999. Handbook of birds of Indian subcontinent.
7. Daniel JC. 1980. Book of Indian reptiles. OUP 10. Indraneil Das. 1987. Turtles and Tortoises of India, OUP
8. Wilson, K.; Hofmann, A.; Walker, J.; Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology. United Kingdom: Cambridge University Press.
9. Indraneil Das & Abhijit Das, Reptiles of India, Prakash Books India Private Limited.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
3rd Semester (DSE)

Course Title: Fish & Fisheries-I

Course Code: PGZO- E307

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Credits: 4

No. of Contact Hrs: 60

Course Objectives: To introduce the learners to general description and taxonomy of fishes and also to their morphological and physiological characteristics. To provide knowledge of physiology and behavior of fish. The course aims at enabling the learner to use molecular markers in stock identification. The course will expose the learner to the latest technological developments in the field of fisheries and aquaculture.

Course Outcomes: By the end of the course the student will be able to:

- Understand different morphological, physiological and behavioral modifications in fish.
- Thoroughly work out the ecology, biology and behavior of Indian major carps which are commercially very important.
- Understand the migration and schooling behavior in fish. Students will get acquainted with knowledge of adaptive features in hill stream fish.
- Explore the recent technological developments in the field of fisheries and aquaculture.

UNIT-I (15 hours)

- 1.1 General description of fish; Account of systematic classification of fishes; Distinctive characteristics of fishes.
- 1.2 Origin, Evolution and Distribution of major groups of fishes.
- 1.3 Comparative anatomy of skin; Scales: structure, types of scales; placoid, ganoid, cycloid, ctenoid; and modifications.
- 1.4 Comparative anatomy of fins and gills: types and modification of fins; types and structure of gills.

UNIT-II (15 hours)

- 2.1 Importance of fishery Science; Indian scenario.
- 2.2 Lacustrine fishery: origin and classification of lakes
- 2.3 Riverine fishery: resources, characteristics and production.
- 2.4 Marine fishery: resources, characteristics and production

UNIT-III (15 hours)

- 3.1 Growth and Metabolism: Regulation of food intake by hormones, environmental factors, digestive physiology and nutrient digestibility in fishes.
- 3.2 Buoyancy: Propulsive systems, swimming modes, structure, types and function of swim bladder in fishes; Weberian ossicle in fishes – structure and functions.
- 3.3 Gas exchange: Aquatic and aerial respiration; cardiovascular physiology, Acid-base balance.
- 3.4 Reproductive strategies (special reference to cold water fishes); Environmental factors regulating reproductive cycles.

UNIT-IV (15 hours)

- 4.1 Behavior in relation to feeding, schooling, migration, courtship, mating and parental care.
- 4.2 Migration: general account, types of migration, advantages of migration, factors influencing migration.
- 4.3 Bioluminescence, colouration; chromatophores, pigments and biological significance of coloration in fishes; mechanoreceptors and electric organs in fish.
- 4.4 Fishes and their relationship with abiotic and biotic factors.

Practical (45 hours)

1. Museum specimens: General account of Elasmobranchs and Teleosts.
2. Study of different types of scales (through permanent slides/ photographs).
3. Identification of commercially important fishes.
4. Study of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias* through visuals/charts.
5. Study of modification of fins using museum specimens.
6. Demonstration of parental care in fishes (video).
7. Physico-chemical properties of water: estimation of DO by Winkler's method; estimation of BOD; estimation of free carbon dioxide and determination of total alkalinity in the given water sample.
8. Length-weight relationship and condition factor determination.
9. To study the morphometric and meristic characters of fishes.
10. To identify given fish through morphometric analysis and draw diagram of the same.

Recommended Books

A. Essential Readings:

1. Khanna, S.S. and Singh, H.R. (2012). A Text Book of Fish Biology and Fisheries. 3rd edition. Narendra Publishing House, New Delhi. ISBN No: 9788185375762.
2. Jhingran, V.G. (1982) Fish and Fisheries in India. Hindustan publication Cooperation, India.
3. Talwar, P.K. and Jhingran, A.G. (1991). Inland Fishes of India, Vols. I & II, Oxford and IBH, New Delhi ISBN No. 9788120406391.
4. Evans, D. H. and Claiborne, J. D. (2013) The Physiology of Fishes. Taylor and Francis, U.K. ISBN No.- 9780849320224.

A. Suggested Readings:

5. Bone, Q. and Moore, R. Biology of Fishes. Taylor and Francis Group, CRC Press, U. K.
6. Moyle, P.B. and Cech, J.J. (1986) Fishes: An Introduction to Ichthyology, Prentice – Hall, Inc. Jersey, U.S.A. ISBN No. 978-0131008472.
7. Jayaram, K.C. (2013) Fundamentals of Fish Taxonomy, Narendra Publishing House, New Delhi. ISBN 81-85-375-71-2.
8. Srivastava, C.B.L. and Srivastava, S. (2007). A text book of Fishery Science and Indian Fisheries. Narendra Publishing House, New Delhi. ISBN No: 9788185375557.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
4th Semester (Core)

Course Title: Enzymology and Biostatistics

Credits: 4

Course Code: PGZ0-C401

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To know the biological function of enzyme and enzyme kinetics. To introduce the application of statistical tools to eliminate chance outcomes in research.

Course Outcomes: the expected out come of the course are:

- Students will be able to understand types and classification of enzymes. Students will be able to work out how enzymes speed up biochemical reactions and the enzyme kinetics.
- Students will be able to apply various statistical tools on scientific data to eliminate chance conclusions.
- The learner will be able to test their hypothesis and make sound generalization through logical application of statistical tools.

UNIT- I (15 hours)

- 1.1 Enzyme: Structure, Classification & kinetics; nomenclature of enzymes; Structure of enzyme, e.g., Chymotrypsin
- 1.2 Active site, Mechanism of action of – Chymotrypsin, Enolase and Hexokinase.
- 1.3 Kinetics of single substrate and bisubstrate enzyme; catalyzed reactions, cooperativity.
- 1.4 Enzyme: Categories & Functions; Enzymes involved in energy production; Enzymes involved in biodegradation

UNIT- II (15 hours)

- 2.1 Activators and inhibitors of enzymes; Isozymes, ribozymes and abzymes.
- 2.2 Allosteric enzymes; Zymogen activation & covalent modification;
- 2.3 Coenzymes, mechanism of action; Enzymes involved in protein synthesis; Enzymes involved in free radical formation;
- 2.4 Enzymes involved in cell signaling; Enzymes involved in nucleic acid metabolism;

UNIT- III (15 hours)

- 3.1 Biostatistics: population, sample, variable, parameter, primary and secondary data, screening and representation of data, frequency distribution.
- 3.2 Diagrammatic representation of data (Line graph, Bar diagram, Pie diagram); Graphic representation of data (histogram, frequency polygon, frequency curve cumulative frequency).
- 3.3 Measure of central tendency: mean, median, mode, quartiles and percentiles.
- 3.4 Measure of dispersion: variance, standard deviation, coefficient of variation.

UNIT- IV (15 hours)

- 4.1 Probability and distributions- definition of probability (frequency approach), Addition and multiplication rules, conditional probability.
- 4.2 Bernoulli, binomial, poisson and normal distributions, correlation coefficient (r), properties (without proof), interpretation of r; P- value of the statistic, confidence limits.
- 4.3 Tests of statistical significance (Chi-square - test, Z-test, F-test, Student t- Test).

4.4 Analysis of variance – one way ANOVA. Coefficient of correlation; Simple & multiple regression.

Practical (to be evaluated as part of the dissertation)

1. Study effect of pH and temperature on enzyme activity. Ex. Salivary amylase.
2. To study the effect of inhibitors on enzyme activity.
3. Determination of acid value and saponification value of fat.
4. Colorimetric estimation of some respiratory enzymes.
5. Calculation of dispersion, Calculation of measure of central tendency.
6. Fitting of Binomial distribution and Poisson distribution.
7. Tests of statistical significance.
8. Use of excel sheet for data processing.
9. Web– based tools for sequence searches and homology screening.

Books recommended.

A. Essential Books:

1. J. Darnell, H.Lodish and D. Baltimore, Molecular Cell Biology, Scientific American Book, Inc. USA
2. Samuel Delvin, Enzymes, Sarup & Sons, N. Delhi
3. Goon, A.M., M.K. Gupta and B. Dasgupta. 1983. Fundamentals of Statistics. Vol.I.
4. Banerjee P.K. Introduction to Biostatistics (A Textbook of Biometry) S. Chand and company Ltd.

B. Further Readings:

5. K. Wilson & K.H. Goulding, A Biologists Guide to Principles and Techniques of Practical Biochemistry, ELBS Edn
6. Daniel, W.W. 1983. Biostatistics: A Foundation for analysis in the Health Sciences. John Wiley and Sons, New York.
7. Dunn, O.J. and V.A. Clark. 2001. Basic Statistics: A primer for Biomedical Science. John Wiley and Sons, New York. 3.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
4th Semester (Core)

Course Title: Fundamentals of Biochemistry

Credits: 4

Course Code: PGZ0-C402

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To introduce the chemistry, classification, structural and functional diversity of biomolecules. To understand their physico-chemical properties and significance in biological system. To acquaint the students with the structure, chemical properties and biological significance of macromolecules of physiological importance.

Course outcomes: after completion of this course, students will be able:

- To know the basic chemistry of biomolecules like carbohydrates, lipids, proteins etc.
- To understand various enzyme-controlled reaction, cascade reactions, chain and cyclic reactions underlying fundamental life processes.
- Students will be able to appreciate life as an interplay of atoms, compounds and molecular complexes

UNIT- I (15 hours)

- 1.1 Biomolecules; Van-der-Waals, electrostatics, Hydrogen bonding and Hydrophobic interactions, Bonds and forces stabilizing biomolecules.
- 1.2 Ph, pK, Acids, Bases, Buffers, and isomerization.
- 1.3 Structure of DNA; Structure, types and function of RNAs. Nucleic acid protein interactions;
- 1.4 De novo and salvage pathways of nucleotide biosynthesis.

UNIT- II (15 hours)

- 2.1 Amino acids; Structure and chemistry of amino acids; Essential and non-essential amino acids
- 2.2 Transamination and deamination; Ornithine cycle.
- 2.3 Protein structure & folding, Ramachandran plot.
- 2.4 Conjugated proteins: structure and function; Protein-protein interactions.

UNIT- III (15 hours)

- 3.1 Carbohydrate metabolism; Glycolysis, regulation & energetics.
- 3.2 TCA cycle, regulation and energetics; Electron transport chain & oxidative phosphorylation.
- 3.3 Gluconeogenesis; Glycogenesis & glycogenolysis, regulation.
- 3.4 Pentose phosphate pathway and its significance.

UNIT- IV (15 hours)

- 4.1 Lipid metabolism; Chemistry, biosynthesis and functions of triglycerides, phospholipids, sphingolipids, prostaglandins and cholesterol.
- 4.2 Mitochondrial and peroxisomal systems of fatty acid oxidation; β -oxidation of fatty acids (Palmitic acid).
- 4.3 α - and ω -oxidation of fatty acids; Energetic of fatty acid oxidation; Role of carnitine shuttle.
- 4.4 Ketone bodies – Structure, biosynthesis and functions

Practical (to be evaluated as part of the dissertation)

1. Estimation of alkaline and acid phosphatases in the liver procured from local market.
2. Quantitative estimation of glycogen, cholesterol protein in tissue procured from local market.
3. Qualitative estimation of carbohydrates, lipids and protein in tissue procured from local market.
4. Determination of isoelectric pH of protein and amino acids.
5. Estimation of plasma / serum glucose and serum cholesterol.

Books recommended.**Essential Books:**

1. Beckatt, A.H. and Stenlake, J.B. (1988)., Practical Biochemistry, the Athlone Press, London.
2. Lehninger – Principles of Biochemistry & Bartle. Nelson & Cox. 4th edition. W H Freeman and Company, New York.
3. Eric E. Conn, Paul K. Stumpf and others (1995)., Outlines of Biochemistry 5/E. John Wiley and Sons.

Further readings:

4. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer. Biochemistry. 5th edition W.H. Freeman and Company, New York (2006).
5. Freefelder, D. (1982)., Practical Biochemistry: Application to Biochemistry and Molecular Biology, W.H.Freeman.
6. Wilson, Keith and Walker, John (2000)., Practical Biochemistry: Principles and techniques, 5th Edition Edited, Cambridge University Press.
7. Donald Voet and J.G. Voet, Biochemistry, 3rd edition. John Wiley and Sons (2004).

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
4th Semester (DSE)

Course Title: Entomology-II

Credits: 4

Course Code: PGZO-E403

No. of Contact Hrs: 60Hrs

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: the main objective of the course is to provide the learner, a platform to explore and understand the vast and divers structural and functional characteristics of insects. The course will expose students to the morphology, anatomy, physiology and ecology of insects. The course will also deal with insect groups of medical, agricultural and economical importance.

Course Outcomes: after the completion of the course the students will be able:

- To understand the morphology, taxonomy, anatomy and physiology of entognathus and ectognathus hexapods. Students
- To explore the adaptive diversity in several major groups of insects. To identify and diagnose the destructive and useful group of insects and important families of medical and agricultural importance.
- With through knowledge of the subject, the learner shall be able to design and executed research in the field of entomology more successfully.

Unit I: Insect pest control and management (15 hours)

- 1.1 Insect pests; Causes and success of insects, Origin of insect pests, Factors affecting the abundance of insects.
- 1.2 Natural and cultural control of insect pest.
- 1.3 Chemical control of insect pest.
- 1.4 Botanical insecticides

Unit II Biocontrol and IPM (15 hours)

- 2.1 Insect predators and parasitoids.
- 2.2 Microbial control of insect pests.
- 2.3 Behavioural control: Types of pheromones, Uses of pheromones in pest management (monitoring, mass trapping and mating disruption).
- 2.4 Integrated pest management: Concept, strategies and tools in IPM

Unit III: Insect pest of major crops (15 hours)

Insect pest with emphasis on occurrence, morphology, lifecycle, nature of damages caused and pest management of the following crops

- 3.1 Temperate fruits (codling moth and brown tail moth)
- 3.2 Vegetables (*Pieris brassicae* and *Brevicoryne brassicae*).
- 3.3 Food crops: Barley, wheat and maize (*Helicoverpa armigera* and *Chilo partellus*)
- 3.4 Stored grain pests (*Tribolium castaneum* and *Rhizopertha dominica*).

Unit IV: Medical and veterinary entomology (15 hours)

- 4.1 Pests of public importance and their control: mosquitoes, house flies, lice, bedbugs, fleas.
- 4.2 Insect borne diseases of man: typhus, yellow fever, dengue fever, encephalitis, plague, leishmaniasis, sleeping sickness, malaria, filaria.
- 4.3 Brief account of non-blood sucking flies: House fly, Eye fly, Blow fly and Flesh fly. (Morphology, lifecycle and control), Myiasis and maggot therapy.
- 4.4 Morphology and disease relationship of blood sucking insect lice, bugs and mosquito.

Practical (to be evaluated as part of the dissertation)

1. Study of life cycle of grasshopper, house flies, flesh fly and bottle fly and their habitats.
2. Study of antifeedant effect of neem extract on grasshoppers.
3. Study of the effect of any available chemical insecticide on any available insect.
4. Visit to a local Agriculture farm to study the agriculture pest management.
5. Visit to a local animal farm centre/Animal husbandry department to study farm insect pest management.
6. Collection and preservation of insects by:
 - 6.1 Dry preservation methods (direct pinning, carding and pointing).
 - 6.2 Liquid preservation and processed mounting methods.
 - 6.3 Presentation and report submission on the agriculture and animal farm visit

Recommended Books**A. Essential Readings:**

1. Srivastava: A Text Book of Applied Entomology (Vol. I, 2nd ed.) Kalyani Publ., 2001
2. Srivastava: A Text Book of Applied Entomology (Vol. II, 2nd ed.) Kalyani Publ., 2001.
3. Pruthi: A Text Book of Agricultural Entomology, ICAR, New Delhi, 1969

B. Further Readings:

4. D. B. Tembhare: Modern Entomology by Himalaya Publishing House.
5. Dhaliwal and Arora: Principals of Insect pest management, National Agricultural Technology Information Centre, Ludhiana, 1996.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
4th Semester (DSE)

Course Title: Animal Physiology-II

Credits: 4

Course Code: PGZO-E404

No. of Contact Hrs: 60Hrs

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: The major aims of this course are to provide students with a basic understanding of the fundamental processes and mechanisms that serve and control the various functions of the body.

Course Outcomes: After completion of the course the:

- Students will be Able understand animal physiology as the manifest of both relatively simple cellular mechanisms as well as more complex interactions between whole organ systems.
- Students will be able understand various biological processes, include excitable tissues, muscle, blood, the cardiovascular system and neurophysiology.
- Learners will be able to think critically about issues in animal physiology and carryout research in an effective manner.

Unit- I: Physiology of Respiration (15 hours)

- 1.1 Anatomical and physiological organization of respiratory system, Mechanism of respiration breathing movements and the exchange of respiration, Respiratory gases at pulmonary surface.
- 1.2 Blood pigments, Transport of gases by blood, Role in oxygen transport, Transport of CO₂, Vital capacity and partial pressure of gases, Oxygen dissociation curve, Co₂ dissociation curve.
- 1.3 Respiratory centre and Neuro Hormonal and Chemical regulation of respiration, Carbonic anhydrase, Chloride shift.
- 1.4 Infectious respiratory diseases (SARS, Avian Flu and Swine flu)

Unit-II: Physiology of Circulation-I (15 hours)

- 2.1 Anatomy, Structure, histology & function of mammalian heart.
- 2.2 Cardiac output, Cardiac sound, Origin and conduction of cardiac impulse, Cardiac cycle
- 2.3 Regulation of heart beat and blood pressure.
- 2.4 Electro cardiograph, and interpretations of ECG. Myocardial infarction and cardio myopathy.

Unit-III: Homeostasis Physiology-I (15 hours)

- 3.1 Water contents and distribution, Composition of ECF (Extra cellular fluid) and ICF (Intracellular fluid).
- 3.2 Abnormal water and electrolyte metabolism and water intoxication Maintenance of pH
- 3.3 Components of Homeostatic Control system. Reflexes, Local Homeostatic Responses.
- 3.4 Intercellular chemical messengers - Paracrine and Autocrine agents. Process related to Homeostasis.

Unit-IV: Homeostasis Physiology-II (15 hours)

- 4.1 Adaptation and Acclimatization. Biological Rhythms.
- 4.2 Mechanism of calcium and phosphate Homeostasis.
- 4.3 Homeostatic mechanism of minerals, Homeostasis and ant diuretic hormone.
- 4.4 Liver is important in the storage and Homeostasis of Iron.

Practical (to be evaluated as part of the dissertation)

1. Preparation and examination of blood smear to study blood cells.
2. Differential leucocytes count.
3. Determination of Erythrocyte sedimentation rate (E.S.R.)

4. Determination of pack cell volume (P.C.V).
5. Determination of mean corpuscular volume (M.V.C.).
6. Detection of blood by hemin crystals test.
7. Estimation of protein in blood.

Recommended Books.

A. Essential Readings:

1. Eckert, Marsall: Animal physiology mechanism and Adaptations, 1983.
2. Hall, J. E., & Hall, M. E. Guyton and Hall textbook of medical physiology e-Book. Elsevier Health Sciences, 2020.
3. Tortora, G. J., & Derrickson, B. H. Principles of anatomy and physiology. John Wiley & Sons, 2018.

B. Further Readings:

4. Randall DJ, Burggren W, French K, Eckert R. Eckert animal physiology. Macmillan; 2002.
5. Rastogi SC. Essentials of animal physiology. New Age International; 2007.
6. Garden M.S.: Animal physiology principal and Adaptations. 4th Edition, Macmillan, 1992.
7. Sherwood, L.. Human physiology: from cells to systems. Cengage learning, 2015.
8. Hoar WS. General and comparative physiology. (No Title). 1966.
9. Houssa: Human physiology (McGraw Hill Books Company).
10. Keil J.B., Samson Wrightsa, : Applied Physiology.
11. Heil E. Joets N.: Physiology (Oxford Uni press) (1982).
12. Kay, I. Introduction to animal physiology. Garland Science, 2020.

University of Ladakh
M. Sc. Zoology Syllabi, Effective from Academic Year 2023
4th Semester (DSE)

Course Title: Wild Life-II

Credits: 4

Course Code: PGZO-E405

No. of Contact Hrs: 60Hrs

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: This course deals with diversity, ecology and ethology of wild fauna. The learners will get basic information on biogeographic zones, food, cover, space, wet lands, sanctuary and national park. The learner will also know the tools and techniques in wild life studies. They will also be acquainted with need of wild-life conservation, conservation strategies being adapted at global level and legislations in this regard.

Course Outcomes: after the completion of the course the students will be able:

- To thoroughly understand primers of local and national wild life fauna, their habits and habitat, their social organisation, and their conservation status.
- To handle various tools and techniques in wildlife and their application during field studies.
- With thorough knowledge of the subject, students will be able to design and execute research in wild life more successfully.

UNIT-I (15 hours)

- 1.1 Environment and wildlife conservation, history of man's role in environment and relationship with wildlife- a national perspective.
- 1.2 changing patterns of resources exploitation and environmental management, outstanding contemporary problems in regard to ecological balance and wildlife conservation in India.
- 1.3 Important conservation programmes for restoration of degraded habitats and rehabilitation of wildlife, social forestry, pasture development programmes.
- 1.4 Control and regulation of grazing, weed eradication. Water hole management.

UNIT-II (15 hours)

- 2.1 Evaluation and management of wetland habitats: classification of wetlands,
- 2.2 methods of wetland evaluation, biological assessment of wetlands,
- 2.3 wetlands as habitat for waterfowl, migration patterns of waterfowl and management implications.
- 2.4 Introduction and spread of exotic wetland species in India and its impact on local riverine faunal resources.

UNIT-III (15 hours)

- 3.1 Introduction to sampling theory, various types of sampling techniques. Concept of sampling effort and species area curve.
- 3.2 Detailed treatment of various abundance estimation techniques for mammals, birds, reptiles and amphibians.
- 3.3 Fundamentals of Photogrammetry, types of Aerial Cameras, Depth perception and stereoscopic viewing. Concept of digital Photogrammetry.
- 3.4 GIS & GPS applications: Fundamentals of GIS. Functions of GIS, Data format, spatial & non-spatial data-vector and Raster data. Applications in wildlife sciences.

UNIT-IV (15 hours)

- 4.1 Legislative Safeguards for Wildlife Protection: Convention on protection of wild Flora & Fauna (CITES), 1970.

- 4.2 Wildlife (Protection) Act, 1972 and its salient features. Administrative Enforcement & Judicial Annihilation of Wildlife Conservation.
- 4.3 National Bio-diversity Laws & Rules: Conservation of Biological Diversity Act, 2002 & Rules.
- 4.4 Breeding & Experiments on Animals (Control & Supervision) Rules, 1998.

Practical (to be evaluated as part of the dissertation).

A. Visit Exercises to be carried out during dissertation tours:

1. Visit of a Zoological Park for Faunal study.

B. Familiarization and study of wildlife evidences in field:

3. Identification of animals through indirect evidences: pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna.
 - d. PCQ, ten tree method, Circular, Square & rectangular plots, Parker's 2 Step and other methods for ground cover assessment, Tree canopy cover assessment, Shrub cover assessment.
 - e. Line transect method for abundance estimation of mammals and bird (direct and indirect evidences).
 - f. Call counts, point counts and Species Richness Counting methods for bird species abundance.

Recommended Books.

A. Essential Reading:

1. Fundamentals of limnology, Jayashree Datta Munshi & Jyotishwarup Datta Munshi.
2. Shyam Divan & Armin Rosencranz, Environmental law & policy in India: Cases Materials & Statutes, Oxford: New Delhi; 2000.
3. Odum, E. P., & Barrett, G. W. (1971). Fundamentals of ecology (Vol. 3, p. 5). Philadelphia: Saunders.
4. Silvy, N. J. (Ed.). (2020). The Wildlife Techniques Manual: Volume 1: Research. Volume 2: Management. JHU Press.
5. Usher, M. B. (1986). Wildlife conservation evaluation: attributes, criteria and values. In Wildlife conservation evaluation (pp. 3-44). Dordrecht: Springer Netherlands.

B. Further Reading:

6. P. Leelakrishnan, Environmental Law: Case Book, Butterworth: New Delhi; 2004.
7. Sanjay Upadhyaya et al, Environmental Law in India, [Vols. I, II, III] Butterworth: New Delhi; 2004.
8. M. Zafar Mahfooz Nomani, Natural Resources Law & Policy Uppal: New Delhi; 2004 6. Raj Punjwani, Wildlife Conservation in India, Natraj: Dehradun; 2000.
9. Ali, S. and Ripley, D.S. 1987. A compact Handbook of Birds of Indian subcontinent. OUP, Bombay

University of Ladakh
Syllabus M. Sc. Zoology, Effective from Academic Year 2023
3rd Semester (DSE)

Course Title: Fish & Fisheries II

Credits: 4

Course Code: PGZO-E406

No. of Contact Hrs: 60

Max. Marks: 100 (External=70 Continuous Internal Assessment= 30)

Course Objectives: To introduce the learners to general description and taxonomy of fishes and also to their morphological and physiological characteristics. To provide knowledge of physiology and behavior of fish. The course aims at enabling the learner to use molecular markers in stock identification. The course will expose the learner to the latest technological developments in the field of fisheries and aquaculture.

Course Outcomes: By the end of the course the student will be able to:

- Understand different morphological, physiological and behavioral modifications in fish.
- Thoroughly work out the ecology, biology and behavior of Indian major carps which are commercially very important.
- Understand the migration and schooling behavior in fish. Students will get acquainted with knowledge of adaptive features in hill stream fish.
- Explore the recent technological developments in the field of fisheries and aquaculture.

UNIT-I (15 hours)

- 1.1 Fish identification: Fish diagnostics, collection and preservation of fish, measurements and counts.
- 1.2 Stock identification: Morphometric and meristic tools for stock identification and use of hard parts such as vertebrae, otolith and scale for fish stock identification.
- 1.3 Age and growth in fish: use of scales for age and growth determination; Length-weight relationship.
- 1.4 Use of molecular markers in stock identification: Allozymes, RFLP, RAPD, AFLP, Microsatellites, ESTs, SNPs, Type I and II markers, mtDNA and nuclear DNA markers.

UNIT-II (15 hours)

- 2.1 Identification, description, habit and habitat of endemic cold-water fish of Ladakh: (*Diptychus maculatus*, *Triplophysa ladicensis*, *Schizothorax sp.*).
- 2.2 Aquatic environment and fish health: Aquatic pollution- algal blooms and their effects on fish production, biological, mechanical and chemical control of algal blooms.
- 2.3 Hill stream fish: Conditions in hill streams (physico-chemical and biotic); adaptation in hill stream fish.
- 2.4 Fishing gears used in lotic and lentic waters such as cast net, gill net, drag net, scoop net, hand net, potting gears, electro-fishing and destructive fishing methods.

UNIT-III (15 hours)

- 3.1 Fish farming: concept and types of culture system; Intensive, composite culture, integrated fish farming.
- 3.2 Fish breeding: Natural and bundh breeding, fish seed collection from natural sources, breeding hapas, technique of induced breeding, use of synthetic chemicals for induced breeding.
- 3.3 Pearl culture: Species involved in pearl culture, implantation procedure, water quality, pearl composition, kinds of pearls, economics and enemies of oysters.

3.4 Technological development in fish farming: Recirculating aquaculture system (RAS), Aquaponic, Bifloc technology and eDNA etc.

UNIT-IV (15 hours)

- 4.1 Fish nutrition: Nutritional requirement of commercially important fish; major and minor constituents of fish feed-moisture, proteins, lipids, carbohydrates, vitamins and mineral, biochemical.
- 4.2 Feed formulation: Principle of feed formulation, feed ingredients, evaluation of ingredient quality, feed additives and feed binders, anti-nutritional factors and their processing.
- 4.3 Types of feed: various feed types such as moist, semi-moist, dry, crumble, pellet, sinking, slow sinking, floating, micro-bound, micro-encapsulated, micro-coated and high energy.
- 4.4 Fish growth indices: live weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio and feed conversion efficiency.

Practical (to be evaluated as part of the dissertation).

11. Determination age and growth: gonadosomatic index in fish
12. To study various parts and accessories of aquaculture.
13. Study of fishing gears and nets with the help of models
14. Feed formulation and different methods.
15. Field visit to a fish farm.

Recommended Books.

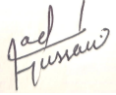









A. Essential Reading:

1. Bangenal, T. (1970). Methods for Assessment of Fish Production in Freshwaters 3rd Ed, IBH Handbook No.3, Blackwell Scientific Publication, Oxford.
2. Datta Munshi, J. and Datta Munshi, J. (1995) Fundamentals of Freshwater Biology, Narendra Publishing House, Delhi. ISBN 81-85375-34-8.
3. Jhingran, V.G. (2002). Fish and Fisheries of India, Hindustan Publishing House (India), New Delhi. ISBN No. 9788170750178 Johal, M.S. and Aggarwal, S.C. (1997). Fishery Development, Narendra Publishing House, Delhi. ISBN No. 818537550X.
4. Pillay, T.V.R. (1993), Aquaculture principles and practices.

B. Further Reading:

5. Arrington, J. (1999). Management of Freshwater Fisheries, Oxford and IBH, New Delhi.
6. Badapanda, K.C. (2013). Basics of Fisheries Science: Fishing Craft & Gear Technology. Narendra Publishing House, Delhi. ISBN No. 9789380428741.
7. Boyd, (1982), Water quality management for land fish culture, CE Elsevier Scientific publishing company.
8. Srivastava, C.B.L. and Srivastava, S. (2007). A text book of Fishery Science and Indian Fisheries. Narendra Publishing House, New Delhi. ISBN No: 9788185375557.

Note: Approved by the Board of Studies (Zoology) University of Ladakh, constituted vide University Order Nos: UOL/2023/DAA-20/303-343 Dated: 18th of Feb. 2023 and UOL/2023/DAA-01/581 Dated: 18/09/2023.

Name of the Member	Signature	Name of the Member	Signature
Dr Amjad Hussain Assistant Professor, Department of Zoology UOL.		Dr Basharat Ali, Assistant Professor, Department of Zoology UOL.	
Mr. Mohsin Ali, Assistant Professor, Department of Zoology UOL		Mr. Padma Wangchuk Assistant Professor, EJM Leh.	
Dr Javed Naqi, Assistant Professor, GDC- Kargil		Dr Abid Hussain, Assistant Professor, GDC-Kargil.	
Dr Mohd Hussain, Assistant Professor, Department of Zoology UOL		Dr Tsewang Mutup, Principal GDC- Nubra	
Prof. Sukhbir Kaur, Professor Department of Zoology, Panjab University (Ext Member)		Prof. Linz Buoy George, Head Department of Zoology, Gujarat University (Ext Member)	

No: UOL/BOS-Zoology/2023/04

Dated: 4th October 2023.