



**MODERN COLLEGE OF ARTS,
SCIENCE AND COMMERCE
GANESHKHIND, PUNE-16
(AUTONOMOUS)**

**Three Year B.Sc. Degree Program
in ZOOLOGY
(Faculty of Science)**

**To be implemented from Academic Year
2024-2025**

BOARD OF STUDIES IN ZOOLOGY

**Progressive Education Society's
MODERN COLLEGE OF ARTS, SCIENCE AND COMMERCE, GANESHKHIND,
PUNE- 16
(AUTONOMOUS)**

Preamble:

Zoology is one of the major subjects of Basic Sciences and deals with all aspects of animal biology. It includes an interesting range of highly diverse topics. A zoology student needs to gain understanding of many areas of the subject to keep pace with advancements in Life Sciences.

This under-graduate degree program has been designed by the Board of Studies in Zoology of Savitribai Phule Pune University with a substantial component of what is needed from a zoologist as a skilled career and what zoologists need to pursue for post-graduation and further academic studies. It follows the guidelines laid down by the University Grants Commission, New Delhi. This newly designed curriculum is a perfect blend of the classical aspects in Zoology with the advanced and more specialized areas.

This degree offers Discipline Specific Core Courses [CC] in Animal Systematics, Animal Ecology, Animal Cell biology, Applied Zoology, Pest Management, Histology, Biological Chemistry, Genetics, Developmental Biology, Parasitology, Medical & Forensic Zoology, Animal Physiology, Molecular Biology, Entomology, Techniques in Biology and Evolutionary Biology.

In addition to the Core Courses, Ability Enhancement Compulsory Courses [AECC] have been added in the second year i.e. Semester III and Semester IV of the undergraduate course. In the third year i.e. Semester V and Semester VI, Discipline specific Elective Courses [DSEC] and Skill Enhancement Courses [SEC] have been offered. The students, therefore, have an opportunity to take courses in Environment Awareness, Language & communication, English / Marathi, Aquarium Management, Poultry Management and Environmental Impact Assessment. In Semester VI the students also have a course dedicated to Project work.

The syllabus has been framed in such a way that the student gains each year, a broader perspective of the subject as he progresses towards completion of the degree program. Field visits, Educational visits and the Project work have been included for the student to experience the applications of the theory learnt in the classroom.

After completion of the program, it is expected that students will understand and appreciate: animal diversity, few applications of Zoology, the structure, functions and life processes at cellular, tissue, organ and system level, significance of evolution, and basic concepts of human health. The students would also gain an insight into laboratory and field work through the practical course, field work and the project.

The new course will be effective from the academic year 2024- 2025 and will follow the Choice Based Credit System in a Semester mode. It has been primed keeping in view the distinctive requirements of B. Sc. Zoology students. The contents have been drawn-up to accommodate the widening prospects of the discipline of Life Sciences. They reflect the changing pre requisites of the students. This graduate program has been introduced with 144 credits for the subject group

while 08 credits to earn from any of the 08 groups offering a range of curricular, co-curricular and extracurricular activities. This pattern has been specially aimed towards the overall development of the students.

The calculation of credits and CGPA will be as per the guidelines of the University. The B. Sc. Zoology program provides an appropriate blend of classical and applied aspects of the subject. This newly designed curriculum will allow students to acquire the skill in handling scientific instruments planning and performing in the laboratory and exercising critical judgement, independent thinking and problem solving skills. The Syllabus has been revised with the following aims -

- To foster curiosity in the students for Zoology,
- To create awareness amongst students for the basic and applied areas of Zoology,
- To orient students about the importance of abiotic and biotic factors of environment and their conservation,
- To provide an insight to the aspects of animal diversity,
- To inculcate good laboratory practices in students and to train them about proper handling of lab instruments.

Course Structure with Credit Distribution of the Third year Zoology Syllabus

Semester	Course	Course code	Name of the Course	Credits
V	DSEC	24-ZO -351	Applied Entomology	2 Credits (30 L)
	DSEC	24-ZO-352	Histology and Histopathology	2 Credits (30 L)
	DSEC	24 -ZO -353	Biological Chemistry	2 Credits (30 L)
	DSEC	24 -ZO -354	Genetics	2 Credits (30 L)
	DSEC	24-ZO -355	Developmental Biology	2 Credits (30 L)
	DSEC	24 -ZO-356	Medical Parasitology	2 Credits (30 L)
	DSEC	24-ZO-357 (Based on 24- ZO -351+24- ZO-352)	Zoology Practical –I	2 Credits
	DSEC	24-ZO-358 (Based on 24 - ZO -353+24 - ZO -354)	Zoology Practical –II	2 Credits
	DSEC	24-ZO-359 (Based on 24- ZO -355+24 - ZO-356)	Zoology Practical –III	2 Credits
	SEC	24-ZO-3510	Fishery Management	2 Credits (30 L)
SEC	24-ZO-3511	Basics in Biostatistics/Veterinary Management	2 Credits (30 L)	
Semester VI	DSEC	24-ZO-361	Forensic Zoology	2 Credits (30 L)
	DSEC	24-ZO-362	Animal Physiology	2 Credits (30 L)
	DSEC	24-ZO-363	Molecular Biology	2 Credits (30 L)
	DSEC	24-ZO-364	Pest Management	2 Credits (30 L)
	DSEC	24-ZO-365	Tools and techniques in Biology	2 Credits (30 L)

	DSEC	24-ZO-366	Evolutionary Biology	2 Credits (30 L)
	DSEC	24-ZO-367 (Based on 24-ZO-361+24-ZO-362)	Zoology Practical –I	2 Credits
	DSEC	24-ZO-368 (Based on 24-ZO-363+24-ZO-364)	Zoology Practical –II	2 Credits
	DSEC	24-ZO-369 (Based on 24-ZO-365+24-ZO-366)	Zoology Practical –III	2 Credits
	SEC	24-ZO-3610	Biodiversity Assessment	2 Credits (30 L)
	SEC	24-ZO-3611	Project/Internship/Hands on Training or Workshop	2 Credits (Minimum 1 week duration)

CC=Core Courses,
AECC =Ability Enhancement Compulsory Courses,
DSEC= Discipline Specific Elective Courses
SEC= Skill Enhancement Courses

Course Title: Applied Entomology

Course Code: 24-ZO -351

Credits: 02

Course outcomes:

At the end of this course, Students will -

1. Understand basic concepts in Entomology and its scope.
2. Learn morphology and anatomy of Insects.
3. Understand the concept of social organization in Insects.
4. Gain knowledge of the development process of Insects.

Title & Contents

Number of lectures

1. Fundamentals of Entomology:

2 L

- 1.1 Definition and scope of Entomology.
- 1.2 General Classification of Insects.
- 1.3 General Characters of Insects.

2. Insect Morphology:

7 L

- 2.1 Insect Integument and its derivatives.
- 2.2 Insect Head, Head Orientations, Head articulations, Insect antennae and Mouth parts.
- 2.3 Insect Thorax, Insect Wing and modifications, Insect Leg and Modifications – a) Cursorial – Cockroach, b) Fossorial – Mole cricket, c) Saltorial – Grasshopper, d) Raptorial – Praying mantis, e) Pollen basket – Honey bee.
- 2.4 Insect Abdomen, Genital and Pre – genital appendages of Grasshopper.

3. Insect Anatomy (Grasshopper):

4 L

- 3.1 Digestive System.

3.2 Circulatory System.

3.3 Nervous System.

3.4 Respiratory System.

3.5 Reproductive System.

4. Insect Ecology: 3 L

4.1 Definition of Insect Ecology.

4.2 Abiotic Factors (Photoperiod, Temperature and Humidity) and Biotic Factors (Food, Foraging and Nesting).

4.3 Mimicry in insects with suitable examples.

5. Insect Metamorphosis: 2 L

5.1 Definition.

5.2 Types and examples of Metamorphosis.

6. Insects as social groups: 6 L

6.1 Definition & significance of Eusociality, Intraspecific and Interspecific relationships among insects.

6.2 Social organization in Wasps and Termites.

7. Economic Importance of Insects: 3 L

7.1 Insects in Research.

7.2 Insects in Medicines and Cosmetics.

7.3 Insects as Vectors.

7.4 Insects as food.

References

1. Social Insects: Their Origin and Evolution, 2006, W. M. Wheeler, Discovery Publishing House, Delhi.

2. Lives of Social Insects, 1968, P. P. Larson, M. W. Larson, World Pub. Co.

3. Modern Entomology, 2nd edition - By D. B. Tembhare, Himalaya Publication House, Bombay.
4. Principles of Insect Morphology - By R. E. Snodgrass, Tata Mc-Graw Hill Bombay.
5. The Insect: Structure & Function - By R. F. Chapman, E. L. B. S., & E. U. P. London.
6. General Entomology, 2nd edition - By M. S. Mani Oxford & IBH Publishing Company, New Delhi.
7. A Text book of Entomology - By H. H. Ross, John Wiley and Sons, Ins. New York.
8. An Introduction to Entomology - By J. H. Comstock, Ithaca, New York.
9. General & Applied Entomology - By K. K. Nayar, T. N. Anathakrishnan & B.V. David, Tata McGraw-Hill, New Delhi.

Course Title: Histology and Histopathology

Course Code: 24-ZO-352

Credits: 02

Course outcomes:

1. The students will be able to understand the basic knowledge of Histology and Histopathology.
2. The students will be able to understand the causes, gross and microscopic findings in different pathological conditions.
3. The students develop skills of interpretation of macroscopic and microscopic findings of pathological changes in cells.
4. The students develop skills of various techniques and tools used in Histopathology.

Title & Contents

Number of lectures

1. Introduction:

2 L

1.1 Definition and Scope of Histology.

1.2 Importance of Histology.

1.3 Overview of Microscopic Anatomy: Cells, Tissues & Organs.

2. Definitions and Review of Types of Tissues:

3 L

2.1 Epithelial tissue.

2.2 Connective tissue.

2.3 Nervous tissue.

2.4 Muscular tissue.

3. Histological study of following mammalian organs: 4 L

3.1 Skin (V. S.).

3.2 Tooth (V. S.).

3.3 Tongue (C. S.) with reference to mucosa papillae and taste buds.

4. Histological study of Alimentary canal and Liver: 6 L

4.1 Oesophagus (T. S.).

4.2 Stomach (T. S.).

4.3 Duodenum (T. S.).

4.4 Rectum (T. S.).

4.5 Liver (C. S.).

5. Histological study of Respiratory organs: 2 L

5.1 Trachea (T. S.).

5.2 Lung (C. S.).

6. Histological study of Excretory organs: 3 L

6.1 Kidney (L. S.).

6.2 Juxtaglomerular complex.

7. Histological study of Reproductive organs: 4 L

7.1 Testis (T. S.) with reference to Seminiferous Tubules and Cells of Leydig.

7.2 Ovary (C. S.).

8. Histology of Endocrine glands: 6 L

8.1 Pituitary gland.

8.2 Thyroid gland.

8.3 Adrenal gland.

8.4 Pancreas (C. S.) including both exocrine and endocrine components.

8.5 L.S. of Mammary gland.(exocrine gland)

9 Microbial Diseases :

9.1 Signs and symptoms of –

9.2 Bacterial Disease

9.3 Viral Disease

9.4 Fungal disease

10 Necrosis / Gangrene:

10.1 Necrosis / Gangrene –Definition and Causes

10.2 Apoptosis -Types of necrosis -Features of necrosis.

10.3 Gangrene - Def Dry/wet/gas.

Reference Books: -

1. A Text Book of Histology, 2014, 5th Edn. Krishna Garg, Indira Bahl & Mohini Kaul CBS Publication & Distributors, Delhi.
2. Histology, 1987, 9th Edn., Arthur W. Ham, David H. Cormack, J. B. Lippincott Co. Philadelphia.
3. Histology, 1977, 4th Edn., R. O. Greep and L. Weiss, McGraw Hill Int. Book Co., New York.
4. Hand Book of Histo-pathological & Histo-chemical Techniques, 1983, 3rd Edn. reprint, Butterworth & Co. (Publishers) Ltd, UK.

Course Title: Biological Chemistry**Course code: 24 -ZO -353****Credits: 02**

Course outcomes-

1. To understand the basic concepts and significance of biochemistry.
2. To know the basic concepts pH and Buffers
3. To learn the chemical structures of carbohydrate, and their biological and clinical significance.
4. To analyse the structure and importance of proteins and lipids
5. To understand the variations in enzyme activity and kinetics.

Title & Contents**Number of lectures****1. Introduction of Biochemistry: 1 L**

Importance of Biochemistry in Life Sciences.

2.pH and Buffers: 3 L

2.1 Concept of pH.

2.2 Concept of pH scale, biological significance of pH

2.3 Concept of acid and base, Ionization of acids and bases.

2.4 Derivation of Henderson-Hassel Balch equation & **its applications.**2.5 Buffer - Definition, Concept, Functions, Types of buffer and **Buffering Capacity.****3.Carbohydrates: 6 L**

3.1 Definition, Classification & Biological importance of Carbohydrates.

3.2 Isomerism in carbohydrates - Structural and Stereoisomerism.

3.3 Significance of Gluconeogenesis, Glycogenolysis and Glycogenesis.

3.4 Clinical Significance - Hypoglycemia and Hyperglycemia.

4. Amino acids and Proteins: 6 L

4.1 General Structure of amino acids and Peptide bond.

4.2 Essential and non-essential amino acids.

4.3 Types of proteins, protein structures (primary, secondary, tertiary and quaternary structures with suitable example), Forces responsible for their stability.

4.4 Biological importance of proteins – Biocatalysts, Carrier proteins Contractile proteins, Hormonal role of proteins.

5. Enzymes: 7 L

5.1 Nomenclature, Types and properties of enzymes.

5.2 Regulatory and non-regulatory enzymes.

5.3 Enzyme inhibition.

5.4 Factors influencing enzyme activity (pH, temperature, substrate concentration).

5.5 Introduction of isoenzymes and cofactor.

5.6 Clinical significance of enzymes - PKU and AKU.

5.7 Industrial applications of enzymes

6. Lipids: 3 L

6.1 Introduction.

6.2. Fatty acids - Types and nomenclature (saturated and unsaturated).

6.3 Clinical significance (obesity, atherosclerosis, myocardial infarction).

6.4 Biological importance of lipids.

7. Vitamins: 3L

7.1 Fat soluble and water soluble

7.2 Dietary Sources,

7.3 Deficiency disorders

7.4 Biological functions

Reference books

1. Principles of Biochemistry, 1993, Lehninger A. L. Nelson D. L. & Cox M. M. W. H. Freeman Company, USA.
2. Biochemistry, 1995 5th Edn. Zubly G. W, C. Brown Communications USA.
3. Harpers Biochemistry, 1996 26th Edn. p Murray R. K., Granner D. K., Mayes P. A. & Rodwell V.
W. Prentice Hall international USA.
4. Outline of Biochemistry, 1995 5th Edn, Conn E. E., Stumph P. K. Bruening G & Doi R. H. John Wiley & Sons, USA.
5. Principals of Biochemistry, 1993, 1st Edn., Pattabhiraman T. N. Gajanan Book publishers and distributors Bangalore.
6. Clinical Biochemistry, 1994, B. P. Godkar, Bhalini Publishing House, Mumbai.
7. Biochemistry, 1995 5th Edn., Stryer San Francisco, W. H. Freeman & Co.
8. Biochemistry, 1990, 8th Edn., D. Voet & J. Voet, John Willey, New York
9. David T. Plummer: An Introduction to Practical Biochemistry, IIIrd edition (1988)

Course Title: Genetics

Course code: 24 –ZO -354

Credits: 02

Course outcomes:

- 1) To understand basic concepts of gene.
- 2) to understand Mendelian inheritance and Gene mutation
- 3) students acquaint with sex determination and Population Genetics.
- 4) Students understand Application Genetics.

Title & Contents	Number of lectures
1. Introduction to genetics:	3 L
1.1 Classical and Modern concept of Gene, Cistron, Muton, Recon.	
1.2 Mendel's laws of Inheritance.	
2 Exceptions to Mendelian Inheritance:	6 L
2.1 Incomplete dominance.	
2.2 Co-dominance.	
2.3 Multiple alleles: Concept, characteristics and importance of multiple alleles, ABO & Rh - blood group system and its medico legal importance.	
2.4 Lethal alleles.	
3. Gene Mutation:	6 L
3.1 Definition.	
3.2 Types of mutations: spontaneous, induced, somatic, gametic, forward, reverse. Types of point mutation - deletion, insertion, substitution, transversion, transition.	
3.3 Mutagenic agents	
4. Sex-determination:	4 L
4.1 Introduction.	
4.2 Types of sex determination: -XX-XY, ZZ-ZW, XX-XO and Parthenogenesis, Hypodiploidy.	
4.3 Gynandromorphism.	
5. Population Genetics:	3 L
5.1 Basic Concepts in population genetics: Mendelian population, gene pool, gene / allele, Frequency, chance mating (Panmictic mating).	
5.2 Hardy Weinberg law and its equilibrium.	

6. Human Population Genetics: 4 L

6.1 Karyotype.

6.2 Genetic disorders, Structural & numerical alterations of chromosomes (chromosomal aneuploidy - Down, Patau, Edward, Turner and Klinefelter syndromes).

7. Sex linked inheritance in human: 2 L

7.1 Colour – blindness.

7.2 Haemophilia.

7.3 Hypertrichosis.

8. Application of genetics: 2 L

8.1 Genetic counselling.

8.2 Diagnostics & breeding technology.

Reference Books -

1. Principles of Genetics, 1997, P. D. Snustad, M. L. Simmons J. B. Jenkins, John Wiley & Sons, USA
2. Genetics, 2014, 9th Edn., Verma P. S. and Agarwal V. K., S. Chand and Co., New Delhi.
3. Genetics, 2014, 4th Edn. Gupta P. K., Rastogi Publications, Meerut.
4. Principles of Genetics, Gardner, E. J. et al. (2006), John Wiley and Sons Inc.
5. Genetics: A Molecular Approach, 3rd Edn, Russell, P. J., Benjamin Cummings.
6. Principles of Genetics 8th Edition, Gardner, E. J., Simmons, M. J., Snustad, D. P. (2008). John Wiley and Sons Inc.
7. Principles of Genetics. 5th Edn. Snustad, D. P. and Simmons, M. J. (2009). John Wiley and Sons Inc.
8. Concepts of Genetics, 10th Edn. Benjamin Cummings. Klug, W. S., Cummings, M. R. and Spencer, C. A. (2012).

9. An Introduction to Genetic Analysis, 11th Edn. Carroll S. B.; Doebley J., Griffiths, A. J. F. and Wessler, S. R. (2018) W. H. Freeman and Co. Ltd

Course Name: Developmental Biology

Course Code: 24-ZO-355

(2 Credits: 30 Lectures)

Course outcomes:

After successfully completing this course, students will be able to:

CO1: Define basic terms, concepts and theories of developmental biology.

CO2: Explain the process of gamete formation and fertilization.

CO3: Explain the cleavage, blastulation and gastrulation events in fertilized egg.

CO4: Explain the various events in chick embryology.

Title & Contents

Number of lectures

1. Fundamentals of Developmental Biology: 03L

1.1 Definition and scope.

1.2 Concepts in Developmental Biology: Growth, Differentiation, Dedifferentiation, Cell determination, Cell Specification, Cell communication, Morphogenesis, Induction, Competence and Regeneration.

2. Theories of Developmental Biology: 03L

2.1 Preformation.

2.2 Pangenesis.

2.3 Epigenesis.

2.4 Axial gradient.

2.5 Germplasm.

3. Gametogenesis: 05L

3.1 **Structure of T.S. of Testis**; Spermatogenesis & Structure of sperm with respect to human.

3.2 **Structure of T.S. of Ovary**; Oogenesis & Structure of ovum with respect to human.

3.3 Types of eggs.

4. Fertilization:**06L**

4.1 Concept and types.

4.2 Chemotaxis.

4.3 Sperm penetration: Acrosome reaction, Capacitation & Decapacitation.

4.4 Activation of ovum: Fertilization cone.

4.5 Prevention of polyspermy: Fast block & Slow block.

4.6 Significance of fertilization.

5. Cleavage and Blastula:**05L**

5.1 Definition and concept.

5.2 Planes and symmetry of cleavage.

5.3 Types of cleavage.

5.4 Significance of cleavage.

5.5 Definition and types of Blastula.

6. Gastrulation:**03L**

6.1 Definition and Concept.

6.2 Basic cell movements in gastrulation: Epiboly, Emboly, Convergence, **Divergence**, Invagination, Ingression & Involution, **Delamination** with reference to frog.

6.3 Concept of Organizer : Primary, Secondary and Tertiary.

7. Chick Embryology:**06L**

7.1 Structure of Hen's egg.

7.2 Fertilization and cleavage in Chick.

7.3 Blastulation and Gastrulation in chick (Formation of primitive endoderm, Primitive streak development, Head process and regression of Primitive streak).

Reference Books

1. An Introduction to Embryology (2012), 5th Edition., Balinsky B. L., Fabian B. C. Brooks Cole Pub. Co., USA
2. Developmental Biology (2013), 10th Edn. Gilbert S. F., Sinauer Associates Inc.
3. Developmental Biology: Patterns, Principle and Problems (1982), Saunders J. W., Prentice Hall Coll Div.
4. Principles of Development (2007), 3rd edition, Lewis Wolpert, Oxford University Press Publisher

Course Title: Medical Parasitology

Course code: 24 –ZO-356

Credits: 02

Course outcomes:

1. To learn about basics and scope of parasitology.
2. To know the types of host and parasite with examples.
3. To understand about the morphology, life cycle, pathogenicity and treatment of common parasites (Protists and Platyhelminthes).
4. To learn about host -parasite relationships and their effects on host body.

Title & Contents

Number of lectures

1. Introduction, Scope and Branches of **Medical Parasitology.**

2 L

1.1. Definition: host, parasite, vector, commensalisms, mutualism and parasitism.

1.2. Branches of medical parasitology.

2. Types of Parasites and Hosts:

3 L

2.1 Ectoparasites.

2.2 Endoparasites and its subtypes.

2.3 Types of hosts - Intermediate, definitive, paratenic and reservoir.

3. Host - Parasite relationship:

3 L

3.1 Host specificity.

3.2 Types of host specificity: structural specificity, physiological specificity and ecological specificity.

3.3 Effects of parasite on host.

4. Study of Parasitic Protists:

8 L

4.1 Entamoeba histolytica - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

4.2 Plasmodium vivax - Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

5. Study of Parasitic worms: 6 L

5.1 *Ascaris lumbricoides* - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

5.2 *Taenia solium* (Tapeworm) - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.

6. Study of Parasitic Arthropoda: 3 L

Morphology, pathogenicity and control measures of –

6.1 Soft tick.

6.2 Head louse.

6.3 Rat flea.

6.4 Bed bug.

7. Zoonotic diseases- causative agents, modes of transmission 3L

8. Tools and techniques used in the diagnosis of parasites 2L

Reference Books:

1. Parasitology: K. D. Chatterjee.
2. Parasites: ecology, diseases, and management (2013).
3. Parasitic Helminths: Targets, Screens, Drugs, and Vaccines, 201.
4. Parasitism: The Diversity and Ecology of Animal Parasites (2014) Tim Goater, Timothy M. Goater, Cameron P. and Esch, Gerald W. Cambridge University Press.
5. Principles of Veterinary Parasitology (2016), 1st Edn, Dennis E. Jacobs, Mark Fox, Lynda M. Gibbons, Carols Hermosilla, John Wiley & Sons.
6. Veterinary Parasitology (2013), Hany M. Elsheikha, Jon S. Patterson, CRC Press Taylor & Francis Group
7. Textbook of medical parasitology – C. K. Jayaram Panikar.

8. Textbook of medical parasitology – Arora & Arora.
9. Textbook of medical parasitology – S. C. Parija.
10. Veterinary Parasitology, 2013 - (Taylor, M. A.).
11. Encyclopedia of parasitology, 2008.
12. The Biogeography of Host-Parasite Interactions by Serge Morand, Boris R. Krasov, Oxford University Press.
13. Textbook of medical microbiology – Rajesh Bhatia & Itchpujani.

Course Code and Course Name:

24-ZO-357: Zoology Practical-I (2 Credits)

Semester V

Section I: Practicals in Applied Entomology

1. Study of external characters of any Insect (Grasshopper / Cockroach / Plant bug). E
2. Study of Insect Head, its articulations and types of mouthparts and their modifications. D
3. Study of Insect Legs, wing and their modifications. D
4. Study of Digestive system of any locally available insect pest. (C) E
5. Study of Reproductive system of any locally available insect pest. (C) E
6. Study of Social organization in Termites and Honey Bees. D
7. Study of Insect egg, larva, pupa and their types. D
8. Study of Insect vectors - Mosquito, House fly, Cockroaches, Bugs. D
9. Temporary mountings of Mouthparts, Antennae, Legs and Wings of any locally available insect pest. (C) E
10. Study of Preservation of Insect pest by using spreading techniques & submission of any five insect pests / vectors. (C) E
11. Compulsory field visit to a Wildlife Sanctuary / National Park / Tiger Reserve /to study the Insect diversity – 2P. E

Section II: Practicals in Histology & Histopathology

1. Study of the different types of tissues with the help of permanent slides – Epithelial tissue, Connective tissue, Muscular tissue and Nervous tissue. D
2. Study of permanent histological slides of T. S. of skin, V. S. of tooth and C. S. of tongue. D
3. Study of permanent histological slides of digestive parts – T. S. of Stomach, T. S. of Duodenum, T. S. of Rectum, C. S. of Liver. D
4. Study of permanent histological slides of glands - T. S. of Pituitary gland, T. S. of Thyroid gland, T. S. of Adrenal gland, C. S. of Pancreas. D
5. Study of permanent histological slides of reproductive organs- T. S. of Testis, C. S. of Ovary. D
6. Study of human blood smear to observe different types of blood cells. (C) E
7. Temporary mounting of tissues of any mammal (freshly dissected or preserved) - Striated Muscle Fibre. (C) E
8. Temporary mounting of tissues of any mammal (freshly dissected or preserved) - Smooth Muscle Fibre. (C) E

Course Code and Course Name:**24-ZO-358: Zoology Practical-II (2 Credits)****Semester V****Section I: Practicals in Biological Chemistry**

1. Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests. (C) E
2. Isolation of starch from potato and digestion of starch by salivary amylase. (C) E
3. Preparation of buffer of desired pH and molarity. (C) E

4. Protein estimation by Lowry et al. method. (C) E
5. Isolation of Caesin from milk by adjusting iso-electric point. (C) E
6. Preparation of Acid, Alkali & it's standardisation. E
7. Principle, Working & Measurement of pH of any three samples. E

Section II: Practicals in Genetics

1. Study of monohybrid ratio by providing hypothetical data and deducing applicability of Mendelian laws (Two examples). (C) D
2. Study of Dihybrid ratio by providing hypothetical data and deducing applicability of Mendelian laws (Two examples). (C) D
3. Study of genetic traits in human beings (tongue rolling, widow's peak, ear lobes, colour-blindness and PTC tasters/ non-tasters). D
4. Study of blood groups in human (ABO and Rh). (C) D
5. Study of Hardy - Weinberg law with suitable recording of genetic traits. D
6. Study of human karyotypes and numerical alterations (simulated & theoretical sample data) (Down syndrome, Klinefelter syndrome and Turner syndrome). D
7. Temporary preparation of polytene chromosomes from suitable material. (C) E
8. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides / photographs. D
9. Study of external characters, life cycle and Rearing of Drosophila. (C) D
10. Study of Drosophila mutants. D

Course Code and Course Name:

24-ZO-359: Zoology Practical-III (2 Credits)

Semester V

Section I: Practicals in Developmental Biology

1. Study of ultrastructure of Sperm and Ovum of Mammal. D
2. Study of eggs with the help of slide / Photograph / chart / Model (Insect, Amphioxus, Frog and Hen). (C) D
3. Study of cleavage and its types with the help of Slide / Photograph / Chart / Model. D
4. Study of blastulae (Amphioxus, Frog and Hen). D
5. Study of gastrulae (Amphioxus, Frog and Hen). D
6. Study of whole mount slides of chick embryology – 24 hrs, 33 hrs and 48 hrs. (C) D
7. Study of T. S. and V. S. of chick embryo of Brain & Heart with the help of slide / Photograph / chart / Model – 24 hrs & 33 hrs. D
8. Temporary preparation of chick embryo. (C) E
9. Ex-ovo culture of chick embryo. D

Section II: Practicals in Medical Parasitology

1. Study of parasitic association with their example - a) Commensalism. b) Parasitism. D
2. To study the life cycle, pathogenecity, diagnosis and treatment of *Entamoeba histolytica* and *Plasmodium vivax* through permanent slides or microphotographs. D
3. To study the life cycle, pathogenecity, diagnosis and treatment of *Ascaris lumbricoides* and *Taenia solium* through specimen, permanent slides or microphotographs. (C) D
4. Study of following parasites with its role as vector - Soft tick, *Pediculus humanus*, *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides or photographs. (C) D
5. Study of effects of parasites on host body. D
6. Study of the pathogenecity and control measures of - Tick (soft tick and hard tick) and Mite (*Sarcoptes scabiei*). D
7. Study of parasites from the gut of cockroach. (C) D

8. Collection & submission of various parasites. (C)

E

Course Title: Fishery management

Course Code: 24-ZO-3510

Credits: 02

Course Outcomes:

1. The student will be able to identify and describe different species of fish with classification.
2. The student will be able to understand the Fish management.
3. The student will be able to understand different tools used in Fish management.
4. To encourage young learners for self-employment

Title & Contents

Number of lectures

1. Introduction to Fishery management :

3 L

1.1 The potential scope of Fish Industry as a Cottage Industry.

1.2 Exotic and Endemic species of Fishes.

1.3 Various advantages of keeping fishes.

2. Biology of Fishes:

3 L

2.1 Common characters fresh water and marine fishes

2.2 Classification, History, Habit, Habitat of Fishes.

2.3 External morphology, body form, appendages, pigmentation, skin and scales.

3. Food and feeding of Fishes:

4 L

3.1 Use of live fish feed organisms.

3.2 Preparation and composition of formulated fish feeds.

3.3 Characteristics of fish feed.

3.4 Overview on types of fish food.

- 4. Maintenance and management of Fish culture pond: 4 L**
- 4.1 General Maintenance - budget for setting up an Fishery.
- 4.2 Fish Farm as a Cottage Industry, Rules & regulations of fish rearing.
- 4.3 Construction and management of ponds
- 4.4 Important tools for Fishery management
- 5. Fish Transportation: 4 L**
- 5.1 Live fish transport: a) Fish handling. b) Fish packing.
c) Fish forwarding techniques.
- 5.2 Causes of mortality in transport.
- 6. Fish preservation and Processing: 4 L**
- 6.1 Fish preservation and processing.
- 6.2 Fish preservation techniques.
- 7. Physico-chemical parameters of water for fish culture: 3 L**
- 7.1 Acidity, Alkalinity, Calcium, Nitrate, Ammonia, Total hardness.
- 8. Fish Diseases and Management: 5 L**
- 8.1 Protozoan diseases
- 8.2 Bacterial diseases
- 8.3 Fungal diseases
- 8.4 Viral diseases

REFERENCES

1. Alappat, H.J. & A. Biju Kumar 1996. Aquarium Fishes (A Colourful Profile). B.R. Publ., Delhi, 106 pp.
2. Atz, W. 1971. Aquarium Fishes. Pelham Books Ltd., London, 110 pp.
3. Axelrod, H.R. & W. Vorderwinkler 1962. Encyclopedia of Tropical Fishes with Special

Emphasis on Techniques of Breeding. TFH. Publ., Inc., NJ, 763 pp.

4. Biju Kumar, A. & H.J. Alappat 1996. A Complete Guide to Aquarium Keeping. Books for All, Delhi, 80 pp.

5. Dholakia, A.D. 2009. Ornamental fish Culture & Aquarium Management. Daya Publishing House, Delhi, 313pp.

6. Faulkner, D. & J.W. Atz 1971. Aquarium Fishes, Their Beauty, History and Care. Pelham Books, London, 110 pp.

7. Favre, H. 1977. Dictionary of the Freshwater Aquarium. Wardlock Ltd., London, 160 pp.

8. Frey, H. 1961. Illustrated Dictionary of Tropical Fish. TFH. Publ. Inc., NJ, 768 pp.

9. Gohm, D. 1984. Tropical Fish. Hamlyn Publ. Group Ltd., London, 143 pp.

10. Gopakumar G. 2011. Marine Ornamental fish Culture: Package of Practices. CMFRI Cochin. 100pp.

11. ICAR 2011. Handbook of Fisheries and Aquaculture. ICAR, New Delhi, 1116 pp.

Course Title: Poultry Management

Course Code: 24-ZO-3511

Credits: 02

Course Outcomes:

1. To understand the Poultry farming practices.
2. To know the poultry breeding techniques.
3. To understand feeding requirement and food ingredients.
4. To learn about the poultry disease and their pathogens.
5. To understand the market value of poultry products.

Title & Contents	Number of lectures
1. Introduction to Poultry Farming:	2 L
1.1 Definition of Poultry, Importance of Poultry Farming and Poultry Development in India.	
1.2 Present and future prospects.	
2 Breeding Management:	5 L
2.1 Male and female reproductive system of chicken.	
2.2 Breeds and strains of broilers and layers of chicken.	
2.3 General aspects of breeding for better egg production and body weight gain.	
2.4 Selection and culling.	
2.5 Artificial insemination.	
3 Housing Management:	5 L
3.1 Establishment of poultry farm.	
3.2 Housing and equipment.	
3.3 Incubation and hatching of eggs.	
3.4 Broiler and layer management.	
3.5 Lighting schedule for poultry.	
3.6 Transport strategy of Poultry birds.	
4 Feeding Management:	6 L
4.1 Digestive system and Digestion Mechanism of chicken.	
4.2 Feed ingredients.	
4.3 Feed processing.	
4.4 Formulation of feed viz., Starter, Grower, Layer, Finisher and Breeder ration, Feed conversion ratio (FCR), Nutritional deficiency conditions.	
5 Health Management:	5 L
5.1 Vaccination schedule for poultry birds.	

5.2 Common poultry diseases, i. e. Ranikhet, Marek, Chicken pox, Gumboro, Infectious bronchitis and Chronic Respiratory Disease (CRD).

5.3 Control of internal and external parasites.

6 Poultry Products:

4 L

6.1 Preservation and storage of eggs.

6.2 Grading of eggs and AGMARK standard of egg.

6.3 Egg powder.

6.4 Slaughtering and processing of chicken.

6.5 Poultry By Products – Feathers and Poultry Manure.

Reference Books

1. Commercial Chicken Meat and Egg Production (2007), 5th Edn, Bell D. Donald and Weaver D. William Jr., Springer India Pvt. Ltd., Noida.
2. Poultry Science (2015) 3rd Edn, Ensminger. M. E., International Book Distribution Co., Lucknow, India.
3. Modern Poultry Farming (2003), 1st Edn, Hurd M. Louis, International Book Distributing Company, Lucknow.
4. Handbook of Poultry Production and Management (2007), 2nd Edn., Jadhav N. V., and Siddique M. F., Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi.
5. Successful Poultry Management (2007), 2nd Edn, Jull A. Morley, Biotech Books, New Delhi.
6. Poultry Husbandry (2008) 2nd Edn, Jull A. Morley, J. V. Publishing House, Jodhpur, Rajasthan.
7. Broiler Breeder Production (2001), 1st Edn, Leeson. S., and Summers J. D. International Book Distributing Company, Lucknow.
8. Poultry and Ratite Nutrition (2013), 1st Edn, Pathak N. N., Narendra Publishing House, New Delhi, India.
9. Simply Poultry Science (2011) 1st Edn, Rajini Asha R., Alfa Publications, New Delhi.

Course Title: Medical & Forensic Zoology**Course Code: 24-ZO-361****Credits: 02****Course Outcomes:**

1. To understand the basics principles of Medical and Forensic Zoology.
2. To know the scientific methods in crime detection.
3. To evaluate the advancements in the field of Medical and Forensic Zoology.
4. To analyse the fundamental principles and functions of forensic science and its significance to human society.

Title & Contents**Number of lectures****1. Introduction to forensic zoology and its importance:****4 L**

1.1 Definition of Forensic Zoology.

1.2 Forensic Laboratories in India.

1.3 Basic Principles of Forensic Science with Examples.

2. Principles Importance of Forensic zoology.**5 L**

2.1 Application, need of Forensic Zoology.

2.2 Basic Principles of Forensic Science with Examples.

2.3 Scope of development of forensic zoology.

2.4 Functions of Forensic Science, Different branches of Forensic Science.

3. Forensic Medicine**4 L**

3.1 Introduction to Forensic Medicine: Definitions of Forensic Medicine.

3.2 Medical Jurisprudence.

3.3 Medical evidence documentations.

4. Examination of Biological Materials **5 L**

4.1 Examination of Hair, Fibres, Diatoms, plants materials, human tissues.

4.2 Examination of Body Fluid: Blood, Semen and Saliva.

5. Forensic Importance of Insects: Insects of forensic importance **4 L**

5.1 Indicators of time of death stages of insect development & comparative decomposition of human body - colonization –

5.2 Evidence collection of insects – Territorial & Aquatic Insects.

6. DNA Fingerprint Technique and Examination of Biological Traces: **3L**

Liquid blood, blood stains, & swabs, semen, Seminal stains, tissues, Bones, Hairs, Teeth, Saliva, Skeletal remains.

7. Toxicological Investigations: **5L**

7.1 Poisons – Definition,

7.2 Forms of Poison – Physical, Chemical & Mechanical state.

7.3 Introduction with examples of – Neurotoxic Poisons – Cerebral & Spinal, Cardiovascular Poisons, Asphyxiants,

7.4 Miscellaneous poisons – Pesticides, Pharmaceutical drugs, Petroleum poisons, Food poisons, Radioactive poisons.

Reference Books

1. Godkar P. B and Godkar D. P, Textbook of Medical Laboratory Technology, II Edition, Bhalani Publications

2. Textbook of Microbiology: R. Ananthanarayan, C. K. Jayaram Panikar, University Press.

3. A textbook of Microbiology: P. Chakraborty

4. Text book of pathology: Robbins & Cotran, Vol. 1 & 2, Tenth Edition, Elsevier Publication.
5. Pathologic basis of disease: M. K. Singh & Vinay Kumar, Vol. 1 & 2, 10th edition, Elsevier.
6. Text book of General pathology: Bhende & Deodhare Part I & II.
7. Pathologic basis of Disease: Robbins & Cotran, Vol. 1 & 2, 10th edition, Elsevier publications.
8. Essentials of medical pharmacology: K. D. Tripathi, 8th edition, Jaypee brothers publishers.
9. Review of pharmacology: K. D. Tripathi, Jaypee brothers publishers.

Course Name: Animal Physiology**Course Code 24-ZO-362****(2 Credits: 30 Lectures)**

After successfully completing this course, students will be able to:

CO1: Define basic terms and concepts related to animal physiology.

CO2: Explain the structure and function of various organs systems in human body.

CO3: Explain the physiology of human reproduction and its hormonal control.

CO4: Explain the structure and function of endocrine glands.

Title & Contents**Number of lectures****1. Nutrition and digestion:****05L**

1.1 **Nutrition**; Nutritional requirement & balanced diet.

1.2 **Digestive system**; Digestion and absorption of carbohydrates, proteins and lipids.

1.3 Vitamins - outline of fat soluble and water-soluble vitamins; sources, deficiency and diseases.

2. Respiration:**05L****2.1 Respiratory system**

2.2. Mechanism of respiration: Regulation of ventilation in lungs, exchange of gases at respiratory surface.

2.3 Respiratory pigments in animals: Haemoglobin, Hemocyanin, Hemerythrin, Chlorocruorin.

2.4 Transport of gases : O₂ and CO₂ transport.

3. Circulation:

05L

3.1 Blood: Definition and its constituents, functions of blood.

3.2 Heart: Structure of human heart, Pace maker, Cardiac Cycle.

3.3 Origin and conduction of heart beat.

4. Excretion:

05L

4.1 **Excretory system; structure and function of kidneys.**

4.2 Structure of Uriniferous tubule.

4.3 Mechanism of urine formation.

4.4 Normal and abnormal constituents of urine, Elementary idea of dialysis.

5. Muscles:

03L

5.1 Structure of smooth, skeletal and cardiac muscles.

5.2 Mechanism of muscle contraction by Sliding filament theory.

6. Reproduction:

04L

6.1 Physiology of male reproduction, hormonal control of spermatogenesis.

6.2 Physiology of female reproduction, hormonal control of menstrual cycle.

7. Endocrine Glands:

03L

7.1 Structure and functions of pituitary, thyroid, parathyroid, pancreas and adrenal glands.

Reference Books

1. Textbook of Medical Physiology, Guyton A. C. & Hall J. E., 2006, 11th Edition, Hercourt Asia Pvt. Ltd. / W. B. Saunders Company

2. Principles of Anatomy & Physiology, 2006, 11th Edition, Tortora G. J. & Grabowski S., John Wiley & sons, Inc.

3. Haematology: De Gruchi.

4. Human physiology, Vol. I & II, 1980, 12th Edn. Dr. C. C. Chatterjee, Medical Applied Agency, Kolkata

5. Text book of Animal Physiology, 2008, 2nd Edn. Nagabhusanam, S. V. S. Rana, S. Kalavathy, Oxford University Press, India.

6. Animal Physiology: Adaptation and Environment, 1997, Schmidt-Nielsen, Knut, Cambridge University Press.

7. General and Comparative Physiology, 1983, 3rd Edn., Hoar W. S., Prentice Hall, UK.7.
8. Medical Physiology, 2006, Asis Das, Books and Allied Pvt. Ltd., Kolkata.
9. Endocrinology, 2005, Lohar P. S., M J P Publishers, Chennai.
10. Vander, Sherman, Luciano's Human Physiology: The Mechanisms of Body Function, 2003, 9th Edn., Eric P. Widmaier, Hershel Raff, Kevin T. Strang, Mc Graw H.
11. Tortora, G. J. and Derrickson, B. H. (2009) Principles of Anatomy and Physiology (12th edition) John Wiley and Sons, Inc.
12. Widmaier, E. P., Raff, H. and Strang, K. T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
13. Human Anatomy and Physiology, (1998) Marieb, E. (4th edition) Addison-Wesley.
14. Experimental Physiology, (2007) Kesar, S. and Vashisht, N., Heritage Publishers.

Course Title: Molecular Biology

Course Code: 24-ZO-363

Credits: 02

Course outcomes:

1. Learner shall get an insight into molecular mechanisms of various biological processes in cells and organisms.
2. Learner shall get an insight into the Structure of DNA and RNA, DNA and RNA as genetic material.
3. The course shall prepare learner to get insight into the Central Dogma of Molecular Biology.
4. Learner shall also understand the concept of gene regulation.

Title & Contents

Number of lectures

1. Nucleic Acids and Chromatin:

7 L

1.1 Structure of RNA & DNA.

1.2 Types of RNA.

1.3 DNA as genetic material - evidences (Griffith's experiment).

1.4 Structure of Chromatin, packaging of DNA, Heterochromatin, Euchromatin.

2. Central Dogma of Molecular Biology: 15 L

2.1 DNA Replication - Semiconservative (Meselson and Stahl experiment), Basic mechanism of replication in prokaryotes and eukaryotes.

2.2 Transcription -

2.2.1 Basic mechanism of transcription in prokaryotes and eukaryotes, RNA polymerase enzyme in prokaryotes.

2.2.2 RNA modifications and processing.

2.3 Translation - Genetic code, properties of genetic code, Basic mechanism of Translation in E. coli and eukaryotic cells.

3. Lac operon: 1 L**4. DNA repair mechanism: 3 L**

Photo repair, dark repair, base excision repair.

5. Recombinant DNA Technology: 4 L

Introduction, restriction enzymes, cloning vector, PCR (polymerase chain reaction), DNA finger printing.

Reference Books:

1. Molecular biology of cell, 3rd and 4th edition, Albert's B. D. Lewis J. Raff M. Roberts K. and Watson.
2. Gene, Vol. V, VI, VII, VIII and IX, Lewin B., Oxford University Press, Oxford.
3. Molecular biology of the Gene, 1993, Watson J. Hopkins, Roberts Steitz & Weiner, Benjamin Cummings.
4. Text Book of Molecular Biology, 1994, K. Sivrama Sastry G. Padmanabhan and C. Subramanyam : MacMillan, India.
5. Cell and Molecular biology, 1996, G. Karp, John Willey & Sons, U.S.A.

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6. Principles of Genetics, 1997, P. D. Snustad, M. L. Smmons, J. B. & Jenkins, John Willey & Sons, U.S.A.

7. Cell and Molecular biology, De Robertis and De Robertis, 8th & 9th Edition, Saunders Publications.

Course Title: Pest Management

Course Code: 24-ZO-364

Credits - 02

Course Outcomes:

1. Define pest management.
2. Describe the economic, ecological, and sociological benefits of IPM.
3. Understand problems resulting from misuse, overuse, and abuse of chemical pesticides.
4. Define and describe pesticide resistance and how it develops.
5. Analyse and compare management tactics to determine the best approach to reducing pest populations, weeds, and disease presence.

Title & Contents

Number of lectures

1. Pest:

2 L

1.1. Definition.

1.2. Types of pests.

1.3. Types of damages caused by the pest.

2. Pest management using Regulatory control:

4 L

2.1. Quarantine.

2.2. Eradication.

2.3. Control districts.

2.4. "Crop-free" periods.

- 3. Pest management using Cultural control: 4 L**
- 3.1. Sanitation.
 - 3.2. Tillage.
 - 3.3. Crop rotation.
 - 3.4. Cropping systems.
- 4. Pest management using Biological control: 4 L**
- 4.1. Ecological considerations.
 - 4.2. Biological control of insects.
 - 4.3. Biological control of plant disease.
 - 4.4. Biological control of weeds.
- 5. Biotechnology approaches in pest management: 4 L**
- 5.1. Introduction.
 - 5.2. Recent advance in use of fungi and viruses.
 - 5.3. Methodology in Biotechnology.
 - 5.4. Soma clonal variability.
 - 5.5. Concept of Genetic engineering and Transgenic plants.
- 6. Integrated pest management (IPM): 5 L**
- 6.1. Principles and its components.
 - 6.2. Advantages and disadvantages.
 - 6.3. Biological control - Predators, Parasitoids, Entomopathogens, Weed killers and their mass production.
- 7. Insecticides: 4 L**
- 7.1. Classification of insecticides based on mode of entry.
 - 7.2. Action and chemical nature.
 - 7.3. Insecticides formulations and their uses.

7.4. Safe handling of insecticides.

8. Insecticide residue:

3 L

8.1. Methods of residue detection – Organochlorine, Organophosphates, Synthetic Pyrethroids, Systemic.

8.2. Problems in fruits, vegetables, medicinal plants.

8.3. Maximum permissible residue limits (MRLs).

Reference Books :

1. Handbook of Pest Management in Agriculture by Pimentel.
2. Principles of Insect Pest Management by Dhaliewal and Arora.
3. Agricultural Pest of India & South East Asia by A. Satwal.
4. Pathological Problems of Economics Crop Plants & their Management by Paul Khurana, S. M., 1998.
5. Integrated Diseases Management and Plant Health by Gupta V. K. & Sharma R. C.
6. Diseases of Millets by Ramkrishnan T. S., I. C. A. R. Publ. New Delhi.
7. Fungal diseases of Rice in India by Padmanabhan S. Y., I. C. A. R. Publ., New Delhi.
8. Analysis of Pesticides Residues by H. A. Moye (JW)
9. Advance in Pest Control Research by R. L. Methcalf (JW)
10. Chemistry of pesticides by K. H. Buchel (JW).
11. Progress in Pesticides Biochemistry and Toxicology Vol. I, II & III by D. H. Hutson and T. R. Robert.
12. Evaluation of Pesticides in Ground Water by W. Y. Garnett, R. C. Honeycatt and others.
13. Chemistry of Pesticides by Edward
14. Insecticide Biochemistry and Physiology by C. F. Wilkinson.

**Course Title: Tools and
Techniques in Biology**
Course Code: 24-ZO 365
Credits: 02

Title & Contents	Number of lectures
1. Microscopy:	5 L
1.1 Definitions - Resolving Power, Limit of Resolution and Magnification, Numerical Aperture.	
1.2 Basic principle of microscopes - Light, Fluorescence, Phase Contrast, Stereo Microscope, SEM and TEM.	
1.3 Principle and working of camera lucida	
2. Microtomy: Tissue fixation and Processing	8 L
2.1 Methods of tissue fixation: Chemical fixation and physical fixation.	
2.2 Procurement of tissue and importance of fixation of tissues.	
2.3 Dehydration, clearing, impregnation, embedding and block making.	
2.4 Types of microtomes.	
2.5 Section cutting: steps and precautions, common faults in section cutting, reasons & remedies.	
2.6 Mounting and spreading of ribbons.	
2.7 General procedure for staining of sections.	
2.8 Demonstration of Nucleic acid (Feulgen Reaction).	
3. Haematological Techniques:	2 L
3.1 Total count of RBCs, WBCs and Differential count of WBCs and their significance.	
3.2 Bleeding time, clotting time and their significance.	
4. Immunological Techniques:	4 L
4.1 Antigen-Antibody Interactions – Immunodiffusion (Ouchterlony)	
4.2 Principle & Working of ELISA.(Direct and Indirect ELISA)	
4.3 Hybridoma technology	
4.4 Application of Immunological techniques in disease diagnosis.	
5. Types of PCR & DNA Barcoding:	2 L

5.1 Types of PCR

5.2 Technique of DNA Barcoding

6. Methods in Biodiversity: 4 L

6.1 Introduction to sampling and sample size.

6.2 Biodiversity Indices - Species richness, Simpson Diversity Index, Shannon Diversity Index.

6.3 Measuring Biodiversity- Quadrat sampling, Transect sampling, Insect survey - Active (sweep netting, aquatic nets) and Passive methodology (Pit fall traps, Light traps).

7. Instruments in Field Biology: 3 L

7.1 Binoculars, GPS, Basic digital camera techniques: Camera lens - prime and kit lens, Aperture mode, Shutter mode, Megapixels, Telephoto lens, macro lens, **rhinox lens**

7.2 Adapters for camera and microscopes, Mobile's camera.

8. Laboratory techniques: 2 L

8.1 Microphotographic techniques - CCD and CMOS camera, digital camera.

8.2 Softwares for image analysis - Image J and GIMP.

References:

1. Welch, P. S. 1948. *Limnological Methods*. Blakiston Philadelphia. 381 pp.
2. Wetzel, R. G. 1983. *Limnology*. 2nd Ed. Saunders Coll. Philadelphia.
3. Wilson, E. O. (1992). *The Diversity of Life*. Cambridge, Mass, Belknap Press of Harvard University Press.
4. Krebs C. J., 2009. *Ecology*. Benjamin-Cummings Publishing Company or Pearson International Edition
5. Eugene P. Odum and Gary W. Barrett. *Fundamentals of Ecology* Brooks / Cole; 5th Revised edition.
6. Suzanne Bell, Keith Morris. *An Introduction to Microscopy*. CRC press.
7. Kato, M. *The Biology of Biodiversity*. Springer.

8. Robert Smith and Thomas M. Smith Ecology and Field Biology.
9. Bikram Grewal *et al.*, A Photographic Field Guide to the Birds of India, Pakistan, Nepal, Bhutan, Sri Lanka, and Bangladesh. Princeton University Press.

Course Title: Evolutionary Biology

Course Code: 24-ZO-366

Credits: 02

Course outcomes:

1. To learn most of the essential aspects of Evolutionary Biology in detail which will help them in acquiring better understanding regarding the subject.
2. Explain important processes, principles and concepts and critically evaluate theories and empirical research within evolutionary biology
3. Apply evolutionary theory and concepts to address empirical and theoretical questions in evolutionary biology.
4. Investigate evolutionary questions using literature and analyses of empirical data.
5. Communicate the principles, theories, problems and research results associated with questions that lie within the evolutionary framework to students

Title & Contents

Number of lectures

1. Introduction:

03 L

1.1 Concept of Evolution.

1.2 Origin of life.

1.3 Origin of eukaryotic cell (Origin of mitochondria, plastids & symbionts).

2. Evidences of Evolution:

04 L

2.1 Analogy and Homology.

2.2 Embryological Evidences of Evolution.

2.3 Evolutionary & Paleontological Evidences.

3. Historical Review of Evolutionary Concept: 03 L

3.1 Theories of Evolution. 3.2 Lamarckism.

3.3 Darwinism and Neo Darwinism.

3.4 Mutation Theory.

3.5 Modern Synthetic theory.

4. Sources of Variations: 03 L

4.1 Variation and Mutations.

5. Isolation: 04 L

6. Speciation: 04 L

6.1 Types of speciation (Allopatric & Sympatric).

6.2 Mechanism of speciation.

6.3 Patterns of speciation.

6.4 Factors influencing speciation.

7. Molecular Evolution 04 L

7.1. Gene evolution

7.2. Evolution of gene families, molecular drive

7.3. Amino acid sequence divergence in proteins

7.4. Nucleotide sequence divergence in DNA

7.5. Molecular clocks

7.6. Ancient DNA.

8. Origin of Man: 03 L

8.1 Evolution of Man (Evolution of anthropoids including man) - Kenyapithecus to Homo sapiens.

9. Zoogeographical Realms With reference to fauna: 02 L

10 Extinctions: 02 L

10.1 Extinction - An Overview.

Reference Books

1. Mark Ridley. Evolution. 3rd Edition. Blackwell Publishing. (2004).
2. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Merrut.
3. Mohan P. Arora. Evolutionary Biology, Himalaya Publishing House, Bombay.
4. P. S. Vermin and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
5. Strickberger. Evolution. Prentic Hall. (2002).
6. Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970).
7. Organic Evolution, Richard Swann Lull, Light & Life Publishers.
8. Introductions to Evolution, Paul Amos Moody, Kalyani Publishers, New Delhi.
9. Organic Evolution, 1991 T.S. Gopal krishanan, Itta Sambashivarab Publ. House.
10. Evolutionary Biology, 1990, Mohan P. Arora, Himalaya Publi. House, Delhi.
11. Evolution, 1968, E. O. Dodson, Reinhold Publ. Crop., New York.
12. The major features of evolution, 1953, Simpson G. G. Columbia, New York.
13. The origin of species, 1959, Charles Darwin, New American Library, New York.

Course Name: Zoology Practical-I (2 Credits)

Course Code : 24-ZO-367

Semester VI

Section I: Practicals in Forensic Zoology

1. To carry out routine analysis of given urine sample for - 2 E
 - i. Physical Properties: Volume, Colour, pH, Turbidity, Specific gravity.
 - ii. Chemical Properties: Sugars, Protein, Bile salts & bile pigments, Ketone bodies, E

Blood. (C)

2. Determination of serum urea. E
3. Determination of serum uric acid. E
4. Determination of serum Calcium. (C) E
5. To examine human hair for cortex and medulla. (C) E
6. To examine hair morphology and determine the species to which the hair belongs. E
7. To prepare slides of scale pattern of human hair. (C) E
8. To Visit a Forensic Laboratory and submission of the report. E
9. To Identify and differentiate various types of Finger prints. (C) E
10. To prepare a case report on forensic entomology with respect to insect's succession and its relationship to determine time since death.

Section II: Practicals in Animal Physiology

1. Haemoglobin estimation using Sahli's haemoglobinometer. (C) E
2. Preparation of haemin and haemochromogen crystals. (C) E
3. To estimate the blood glucose level from given sample. (C) E
4. Estimation of bleeding and clotting time. (C) E
5. Study of disorders caused by endocrine glands with the help of photographs. D
6. Detection of blood groups in human being. E
7. Differential count of blood. E
8. Estimation of haemoglobin percentage with the help of haemometer. E
9. Qualitative detection of nitrogenous waste products (Ammonia, urea, uric acid) in given sample. (C) E
10. Demonstration of kymograph unit, Respirometer through available resources. D
11. Measurement of lung capacity. E

Course Code and Course Name:**24-ZO-368: Zoology Practical-II (2 Credits)****Semester VI****Section I: Practicals in Molecular Biology**

1. Lab safety techniques & sterilisation. D
2. Preparation of DNA paper model and study its characteristics. E
3. Staining of DNA and RNA by methyl green – pyronin. (C) E
4. Estimation of DNA by Diphenylamine method. (C) E
5. Estimation of RNA by Bial's Orcinol method. E
6. Isolation of DNA from Bacteria / liver / Onion/Banana. (C) – 2 P E
7. Absorption spectra of DNA isolated from Bacteria / Liver / Onion/ Banana. (C) E
8. Principle & application of Spectrophotometer & PCR. D

Section II: Practicals in Pest Management

1. To study the plant protection appliances. D
2. Studies on beneficial insects. (C) D
3. Study of pests and diseases of honeybees. (C) D
4. Applications of IPM components in various crops. D
5. Separation of the pesticides or plant products by TLC and Column chromatography. - 2 P (C) E
6. Detection of pesticides residues in food stuffs. (C) E
7. Rearing of pest species (Any 2 species). (C) D
8. Study of life cycle of Red cotton bug and Lemon butterfly. D

9. Study of the detection of damage caused by pests. D
10. Plant disease, its intensity & calculation of VI (Virulence Index) of at least two diseases. D

Course Code and Course Name:

24-ZO-369: Zoology Practical-III (2 Credits)

Semester VI

Section I: Practicals in Tools and techniques in Biology

1. Compound and Stereo microscope: Components, usage and maintenance. D
2. To observe different kind of cells under compound microscope and its measurement using micrometer scale or by image analysis software (Ex. Image J). (C) E
3. Tissue collection, fixation & Block preparation. (C) E
4. Sectioning, staining & mounting. Submission of any three permanent slides from three different organs. (C) E
5. To study population density and percentage frequency of different animal / insect species of a given area. D
6. Calculating the different alpha and beta biodiversity indices of different animal / insect species of a given area. D
7. Survey for insects using pit fall trap and light traps in your college campus / agriculture field. E
8. Use of photography (Mobile camera / DSLR) in scientific documentation of at least 5 species of insects / birds/ mammals. D
9. Visit to a water body / forest to study faunal biodiversity using field equipment – (C) 2P E
10. Study of Principle & working of PCR & DNA Barcoding – 2 P E

Section II: Practicals in Evolutionary Biology

1. Study of morphological similarities and differences between man and ape. (C) D
2. Study of types of fossils with the help of specimens/ charts/ photos. (C) D
3. Study of animal adaptations in: Turtle, Draco, Exocoetus, Bat and Parrot. (C) D
4. Study of evidences of evolution- embryological, paleontological, connecting links, morphology and comparative anatomy. (C) E
5. Study of successive stages of evolution of man: a) Australopithecus b) Homo erectus c) Homo neanderthalis d) Cro-Magnon man e) Homo sapiens. (C) D
6. To record Zoogeographical distribution of animals to respective zoogeographical Realms on the world map (Lung fishes, marsupials, flightless birds, Camel, Elephant, Ostrich etc.). (C) E

COURSE NAME: Biodiversity Assessment

Course code: 24-ZO-3610

CREDITS: 2

Lectures: 30

Course outcomes

1. Understanding the basics of science of biodiversity in an ecological context.
2. Learning tools and techniques relevant to monitoring of biological diversity.
3. Imparting basic knowledge about the environment and its allied problems.
4. Developing an attitude of concern for the environment.
5. Make one striving to attain harmony with Nature, acquiring skills to help the concerned individuals in identifying and solving environmental problems.

Title & Contents	Number of lectures
1. Introduction:	3L
1.1 Definition of biodiversity	
1.2 Clarification of terms (taxonomic, spatial levels, endemism), levels of biodiversity (microbial, genetic, species, ecosystem, landscape), drivers of biodiversity).	
2. Magnitude and Distribution of biodiversity Evolution of biodiversity.	4L
2.1 Overview of ecological communities, number of species worldwide, change in biodiversity over time in different regions of the world	
2.2 Concept of diversity hot-spots; Biodiversity in India: In the past and present.	
3. Assessment and Monitoring of biodiversity Indicators for Biodiversity.	3L
3.1 Methodology of assessment and analysis of different species groups, monitoring of different species groups.	
4. Biodiversity–ecosystem functioning–Ecosystem Services (ES)	4L
4.1 Ecosystem functions related to biodiversity, definition of ES	
4.2 Importance of biodiversity ecosystem functioning for supply of ES (direct and indirect), methods of valuation	
5. Biodiversity loss and its consequences	6L
5.1 Estimates of extinction rates worldwide and in India.	
5.2 Analysing and discussion of causes and extinction/changes in biodiversity	
5.3 Summarising causes and consequences (Causes: Vulnerability to extinction; changing of the environment (Habitat fragmentation and destruction) climate change, overexploitation; Consequences: loss of gene pool, loss of ecosystem services, livelihood)	
6. Conservation strategies- Theoretical background: overview of genetic variability: population biology of endangered species, conservation genetics, wildlife biology	6L
6.1 Ex-situ conservation	
6.2 In-situ conservation	

7. Biodiversity restoration: Principles, definitions, degradation, tools and methods, restoration and ecosystem functioning, discussion of case studies. **4L**

Course Code and Course Name

24-ZO-3611 : Project/Internship/Hands on Training or Workshop (Minimum 1 week Duration]

2 credits