



Savitribai Phule Pune University
(Formerly University of Pune)

Three Year B. Sc. Degree Program in Zoology
(Faculty of Science & Technology)

T. Y. B. Sc. Zoology

Choice Based Credit System Syllabus

To be implemented from
Academic Year 2021 - 2022

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 needs 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.

While presenting this new syllabus to the teachers and students of T. Y. B. Sc. Zoology, I am extremely happy to state that efforts have been made to seek inputs of all the stake holders to make it more relevant.

The new course will be effective from the academic year 2021- 2022 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 132 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.

Board of Studies in Zoology
Savitribai Phule Pune University

1. Course Structure:**Course Structure with Credit Distribution of the Undergraduate Science Program in Zoology**

Course	Course Code and Name of the Course		Credits
F. Y. B. Sc.	SEMESTER I	SEMESTER II	
CC	ZO-111 Animal Diversity I	ZO-121 Animal Diversity II	2+2
CC	ZO-112 Animal Ecology	ZO-122 Cell Biology	2+2
CC	ZO-113 Zoology Practical Paper	ZO-123 Zoology Practical Paper	1.5+1.5
S. Y. B. Sc.	SEMESTER III	SEMESTER IV	
CC	ZO-231 Animal Diversity III	ZO-241 Animal Diversity IV	2+2
CC	ZO-232 Applied Zoology I	ZO-242 Applied Zoology II	2+2
CC	ZO-233 Zoology Practical Paper	ZO-243 Zoology Practical Paper	2+2
AECC	EVS 231-Environment Awareness	EVA 241-Environment Awareness	2+2
AECC	LA 231-English / Marathi	LA 241- English / Marathi	2+2
T. Y. B. Sc.	SEMESTER V	SEMESTER VI	
DSEC	ZO-351 - Pest Management	ZO-361 - Medical & Forensic Zoology	2+2
DSEC	ZO-352 - Histology	ZO-362 - Animal Physiology	2+2
DSEC	ZO-353 - Biological Chemistry	ZO-363 - Molecular Biology	2+2
DSEC	ZO-354 - Genetics	ZO-364 - Entomology	2+2
DSEC	ZO-355 - Developmental Biology	ZO-365 - Techniques in Biology	2+2
DSEC	ZO-356 - Parasitology	ZO-366 - Evolutionary Biology	2+2
DSEC	ZO-357 - Zoology Practical Paper 1	ZO-367 - Zoology Practical Paper 1	2+2
DSEC	ZO-358 - Zoology Practical Paper 2	ZO-368 - Zoology Practical Paper 2	2+2
DSEC	ZO-359 - Zoology Practical Paper 3	ZO-369 - Zoology Practical Paper 3	2+2
SEC	ZO-3510 - Aquarium Management	ZO-3610 - Environmental Impact Assessment	2+2
SEC	ZO-3511 - Poultry Management	ZO-3611 - Project	2+2

2. Detailed Syllabus of T. Y. B. Sc.

Following is the syllabus of each course along with the course outcomes:

SR.NO.	SEMESTER	COURSE NUMBER AND NAME	CREDITS
1	V	ZO 351 - Pest Management	2
2	V	ZO 352 - Histology	2
3	V	ZO 353 - Biological chemistry	2
4	V	ZO 354 - Genetics	2
5	V	ZO 355 - Developmental Biology	2
6	V	ZO 356 - Parasitology	2
7	V	ZO 357 - Zoology Practical Paper 1	2
8	V	ZO 358 - Zoology Practical Paper 2	2
9	V	ZO 359 - Zoology Practical Paper 3	2
10	V	ZO 3510 - Aquarium Management	2
11	V	ZO 3511 - Poultry Management	2
12	VI	ZO 361 - Medical & Forensic Zoology	2
13	VI	ZO 362 - Animal Physiology	2
14	VI	ZO 363 - Molecular Biology	2
15	VI	ZO 364 - Entomology	2
16	VI	ZO 365 - Techniques in Biology	2
17	VI	ZO 366 - Evolutionary Biology	2
18	VI	ZO 367 - Zoology Practical Paper 1	2
19	VI	ZO 368 - Zoology Practical Paper 2	2
20	VI	ZO 369 - Zoology Practical Paper 3	2
21	VI	ZO 3610 - Environmental Impact Assessment	2
22	VI	ZO 3611 - Project	2

SEMESTER - V**Course Title: Pest Management****Course Code: ZO 351****Credits - 02****ZO 351 - Pest Management****Course Objectives:**

After you complete your study of this unit, you should be able to:

- Explain why identification of the pest is the first step in developing an effective pest control strategy.
- Explain the differences between continuous pests, sporadic pests, and potential pests.
- Explain what is meant by prevention, suppression, and eradication of pests.
- Describe "thresholds" and why they are an important consideration in developing a pest control strategy.
- Describe "monitoring" as it relates to pest control and explain why it is important to pest control strategy.

Course Outcomes:

1. Define pest management.
2. Describe the economic, ecological, and sociological benefits of IPM.
3. Distinguish positive and negative impacts of pesticide use.
4. Understand problems resulting from misuse, overuse, and abuse of chemical pesticides.
5. Define and describe pesticide resistance and how it develops.
6. Identify ecological and biological characteristics important in development of pest populations.
7. Identify 10 tactics commonly used in IPM and be able to distinguish them.
8. Understand society's role in IPM decisions.
9. Describe different groups of pests and compare them to weeds and plant pathogens.
10. Analyse and compare management tactics to determine the best approach to reducing pest populations, weeds, and disease presence.
11. Locate appropriate, scientifically valid sources of information on specific tactics to manage insect pests, weeds, and diseases.
12. Know and how to develop an IPM program.

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. Somaclonal 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: Histology

Course Code: ZO 352

Credits: 02

ZO 352 - Histology

Objectives –

1. To understand the histological aspects of mammalian organs.
2. To study the important features of different types of tissues in organ system.
3. To understand the classification of various types of basic tissues.
4. To study structure & functions of various tissues in organ system.
5. To understand histological structure of various glands and its functions.

Learning Outcomes for the course –

1. The students will be able to understand, classify and identify the different types of tissue.
2. The students will understand the complexity of various tissues in an organ.
3. The students will be able to learn structure & functions of various tissues.
4. The students will understand the various diseases related to organs.
5. The student will be able to know the role of glands in mammals.

Title & Contents

Number of lectures

1. Introduction:

Definition and Scope of Histology.

1 L

2. Definitions and Review of Types of Tissues:

2.1 Epithelial tissue.

2.2 Connective tissue.

2.3 Nervous tissue.

2.4 Muscular tissue.

3 L

3. Histological study of following mammalian organs:

3.1 Skin (V. S.).

3.2 Tooth (V. S.).

5 L

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.

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: ZO 353

Credits: 02

ZO 353 - Biological Chemistry

Objectives –

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

Learning Outcomes for the course -

1. Learners shall be able to understand basic concepts and significance of biochemistry
2. The students will learn about the pH and Buffers.
3. The students will learn about the chemical structures of carbohydrate, and their biological and clinical significance.
4. The students will be able to understand, interpret structure and importance of proteins, carbohydrates and lipids
5. Learners will be able to comprehend variations in enzyme activity and kinetics.

Title & Contents	Number of lectures
1. Introduction of Biochemistry: Importance of Biochemistry in Life Sciences.	1 L
2. p^H and Buffers: 2.1 Concept of p ^H . 2.2 Concept of p ^H scale, biological significance of p ^H 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 L
3. Carbohydrates: 3.1 Definition, Classification & Biological importance of Carbohydrates. 3.2 Isomerism in carbohydrates - Structural and Stereoisomerism. 3.4 Significance of Gluconeogenesis, Glycogenolysis and Glycogenesis. 3.3 Clinical Significance - Hypoglycemia and Hyperglycemia.	7 L
4. Amino acids and Proteins: 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. 4.5 Biological importance of proteins – Biocatalysts, Carrier proteins Contractile proteins, Hormonal role of proteins.	6 L
5. Enzymes: 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.	10 L
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.

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. Zuby 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: ZO 354

Credits: 02

ZO 354 - 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	
a) UV radiation and ionising radiation.	
b) Base analogs, alkylating and intercalating 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 Title: Developmental Biology

Course code: ZO 355

Credits: 02

ZO 355 - Developmental Biology

Title & Contents	Number of lectures
1. Fundamentals of Developmental Biology:	3 L
1.1 Definition and scope.	
1.2 Concepts in Developmental Biology: Growth, Differentiation, Dedifferentiation, Cell determination, Cell communication, Morphogenesis, Induction and Regeneration.	
2. Theories of Developmental Biology:	3 L
2.1 Preformation.	
2.2 Pangenesis.	
2.3 Epigenesis.	
2.4 Axial gradient.	
2.5 Germplasm.	
3. Gametogenesis:	5 L
3.1 Spermatogenesis & Structure of sperm with respect to human.	
3.2 Oogenesis & Structure of ovum with respect to human.	
3.3 Types of eggs.	
4. Fertilization:	6 L
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:	5 L
5.1 Planes and symmetry of cleavage.	
5.2 Types of cleavage.	
5.3 Significance of cleavage.	
5.4 Definition and types of Blastula.	
6. Gastrulation:	3 L
6.1 Definition and Concept.	
6.2 Basic cell movements in gastrulation: Epiboly, Emboly, Convergence, Invagination, Ingression & Involution with reference to frog.	
6.3 Concept of Organizer : Primary, Secondary and Tertiary.	
7. Chick Embryology:	6 L
7.1 Structure of Hen's egg.	

- 7.2 Fertilization and cleavage in Chick.
- 7.3 Formation of primitive endoderm.
- 7.4 Primitive streak development.
- 7.5 Head process and regression of Primitive streak.

References:

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: Parasitology**Course code: ZO 356****Credits: 02****ZO 356 - Parasitology****Objectives:**

1. To understand the basic terminologies in parasitology.
2. To understand the concepts of animal association with examples.
3. To understand the morphology and life cycle of common parasites (Protists and Platyhelminthes).
4. To understand the phenomenon of Host-parasite relationship.
5. Explain the importance of arthropod vectors with examples.

Learning outcomes:

1. The students will be able to learn about basics and scope of parasitology.
2. The students will be able to learn the types of host and parasite with examples.
3. The students will be able to learn about the morphology, life cycle, pathogenicity and treatment of common parasites (Protists and Platyhelminthes).
4. The students will be able to learn about host -parasite relationships and their effects on host body.
5. The students will be able to learn about the arthropod parasites and their role as vector.

Title & Contents**Number of lectures****1. Introduction, Scope and Branches of Parasitology:****2 L**

- 1.1. Definition: host, parasite, vector, commensalisms, mutualism and parasitism.
- 1.2. Branches of 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: 9 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: 9 L**
- 5.1 *Ascaris lumbricoides* - Study of Morphology, Life Cycle, Prevalence.
- 5.2 Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.
- 5.3 *Taenia solium* (Tapeworm) - Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment.
- 6. Study of Parasitic Arthropoda: 4 L**
- Morphology, pathogenicity and control measures of –
- 6.1 Soft tick.
- 6.2 Head louse.
- 6.3 Rat flea.
- 6.4 Bed bug.

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. Kransov, Oxford University Press.
13. Textbook of medical microbiology – Rajesh Bhatia & Itchpujani.

14. Textbook of medical microbiology – Arora & Arora.
15. Biological Control of Parasites, 2012.
16. Biology of Malaria Parasites, 2012.
17. Sherris medical microbiology: Ryan.
18. Medical microbiology: Jawetz Melnick & Adelbergs.
19. Current concepts in parasitology, 2012.
20. Textbook of Parasitology, Ashok Kumar, Discovery Publishing.
21. Introduction to parasitology: With special reference to the parasites of man, A.C. Chandler-
John Wiley & Sons.
22. A text book of Parasitology – D. P. Karyakarte & A. S. Damle.

For Practical papers of both V and VI semester, minimum 6 practicals should be conducted from each section, thus a minimum of 12 practicals should be conducted per practical paper. (C) stands for compulsory.

Course Title: Zoology Practical Paper I

Course code: ZO 357

Credits: 02

Course Title : Zoology Practical Paper - I

Section I: 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 |

Section II: Practicals in Histology

- | | |
|--|---|
| 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 Title: Zoology Practical Paper - II**Course code: ZO 358****Credits: 02****ZO 358 - Zoology Practical Paper - II****Section I: Practicals in Biological Chemistry**

- | | |
|---|---|
| 1. To determine the enzyme activity - salivary amylase/ urease/ invertase. | E |
| 2. To determine specific activity of an enzyme. | E |
| 3. Detection of carbohydrates (monosaccharides, disaccharides and polysaccharides) with the help of suitable tests. (C) | E |
| 4. Isolation of starch from potato and digestion of starch by salivary amylase. (C) | E |
| 5. Preparation of buffer of desired pH and molarity. (C) | E |
| 6. Protein estimation by Lowry <i>et al.</i> method. (C) | E |
| 7. Isolation of Caesin from milk by adjusting iso-electric point. (C) | E |
| 8. Preparation of Acid, Alkali & it's standardisation. | E |
| 9. 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 <i>Drosophila</i> . (C) | D |
| 10. Study of <i>Drosophila</i> mutants. | D |

Course Title: Zoology Practical Paper III**Course code: ZO 359****Credits: 02****ZO 359 - Zoology Practical Paper - III****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, <i>Amphioxus</i> , 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 (<i>Amphioxus</i> , Frog and Hen). | D |
| 5. Study of gastrulae (<i>Amphioxus</i> , 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 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 <i>Entamoeba histolytica</i> and <i>Plasmodium vivax</i> through permanent slides or microphotographs. | D |
| 3. To study the life cycle, pathogenecity, diagnosis and treatment of <i>Ascaris lumbricoides</i> and <i>Taenia solium</i> through specimen, permanent slides or microphotographs. (C) | D |

- | | |
|---|---|
| 4. Study of following parasites with its role as vector - Soft tick, <i>Pediculus humanus</i> , <i>Xenopsylla cheopis</i> and <i>Cimex lectularius</i> 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 (<i>Sarcoptes scabiei</i>). | D |
| 7. Study of parasites from the gut of cockroach. (C) | E |
| 8. Collection & submission of various parasites. (C) | E |

Course Title: Aquarium Management**Course Code: ZO 3510****Credits: 02****ZO 3510: Aquarium Management**

Title & Contents	Number of lectures
1. Introduction to Aquarium Fish Keeping:	4 L
1.1 The potential scope of Aquarium Fish Industry as a Cottage Industry.	
1.2 Exotic and Endemic species of Aquarium Fishes.	
1.3 Nutritional value of fish.	
2. Biology of Aquarium Fishes:	6 L
2.1 Common characters and sexual dimorphism of Aquarium fishes - Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish and Fighter fish.	
3. Food and feeding of Aquarium Fishes:	4 L
3.1 Use of live fish feed organisms.	
3.2 Preparation and composition of formulated fish feeds.	
3.3 Overview on types of fish food.	
4. Fish Transportation:	4 L
4.1 Live fish transport: a) Fish handling. b) Fish packing. c) Fish forwarding techniques.	
4.2 Causes of mortality in transport.	
5. Maintenance of Aquarium:	3 L
5.1 General Aquarium Maintenance - budget for setting up an Aquarium.	
5.2 Fish Farm as a Cottage Industry, Rules & regulations of fish rearing.	
5.3 Common diseases of Aquarium fish.	
6. Physico-chemical parameters of water for fish culture:	4 L
6.1 Acidity, Alkalinity, Calcium, Nitrate, Ammonia, Total hardness.	
7. Fish preservation:	2 L
7.1 Fish preservation and processing.	

7.2 Fish preservation techniques.

8. Fish breeding:

3 L

8.1 Types of fish breeding -

- a) Natural fish breeding.
- b) Induced fish breeding.

Course Title: Poultry Management

Course Code: ZO 3511

Credits: 02

ZO – 3511 Poultry Management

Objectives:

1. To understand the basics of Poultry Farming and its important.
2. To understand breeding management of broilers and layers of chickens.
3. To understand housing management and equipment of Poultry farming.
4. To understand food, feeding and digestion mechanism of chickens.
5. To understand the poultry diseases and their control.
6. To understand the economic importance of poultry products.

Expected Outcome:

1. The students will be able to understand the Poultry farming practices.
2. The students will able to understand the poultry breeding techniques.
3. The students will be able to understand poultry rearing techniques.
4. The students will be able to understand feeding requirement and food ingredients.
5. The students will be able to understand the poultry disease and their pathogens.
6. The students will be able to understand 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.

10. Poultry Production (2011) 3rd Edn, Singh, R. A., Kalyani Publishers, New Delhi.
11. Textbook of Poultry Science (2015) 1stEdn, Sreenivasaiah., P. V. Write & Print Publications, New Delhi.
12. Encyclopedia of Broiler Breeder Production: Production, Feeding and Management Techniques (2013) Vol. 1, 2 & 3, Youn Michael, Anmol Publications Pvt. Ltd., New Delhi

Note: Latest editions of the recommended books may be referred.

SEMESTER - VI

Course Title: Medical & Forensic Zoology

Course Code: ZO 361

Credits: 02

ZO 361 - Medical & Forensic Zoology

Objectives:

1. To understand the scope, need and History of Forensic Science.
2. To understand the role of different institutes & allied institutes of Forensic Science.
3. To understand the various branches of Forensic Sciences from Life Sciences.
4. To understand human physiology, post mortal investigations.
5. To understand knowledge of handling different types of evidences and their examinations.

Expected Outcome

1. The students will be able to understand the basics principles of Medical and Forensic Zoology.
2. The students will able to understand scientific methods in crime detection.
3. The students will be able to understand the advancements in the field of Medical and Forensic Zoology.
4. The students will be able to understand modern tools, techniques and skills in forensic investigations.
5. The students will be able to describe the fundamental principles and functions of forensic science and its significance to human society.

Title & Contents

Number of lectures

1. Introduction to medical zoology and its importance :	2 L
2. Medico-legal Autopsy:	6 L
2.1 Death and its Causes- External examination of deceased body – Internal Examination - Determination of time since death and cause of death.	
2.2 Injuries – Classification - Medico-legal aspects of injuries.	
2.3 Post-mortem changes - collection of post-mortem samples and Preservation.	
3. Urine Analysis:	3 L
3.1 Physical characteristics, abnormal constituents, renal failure, renal calculi, dialysis.	

- 4. Non infectious Diseases:** 2 L
4.1 Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Diabetes (Type I and II), Hypertension, Hypotension, Obesity, Atherosclerosis, Myocardial Infraction.
- 5. Infectious Diseases:** 2 L
5.1 Causes, Types, Symptoms, Complications, Diagnosis and Prevention of Tuberculosis and Hepatitis.
- 6. Introduction to Forensic Zoology:** 3 L
6.1 Definition, Scope and Application of Forensic Zoology.
6.2 Forensic Laboratories in India.
6.3 Basic Principles of Forensic Science with Examples.
- 7. Forensic Medicine:** 3 L
7.1 Introduction to Forensic Medicine: Definitions of Forensic Medicine.
7.2 Medical Jurisprudence.
7.3 Medical evidence documentations.
- 8. Forensic Analysis:** 9 L
8.1 Examination of Biological Materials: Examination of Hair, Fibres, Diatoms, plants materials, human tissues.
8.2 Examination of Body Fluid: Blood, Semen and Saliva.
8.3 Forensic Importance of Insects: Insects of forensic importance - indicators of time of death stages of insect development & comparative decomposition of human body - colonization - Evidence collection of insects – Territorial & Aquatic Insects.
8.4 DNA Fingerprint Technique and Examination of Biological Traces: Liquid blood, blood stains, & swabs, semen, Seminal stains, tissues, Bones, Hairs, Teeth, Saliva, Skeletal remains.
8.5 Toxicological Investigations: Poisons – Definition, Forms of Poison – Physical, Chemical & Mechanical state. Introduction with examples of – Neurotoxic Poisons – Cerebral & Spinal, Cardiovascular Poisons, Asphyxiants, 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.

10. Essentials of medical microbiology: Apurba S. Sastry & Sandhya Bhat, Jaypee brothers.
11. W. G. Eckert and S. H. James, Interpretation of Bloodstain Evidence at Crime Scenes, CRC Press, Boca Raton (1989).
12. The essentials of forensic medicine & toxicology: K. S. Narayan Reddy.
13. A textbook of Clinical pharmacology: Roger H. J., Spector R. G., Trounce J. R., Hodder & Stoughton publishers.
14. Pharmacology & Pharmacotherapeutics : Satoskar R. S., Bhandarkar S. D., Popular Prakashan, Mumbai.
15. The synopsis of forensic medicine & toxicology: K. S. Narayan Reddy.
16. Textbook of pathology: Harsh Mohan.
17. G. T. Duncan and M. I. Tracey, Serology and DNA typing in, Introduction to Forensic Sciences, 2nd Edition, W. G. Eckert (Ed.), CRC Press, Boca Raton (1997).
18. T. Bevel and R. M. Gardner, Blood stain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).
19. Arti Nigam and Archana Ayyagari, Lab manual in Biochemistry, immunology and biotechnology, Mc Graw Hill Publishing Company Ltd.
20. Fundamentals of Forensic Science, Second Edition, Max M. Houck and Jay A Siegel, Academic Press.
21. Forensic Science, Third Edition, Stuart H James and Jon. J. Nordby.
22. Forensic Science in India and the World, Deepak Ratna and Mohd. Zaidi, Alia Law Agency, Allahabad.
23. Forensic Science in India - A Vision for 21st Century, B. B. Nanda and Dr. R. K. Tewari, Select Publishers.
24. Cell Biology, Sixth Edition International Students Edition, Gerald Karp, Wiley Publications, 2010.
25. Human Physiology: From Cells to Systems, Lauralee Sherwood, Cengage Learning, 2008.
26. Forensic Biology, Richard Li, CRC Press.
27. Human Anatomy Vol. 1,2,3,4, Chaurasia B. D.
28. Text Book of Medical Jurisprudence, Forensic Medicine and Toxicology by Parikh C. K.
29. Forensic Science: An introduction to Scientific and Investigative Techniques by S. H James, J. J. Nordby.
30. Parikh C. K., Medical Jurisprudence.

Course Title: Animal Physiology

Course Code: ZO 362

Credits: 02

ZO 362 - Animal Physiology

Course Objectives:

1. To acquaint students with the principles and basic facts of Animal Physiology and with some of the laboratory techniques and equipment used in the attainment of physiological data. The importance will be on mammalian.
2. The course will focus on organ-system physiology,
3. Furthermore, emphasis will be placed on nutritive, circulatory, respiratory, excretory, muscular, nervous, reproductive and endocrine physiology. Where appropriate, basic chemical and physical laws will be reviewed in order to enhance and to promote student understanding.

4. The laboratory module of the course is designed to support the topics discussed in theory lecture, as well as to acquaint students with some of the laboratory techniques and equipment used in the gaining of physiological facts.

Learning Outcomes:

Upon successful completion of this course, the students will be able to describe, identify, and/or explain:

1. The various physiological organ-systems and their importance to the integrative functions of the human body.
2. Understand Concept of energy requirements
3. Various aspects of Digestive physiology.
4. Circulatory system with medical conditions
5. Understand Respiratory mechanism and gases transport.
6. Eliminations of waste materials from the body.
7. Develop understanding in Structure and functions of muscles
8. Understand formation of gametes and function of endocrine glands.

Title & Contents	Number of lectures
1. Nutrition and digestion:	5 L
1.1 Nutritional requirement & balanced diet.	
1.2 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:	5 L
2.1 Mechanism of respiration: Regulation of ventilation in lungs, exchange of gases at respiratory surface.	
2.2 Respiratory pigments in animals: Haemoglobin, Hemocyanin, Hemerythrin, Chlorocruorin.	
2.3 Transport of gases : O ₂ and CO ₂ transport.	
3. Circulation:	5 L
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:	5 L
4.1 Structure of Uriniferous tubule.	
4.2 Mechanism of urine formation.	
4.3 Normal and abnormal constituents of urine, Elementary idea of dialysis.	
5. Muscles:	3 L
5.1 Structure of smooth, skeletal and cardiac muscles.	
5.2 Mechanism of muscle contraction by Sliding filament theory.	
6. Reproduction and Endocrine Glands:	7 L
6.1 Physiology of male reproduction, hormonal control of spermatogenesis.	
6.2 Physiology of female reproduction, hormonal control of menstrual cycle.	

6.3 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: ZO 363

Credits: 02

ZO 363 - Molecular Biology

Objectives:

1. The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells and organisms.
2. To understand the Structure of DNA and RNA, DNA and RNA as genetic material
3. To understand the Central Dogma of Molecular Biology
4. To understand the concept of gene regulation
5. To understand the DNA Damage and Repair
6. The course aims to develop basic understanding of structure-function relationships of nucleic acids and proteins.

Learning 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
5. Learner shall get an insight into the DNA Damage and Repair

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, Avery <i>et al.</i> , Hershey and Chase experiment), RNA as genetic material - TMV 4.	
1.4 Structure of Chromatin, packaging of DNA, Heterochromatin, Euchromatin.	
2. Central Dogma of Molecular Biology:	15 L
2.1 DNA Replication - Semiconservative (Messelson 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 (splicing - mRNA, modifications at 3' and 5' end).	
2.3 Translation - Genetic code, properties of genetic code, Basic mechanism of Translation in <i>E. coli</i> 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 Book:

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.

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: Entomology

Course Code: ZO 364

Credits: 02

ZO 364 - Entomology

Objectives:

1. To understand the scope of Entomology and general characters of Insects.
2. To study the morphology and anatomy of Insects.
3. To learn the concept of social organization in Insects.
4. To understand metamorphosis in Insects.
5. To study the economically important insects and Pest management of harmful insects.

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. Understand the development process of Insects.
5. Identify disease causing insect vectors.
6. Will be able to design and implement pest controlling methods against pests.

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: Techniques in Biology**Course Code: ZO 365****Credits: 02****ZO 365 - Techniques in Biology**

Title & Contents	Number of lectures
1. Microscopy:	3 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.	
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:	3 L
4.1 Antigen-Antibody Interactions – Immunodiffusion.	
4.2 Principle & Working of ELISA.	
4.3 Raising Monoclonal Antibodies.	
4.4 Application of Immunological techniques in disease diagnosis.	
5. Types of PCR & DNA Barcoding :	2 L
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.

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

8. Laboratory techniques:

3 L

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

8.2 Software 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: ZO 366

Credits: 02

ZO 366 - Evolutionary Biology

Objectives:

1. To provide comprehensive overview of Concept of Evolution.
2. To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
3. To explore salient features of various theories of evolution comprising of Lamarckism, Darwinism and Neo-Darwinism.
4. To impart detailed understanding of Analogy, Homology, Paleontological Evidences, Embryological Evidences and Molecular Phylogeny.
5. To provide adequate information about Geological Time Scale and Neutral Theory of Molecular Evolution.
6. To develop comprehensive knowledge regarding various Sources of Variations and their role in evolution.
7. To give detailed explanation of key concepts of Population Genetics in terms of Hardy-Weinberg Law, Genetic Drift and Types of Natural Selection.
8. To provide adequate knowledge about Micro-evolutionary changes, Speciation and Adaptive Radiation.
9. To give detailed outline of Extinctions and its types.
10. To impart descriptive knowledge regarding Origin and Evolution of Man.

11. To provide glimpse of Phylogenetic Trees and highlight their construction along with interpretation.

Learning outcomes

After completing the course, the student should be able to

1. Students will be able 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. Independently 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:	4 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:	5 L
2.1 Analogy and Homology.	
2.2 Embryological Evidences of Evolution.	
2.3 Evolutionary & Paleontological Evidences.	
3. Historical Review of Evolutionary Concept:	3 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:	4 L
4.1 Variation and Mutations.	
5. Isolation	5 L
6. Speciation:	4 L
6.1 Types of speciation (Allopatric & Sympatric).	
6.2 Mechanism of speciation.	
6.3 Patterns of speciation.	
6.4 Factors influencing speciation.	

7 Population Genetics:	2 L
7.1 Hardy-Weinberg Law & Genetic Drift.	
7.2 Types of Natural Selection.	
8 Origin of Man:	4 L
8.1 Evolution of Man (Evolution of anthropoids including man) - Kenyanthropus to <i>Homo sapiens</i> .	
9 Zoogeographical Realms With reference to fauna:	2 L
10 Extinctions:	2 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 Title: Environmental Impact Assessment

Course Code: ZO 3610

Credits: 02

ZO 3610 - Environmental Impact Assessment

Title & Contents	Number of lectures
1. Environment:	2 L
1.1 Definition.	
1.2 Divisions.	
1.3 Importance.	
2. Pollution:	3 L
2.1 Definition and types.	
2.2 Impact on wildlife, natural resources, development.	
3. Sustainable development:	2 L

- 3.1 Definition and need.
- 3.2 Exploitation of natural resources.
- 3.3 Concept of carrying capacity.
- 3.4 Three pillars of Sustainability.
- 3.5 UN 17 Sustainable Development Goals (SDGs).
- 4. Overview of Environmental Protection acts: 5 L**
 - 4.1 The Air (Prevention and Control of Pollution) Act 1981.
 - 4.2 The Water (Prevention and Control of Pollution) Act 1974.
 - 4.3 The Environment Protection Act 1986.
 - 4.4 The National Green Tribunal Act 2010.
 - 4.5 Biological Diversity Act 2002.
- 5. Environmental Impact Assessment (EIA): 5 L**
 - 5.1 Definition, need and importance of EIA.
 - 5.2 EIA notification 2006 - key elements, History and Evolution of EIA.
 - 5.3 Categories of Industries / establishments requiring EIA, Types of EIA - strategic EIA, regional EIA, sectoral EIA, project level EIA and life cycle assessment.
 - 5.4 Rapid and comprehensive EIA.
- 6. EIA Process: 5 L**
 - 6.1 Screening, Scoping and consideration of alternatives.
 - 6.2 Baseline data collection, Impact analysis, Mitigation, Reporting, Public hearing.
 - 6.3 Review of EIA.
 - 6.4 Decision-making, monitoring clearance conditions.
- 7. Stakeholders in EIA process: 3 L**
 - 7.1 Project proponent, Environmental consultant.
 - 7.2 CPCB / MPCB.
 - 7.3 Public, EIA agency (IAA).
- 8. Overview of Scheme for Accreditation of EIA Consultant Organizations (NABET / QCI): 5 L**
 - 8.1 Eligibility and benefits.
 - 8.2 EIA coordinator (EC), Functional area experts (FAEs).
 - 8.3 Functional area associate (FAA) and team members: Role, educational qualification, experience and functions.

References:

1. Glasson, J., Therivel, R. (2019) Introduction to Environmental Impact Assessment. Routledge. London.
2. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
3. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.

Course Title: Project
Course Code: ZO 3611
Credits: 02

ZO 3611 - Project

Students have to complete the research project in the stipulated time and present the dissertation at the time of the examination in a proper format. Students should be encouraged to take up laboratory work, hands-on practical investigation and design experimental setup. Field work to be carried out under proper supervision and permissions from the concerned authorities.

Possible key aspects of the project work -

1. Planning the project
2. Selecting a suitable title
3. Significance of the work
4. Hypothesis, Objectives
5. Reviewing the available literature
6. Methodology to be used
7. Outcomes of the Project work
8. Conclusion and Discussion
9. Future plans

Students should be made aware of plagiarism and research ethics.

Course Title: Zoology Practical Paper - I
Course Code: ZO 367
Credits: 02

ZO 367 - Zoology Practical Paper - I

Section I: Practicals in Medical & 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, 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. E

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 Title: Zoology Practical Paper - II

Course Code: ZO 368

Credits: 02

ZO 368 - Zoology Practical Paper - II

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. (C) – 2 P E
7. Absorption spectra of DNA isolated from Bacteria / Liver / Onion. (C) E
8. Principle & application of Spectrophotometer & PCR. D

Section II - Practicals in 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 |

Course Title: Zoology Practical Paper – III**Course Code: ZO 369****Credits: 02****ZO 369 - Zoology Practical Paper III****Section I: Practicals of 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