

FACULTY OF SCIENCES

SYLLABUS FOR THE BATCH FROM 2023 TO 2025

Programme Code: MZOO

Programme Name: M. Sc. Zoology

(Semester I-IV)

Examinations: 2023-2025



Department of Zoology

Khalsa College, Amritsar

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(b) Subject to change in the syllabi at any time.

(c) Please visit the College website time to time.

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S. No.	PROGRAMME OBJECTIVES
1.	Achieve excellence in education and scientific research in the field of Zoology.
2.	Develop and implement ways and means to ensure quality performance and outputs of the Zoology program.
3.	Optimal use of modern technology in education and scientific research
4.	Implementation of advanced training to improve the skills of graduates in Zoology and related fields.
5.	Creating engaging academic and scientific environment to attract outstanding faculty, researchers and students.
6.	Provide consultancy and organize extension activities.
7.	Provide quality education offering skill based programs and motivate the students for self-employment in applied branches of Zoology.
8.	Inculcate the spirit of resource conservation and love for nature
9.	Conduct field studies and different projects of local and global interests.
10.	Provide opportunities for professional and personal development through curricular and co-curricular activities
11.	Improve the national and international partnerships with academic institutions and research centers

S. No.	PROGRAMME SPECIFIC OUTCOMES (PSOS)
PSO-1	Students enrolled in M.Sc. Zoology will study and acquire complete knowledge of disciplinary as well as allied biological sciences
PSO-2	Students are able to correctly use biological instrumentation and proper laboratory techniques
PSO-3	Students will be able to identify the relationship or synchronization between structure and function at all levels: molecular, cellular and organismal
PSO-4	Students will also be able to describe economic, ecological and medical significance of various animals
PSO-5	Students will be able to explain how organisms function at the level of the gene, genome, cell, tissue, organ and organ system
PSO-6	Perform, Assess and implement practical techniques and procedure to solve biological problems and analyze and quantify data collected during any project

COURSE SCHEME												
SEMESTER - I												
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.	
			L	T	P		Th	P	IA	Total		
ZooC-501	Functional Organization of Animals-I	4	3	1	0	4	75	-	25	100	5	
ZooC-502	Biochemistry	3	2	1	0	3	56	-	19	75	7	
ZooC-503	Cell Biology	3	2	1	0	3	56	-	19	75	9	
ZooC-504	Fundamentals of Entomology	3	2	1	0	3	56	-	19	75	12	
ZooC-505	Parasitology	3	2	1	0	3	56	-	19	75	14	
ZooC-506	Computer Fundamentals& Data Processing	3	2	0	1	3	36	20	19	75	17	
ZooC-551	Practical- I (Based on ZooC-501)	2	0	0	1	1	-	19	06	25	19	
ZooC-552	Practical-II (Based on ZooC-502 & ZooC-503)	4	0	0	2	2	-	37	13	50	20	
ZooC-553	Practical-III (Based on ZooC-504 & ZooC-505)	4	0	0	2	2	-	37	13	50	22	
	Total	29				24				600		

COURSE SCHEME												
SEMESTER - II												
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.	
			L	T	P		Th	P	IA	Total		
ZooC-601	Functional Organization of Animals-II	4	3	1	0	4	75	-	25	100	24	
ZooC-602	Metabolic Regulation of Cell	3	2	1	0	3	56	-	19	75	26	
ZooC-603	Molecular Cell Biology	3	2	1	0	3	56	-	19	75	28	
ZooC-604	Biosystematics	3	2	1	0	3	56	-	19	75	30	
ZooC-605	Animal Ecology	3	2	1	0	3	56	-	19	75	32	
ZooC-606	Biostatistics	2	2	0	0	2	37	-	13	50	34	
ZooC-651	Practical-IV (Based on ZooC-601)	2	0	0	1	1	-	19	06	25	36	
ZooC-652	Practical-V (Based on ZooC-603 & ZooC-604)	4	0	0	2	2	-	37	13	50	37	
ZooC-653	Practical-VI (Based on ZooC-605)	2	0	0	1	1	-	19	06	25	39	
	Total	27				22				550		

COURSE SCHEME											
SEMESTER - III											
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.
			L	T	P		Th	P	IA	Total	
ZooC-701	Reproductive Biology	3	2	1	0	3	56	-	19	75	40
ZooC-702	Animal Genetics	3	2	1	0	3	56	-	19	75	42
ZooC-703	Applied Zoology-I (Invertebrates)	3	2	1	0	3	56	-	19	75	44
ZooC-704	Animal Behaviour	3	2	1	0	3	56	-	19	75	47
ZooC-705	Wildlife Conservation	3	2	1	0	3	56	-	19	75	50
ZooC-706	Seminar	3	2	1	0	3	56	-	19	75	52
ZooC-751	Practical -VII (Based on ZooC- 701 & ZooC-702)	4	0	0	2	2	-	37	13	50	53
ZooC-752	Practical VIII (Based on ZooC- 703 & ZooC- 704)	4	0	0	2	2	-	37	13	50	55
Total		26				22				550	

COURSE SCHEME											
SEMESTER - IV											
Course Code	Course Name	Hours /Week	Credits			Total Credits	Max Marks				Page No.
			L	T	P		Th	P	IA	Total	
ZooC-801	Developmental Biology	3	2	1	0	3	56	-	19	75	57
ZooC-802	Molecular Genetics	3	2	1	0	3	56	-	19	75	59
ZooC-803	Applied Zoology-II (Vertebrates)	3	2	1	0	3	56	-	19	75	62
ZooC-804	Evolution	3	2	1	0	3	56	-	19	75	65
ZooC-805	Research Techniques	3	2	1	0	3	56	-	19	75	67
ZooC-806	Concepts of Immunology	3	2	1	0	3	56	-	19	75	69
ZooC-851	Practical -IX(Based on ZooC- 801 & ZooC- 802)	4	0	0	2	2	-	37	13	50	71
ZooC-852	Practical XI (Based on ZooC- 803 & ZooC- 804)	4	0	0	2	2	-	37	13	50	73
ZooC-853	Practical XII (Based on ZooC- 805 & ZooC- 806)	4	0	0	2	2	-	37	13	50	75
Total		30				24				600	

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-501

COURSE TITLE: FUNCTIONAL ORGANIZATION OF ANIMALS- I

Total Hours/wk.: 4 hr.

Maximum Marks: 100

Total Hours: 60

Theory: 75

Total Credits: 4 hr.

Internal Assessment: 25

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Periods per week: 6

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2.5 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answer should not exceed 5 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Imparts conceptual knowledge of invertebrates, their adaptations and associations in relation to their environment
2	Provides a comprehensive knowledge about Complex Vertebrate interactions
3	Basic concepts of developmental & physiological aspects regarding various organ systems
4	Imparts knowledge about the evolutionary trends among different animal groups

Unit –I

• **Nutrition and Digestion**

- Mechanisms of microphagy, macrophagy and fluid feeding
- Symbiotic digestion and its mechanism
- Mechanism of digestion in a typical mammal
- Regulation of secretion in non-chordates and chordates

Unit – II

• **Transport and Circulatory mechanisms**

- Transportation mechanisms among protozoans, poriferans and coelenterates
- Open and closed type of circulatory systems
- Types of hearts on the basis of morphology (tubular, chambered and ampullary) and physiology (Neurogenic and myogenic)
- Evolution of heart and aortic arches

Unit–III

• **Respiratory and reproductive systems**

- Respiratory organs among invertebrates
- Respiratory organs among vertebrates and aerial mode of respiration.
- Respiratory pigments: Brief chemistry, functions and oxygen dissociation curves, Bohr's effect, Root effect
- Different larval forms with special reference to crustaceans, molluscs and echinoderms
- Evolution of the urino-genital system among vertebrates

Unit – IV

• **Osmoregulation and Excretion**

- Osmoregulators and osmoconformers, Stenohaline and euryhaline animals
- Excretory structures among non-chordates (Contractile vacuoles, coelomic ducts, protonephridia and metanephridia, nephromixia, coxal glands, malpighian tubules)
- Structural organization of a typical mammalian kidney, physiology of urine formation, JGA, RAAS, ANF

Suggested Reading Material:

1. Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
2. Barth, R. H. and Broshears, R. E (1982), The Invertebrate world. Holt Saunder, Japan.
3. Brusca, R. C. and Brusca, G. J. (2003), Invertebrates second edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
4. Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
5. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusetts, USA.
6. Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
7. Karp, G.(2005), Cell and Molecular Biology; concepts and experiments (4th ed.),Hoboken, John Willy and Sons, New York.
8. Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
9. Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books seller & Publishers, Agra.
10. Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
11. Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ., Philadelphia.
12. Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.

COURSE OUTCOMES

S. No.	On completing the course, the students will be able to:
CO-1.	Understand the morphological and anatomical aspects of different animals
CO-2.	Have a better understanding of human body
CO-3.	Have an insight on the internal systems and their functions
CO-4.	Understand the physiological aspects of various organ systems
CO-5.	Have a comprehensive knowledge about the evolutionary trends among different animal groups.

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-502
COURSE TITLE: BIOCHEMISTRY

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Understand the fundamental chemical principles that govern complex biological systems
2	To appreciate the chemical foundation of life processes
3	To understand the structure and metabolism of biologically significant molecules
4	Biochemical understanding through scientific enquiry into the nature of mechanical, physical, and biochemical functions of humans, their organs, and the cells of which they are composed

Unit – I

- **Biomolecules**
 - Chemical composition and bindings
 - Three dimensional structure: configuration and conformation
 - Chemical reactivity
 - Macromolecules and their monomeric subunits
- **Water**
 - Physical properties and structure of water, hydrogen bonding
 - Solvent properties of water, ionization of water, water as reactant
 - Weak acids and weak bases- Henderson-Hasselbalch equation
 - Fitness of aqueous environment for living organism
 - pH and buffers, Buffering against pH changes in biological systems

Unit – II

- **Proteins**
 - Amino acids as building blocks of proteins, essential amino acids, non-protein amino acids, structure of peptide bond, Ramachandran Plot
 - Protein classification: Organizational levels of protein structure-Primary, Secondary, Tertiary and Quaternary
 - Supramolecular assembly of Proteins: α -Keratin, Silk Fibroin, Collagen, Haemoglobin
 - Solubility, denaturation, functional diversity and species specificity of proteins,
 - Chemical synthesis and sequencing of polypeptides

Unit – III

• **Enzymes**

- Nomenclature, Classification and Physico-chemical nature of Enzymes
- Catalytic specificity- Lock and Key Theory, Induced Fit Theory
- Enzyme substrate complex, active sites
- Michaelis-Menton kinetics, V_{max} and K_m and their significance
- Reversible and Irreversible inhibition, Regulatory enzymes
- Vitamins as Coenzymes

Unit – IV

• **Carbohydrates**

- Definition, Classification of carbohydrates, Physical and chemical properties, structure of carbohydrates,
- Stereoisomerism and Mutarotation (Epimers, anomers, enantiomers)
- Derived monosaccharides, Formation of oligosaccharides, Structure of Glycosidic linkage
- Polysaccharides (starch, glycogen, cellulose, chitins)
- Sugars of bacterial cell wall
- Function of carbohydrates

• **Lipids**

- Definition, Nomenclature Classification and Biological functions of lipids
- Characterisation of Fats: Acid number, saponification number, Iodine number, Reichert-Meissl number
- General structure and functions of major lipid subclasses, acylglycerols, steroids, phosphoglycerides, Sphingolipids, terpenes, prostaglandins, phospholipids, glycolipids, cholesterol and waxes

Suggested Reading Material:

1. Conn, E.E., Stump. P.K. Bruening, S. and Doi R.H. (1987) Outlines of Biochemistry 5th edition John Wiley and Sons Inc., New York.
2. Fischer, J. and Arriold, J.R.P. (2001). Instant notes in Chemistry for Biologists Viva Books Pvt. Ltd.
3. Harper, H.A. (2000): Harper's Biochemistry 25th ed.
4. Lehninger, A (2000). Principles of Biochemistry. 3rd Edition. Kalyani Publishers.
5. Lehninger A.D. Nelson D.L. & Cox M.M. (1993) & (2000), Principles of Biochemistry, 2nd and 3rd ed. Worth Publishers, New York.
6. Morris, H. Best, L.R., Pattison, S., Arerna, S. (2001). Introduction to General Organic Biochemistry. 7th Ed. Wadsworth Group.
7. Rawn, J.D. (1989). Biochemistry, Niel Patterson Publication U.S.A. North Carolina
8. Stryer, L. (1988). Biochemistry, 3rd edition San Francisco W.H. Freeman
9. Sheehon, D (2000). Physical Biochemistry: Principles and Applications – John Wiley & Sons Ltd., England.

COURSE OUTCOMES

CO-1	The scope of biochemistry is applied in medicine, nutrition and agriculture
CO-2	Students investigate the causes and cure of diseases and effect of nutritional deficiencies
CO-3	Students have scope of career in research laboratories
CO-4	Biochemistry also cover genes, their inheritance and expression

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-503
COURSE TITLE: CELL BIOLOGY

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper is aimed to introduce structural and functional aspects of basic unit of life i.e. cell
2	Provides understanding about differences between prokaryotic and eukaryotic cell
3	Provides knowledge about cell properties and evolution of eukaryotic cell from prokaryotic cell
4	Imparts knowledge about theories, composition and properties of cell membrane
5	Develop understanding about structural and functional aspects of various cell organelles

Unit-I

- **Organization of Prokaryotic Cell**
 - Mycoplasma, Bacteria, Cyanobacteria (Blue Green Algae).
 - Structure and importance of prokaryotic cell forms.
- **Theories of evolution of Eukaryotes from Prokaryotes**
 - Endo symbiotic theory & recent views.
- **Cell Membrane**
 - General properties of cell membrane, chemical composition.
 - The concept of unit membrane
 - Various Lipoprotein models including fluid mosaic model.
 - Transport across cell membranes: Active and passive transport, bulk transport
 - **Cell Surface Modifications:** Glycocalyx, microvilli, caveolae

Unit – II

- **Endoplasmic Reticulum**
 - Structure: Extension of cell membrane, cisternae, tubules and vesicles
 - Types: Smooth and Rough endoplasmic reticulum
 - Functions: Synthesis of secretory, lysosomal and integral membrane proteins on ER-Bound ribosomes, membrane biosynthesis in SER
 - Processing of newly synthesized proteins and quality control.
 - Glycosylation of proteins
- **Golgi Complex**
 - Structure of Golgi Complex

- Functions: Role in secretion: Glycosylation of proteins
- Vesicular transport
- Sorting of lysosomal proteins
- Targeting Vesicles to a particular compartment
- GERL concept

Unit – III

● **Ribosomes**

- A complex of ribonucleoproteins
- Association-disassociation dynamics of ribosomes into polysomes, microsomes.
- Site of protein synthesis (initiation, elongation, translocation and termination phases of protein synthesis)

● **Mitochondria**

- Mitochondrial Structure: Mitochondrial membranes, cristae, matrix, inner and outer compartments, Oxysomes
- Function of Mitochondrion
- Mitochondrial enzymes

Unit – IV

● **Lysosomes**

- Polymorphic single membrane structure
- Site of proteolytic activity for intracellular digestion, Phagocytosis
- Diseases associated with lysosomes.

● **Peroxisomes**

- Single membrane structure: site of enzyme complexes involved in hydrogen peroxide metabolism.
- Micro peroxisomes

● **Nucleus**

- Structure of nuclear envelope and Nuclear Pore complex
- Chromatin, (euchromatin & heterochromatin), nucleolus
- Organization of eukaryotic chromosomes (Role of Histone and other proteins; Nucleosome concept).

Suggested Reading Material:

1. Alberts, B. Bracy, P. Lewis, J. Raff, M. Roberts K and Watson, J. (eds) (1994). Molecular Biology of the Cell, Garland Publishing, New York.
2. Avers, C. J. (1976). Cell Biology, Van Nostrand Reinhold, New York.
3. Cooper, G. M. (1997). The cell, A Molecular Approach ASM press, Washington, D.C.
4. Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.
5. Darnell, J. Lodish, H. and Baltimore, D. (1990). Molecular Cell Biology, 2nd edition, Freeman, New York.
6. Derobertis, E. D. P. and Derobertis, E.M.F. (1987). Essentials of Cell and Molecular Biology. Hold Saunders – Philadelphia.
7. Dewitt, W. (1977). Biology of the Cell – An evolutionary approach, Saunders– Philadelphia.
8. Holtzman, E. and Novikoff, A. B. (1984). Cells and Organelles. Saunder–Philadelphia.
9. Hopkins, C. L. (1978). Structure and Functions of Cells. Saunders – Philadelphia.
10. Karp, G. (1984). Cell Biology 4th Edition, McGraw Hill, New York.
11. Karp G. (1999). Cell and Molecular Biology. Concepts and Experiments, 2nd Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
12. Powar, C. B. (1990). Cell Biology. Himalaya Publishing House, Bombay.
13. Sadava, D. E. (1993). Cell Biology– Organelle, Structure and Functions. H. Jones and Bartlett- Boston.

COURSE OUTCOMES

CO-1	The students will be able to understand the cell theory and cell principle
CO-2	Will Provides understanding about differences between prokaryotic and eukaryotic cell
CO-3	Understanding of properties of cell like cell size, shape, number, life span and death
CO-4	Know the structure and importance of Mycoplasma, Bacteria, Cyanobacteria
CO-5	Study the theories of evolution of eukaryotic cell from prokaryotic cell.
CO-6	Develop understanding about composition and properties of cell membrane including various lipoprotein models.
CO-7	Develop understanding about various cell surface modifications: Glycocalyx, Microvilli and Caveolae.
CO-8	Develop understanding about structural and functional aspects of various cell organelles like Golgi complex, Endoplasmic reticulum, Mitochondrion, Ribosomes, Nucleus, Peroxisomes and glyoxysomes

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-504

COURSE TITLE: FUNDAMENTALS OF ENTOMOLOGY

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	To enable the students to understand the basic concepts in entomology
2	To acquaint students with the different types of insect orders with examples
3	To introduce the students to various structure and function of insect systems
4	To learn about insect morphology
5	It will enable the students to understand the effect of environmental factors on insects
6	To study various methods of controlling the insect pests

UNIT-I

- **Salient features with suitable examples of the following insect orders:** Odonata, Isoptera, Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera.
- **Morphology:** Body segmentation, Structure and functions of cuticle, Moulting
- **Structure and modifications** of antennae, mouth parts, legs, wings.

UNIT-II

- **Structure and function of the following systems in insects:**
 - a. Digestive System
 - b. Respiratory System
 - c. Nervous System
 - d. Reproductive System
 - e. **Sense organs** (simple and compound eyes, chemoreceptors)

UNIT-III

- Post embryonic development and types of metamorphosis in insects.
- Structural modifications in the larvae & pupae.
- Effect of temperature and photoperiod on insects
- Diapause.

UNIT-IV

- **Insect Control:**
 - **Chemical control:** Categories of Pesticides with important examples, Insect repellents and attractants.

- **Biological Control:** Use of parasites, predators and pathogens.
- **Integrated Pest Management (IPM):** Importance, concept, principles and tools of IPM
- Safety issues in pesticide uses.

SUGGESTED READINGS

1. Blum, M. S. (1995), Fundamentals of Insect Physiology, John Wiley and Sons, New York, Toronto.
2. Chapman, R. F. (2000), The Insect structure and functions. 3rd ed., Harvard University Press, Cambridge,
3. Davies, R. G. (1988) Outlines of Entomology. The Editor Chapman and Hall, New York.
4. Gullan, P. J. and Cranstor, P. S. (1994), An outline of Entomology.
5. Klowden, M. J. (2003) Physiological systems in insects. Academic Press New York.
6. Lockwood, A. P. M. (1969), Aspects of Physiology of Crustacea.
7. M. Parkah (2008). Insect Physiology. Discovery Publishing house Pvt. Ltd.
8. Mani, M.S. (1971), Insects. New Delhi, National Book Trust.
9. McGavin, G.C. (2001) Essential Entomology. An order by order introduction . Oxford University Press U.K.
10. Nation, J.L. (2002) Insect Physiology and Biochemistry CRC-Press, BocaRaton, London.
11. Patton R. L. (1963), Introduction to Insect Physiology. B.B. Saunders, London.
12. Rockstein, M. (ed). (1974), The Physiology of Insects (Vol. I– VI) Academic Press.
13. Rockstein, M. (ed) (1978), Biochemistry of Insects, Academic Press .
14. Saxena, A. B. (1996) Hormones of Insects. Anmol Publications, New Delhi.
15. Wigglesworth, V. P. (1972), The principles of Insect Physiology. Chapman and Hall, London.
16. Yadav, M. (2003) Physiology of Insects, Discovery Publishing House, New Delhi.
17. Snodgrass, R. E. (1935), Principals of insect Morphology, McGraw Hill, New York, 676pp.

COURSE OUTCOMES

S. No.	On completing the course, the students will be able to:
CO-1.	Understand the different aspects of insects
CO-2.	Have a better understanding of classification, morphology and physiology of insects.
CO-3.	Have an insight on the sensory systems and their functions
CO-4.	Understand the physiological aspects of various developmental stages of insects
CO-5.	Have a comprehensive knowledge about the insect–pest management using different strategies.

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-505
COURSE TITLE: PARASITOLOGY

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	To enable the students to understand the basic concepts in parasitology
2	To acquaint students with the different types of host parasite interactions, immune response generated during parasitic infections, ecological adaptations and transmission of the parasites.
3	To introduce the students to various pathogens causing diseases
4	To study the reactions of the body against disease causing pathogen.
5	It will enable the students to understand the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.
6	To learn about the prevention and control of various parasitic diseases
7	To study the ecology of parasites

UNIT-I

- **Introduction to Parasitology:**
 - Definitions: Phoresis, Commensalism, Parasitism, Mutualism, Hyperparasitism.
 - Classification of parasites and host
- **Ecology of parasites (in brief):** Habitats and environment of parasite.
- **Nutritional requirements and digestion**
- **Respiration**

UNIT-II

Systematics position, geographical distribution, habitat, morphology, life cycle and mode of action of:

- **Parasitic Protozoans**
 - *Entamoeba histolytica*
 - *Trypanosoma*
 - *Leishmania*
 - *Giardia lamblia*
- **Parasitic Platyhelminthes:**
 - *Taenia solium*

- *Fasciola hepatica*
- *Schistosoma spp.*

UNIT-III

Systematics position, geographical distribution, habitat, morphology, life cycle and mode of action of:

- **Parasitic Animal Nematodes:**
 - *Ascaris lumbricoides*
 - *Trichinella spiralis*
 - *Enterobius vermicularis*
 - *Wuchereria bancrofti*
- **Parasitic Plant Nematodes:**
 - *Meloidogyne incognita*
- **Myiasis (brief introduction) and Its types**
 - *Chrysomya bezziana*
 - *Calliphora erythrocephala*

UNIT-IV

- **Host parasite interaction**
 - Establishment of infection: Active and Passive entry, site selection in their host, entry into specific organs and cells.
 - Parasite induced modifications of the host: Effect on behavior, growth, parasitic castration
- **Immunity to Parasites:** Brief account of immunity to Malaria, Leishmaniasis, Trypanosomiasis, Schistosomiasis and Ascariasis.

SUGGESTED READINGS

1. Arora, D.R. and Arora, B.B. (2014). Medical Parasitology 4th Ed. CBS. Publishers & Distributors. New Delhi.
2. Bogitsh, B.J. & Cheng, T.C. (1979) Human Parasitology. Academic Press, London, ISBN:0-12-110870-8.
3. Chandler A.C. and Read, C.P. (1961) Introduction to Parasitology, John Wiley, London.
4. Chappell, L.H. (1979) Physiology of Parasites, Blackie, Glasgow & London.
5. Chatterjee, K. D. (2009) Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd. ISBN: 8123918100.
6. Cheng, T.C. (1986) General Parasitology. Second Edition, Academic Press, London. ISBN 0-12-170755-5.
7. Gunn, A. and Pitt, J.S. (2012) Parasitology: An Integrated Approach. Wiley-Blackwell. ISBN: 978-0-470-68423-8.
8. James, M.T. and Harwood, .F. (1969) Herins's Medical Entomology. 6th edition, Collier Macmillan Canada Ltd., Don Mills, Qutario.
9. Kumar, R.S. (2013). Simplified Course on Parasitology & Immunology. New Central Book Agency (P) Ltd. London.
10. Loker, ES. And Hofkinb, B.V. (2015). Parasitology- A comprehensive Approach. Garland Science New York
11. Mehlhorn, H. (1988) Parasitology in Focus. Springer-Verlag Berlin Heidelberg New York. ISBN: 3-540-17838-4.
12. Nagoba, B.S. and Pichare, A. (2012). Medical Parasitology 2nd Ed. Elsevier A Division of Reed Pvt. Ltd. India.
13. Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. V Edition, Lea &Febiger. ISBN: 0812111559.
14. Raymand, C. (1963). An illustrated Laboratory Manual of Parasitology
15. Allied Pacific Private Ltd. Bombay. India.

16. Smyth, J.D. (1994) Animal Parasitology. Third Edition, Cambridge University Press. ISBN: 0-521-56696-7.
17. Trager, W. (1986). Living together: The Biology of Animal Parasitism. Plenum Press, New York and London. ISBN: 0-306-42310-3. Wilson, R.A. (1967). An Introduction to Parasitology. Edward Arnold. Ltd. London

COURSE OUTCOMES

S. No.	On completing the course, the students will be able to:
CO-1.	Understand of the basic concepts in parasitology
CO-2.	Students will be acquainted with the different types of host parasite interactions, immune response generated during parasitic infections and transmission of the parasites.
CO-3.	Understand the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.
CO-4.	Learn about the prevention and control of various parasitic diseases

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-506

COURSE TITLE: COMPUTER FUNDAMENTALS & DATA PROCESSING

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 36

Total Credits: 2+1 hr.

Practical: 20

L T P

Internal Assessment: 19

2 0 1

Periods per week: 3+3

Examination Time: 3 hrs.

Instructions to the Paper setters:

- 1. Medium of Examination is English Language.**
- 2. The question paper will be divided into two sections.**

Section A: (Total weightage 8 marks). This section will have 12 compulsory very short answer questions of which 8 are to be attempted (1 marks each) Questions should cover the entire syllabus.

Section B: (Total weightage 28 marks). This section will have 8 questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 7 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

Enable the student to

1.	Get familiarize with components of computer.
2.	To be proficient in office automation applications
3.	Handle the word processing software.
4.	Understand that in In Today's commercial world, automation helps the users with a sophisticated set of commands to format, edit, and print text documents.
5.	Use tools in the creation of applications such as newsletters, brochures, charts, presentation, documents, drawings and graphic images.

Unit-I

- MS-Word-2010:** Overview of word processing software, creating, saving and opening a new file in MS-Word, various formatting tools, paragraphs and sections, indents and outdents, lists and numbering, types of lists, Headings, styles, fonts and font size. Editing, positioning and viewing texts, Finding and replacing text, inserting page breaks, page numbers, book marks, symbols and dates, Inserting header, footer, mail merge

Unit-II

- MS-Excel-2010:** Worksheet: Introduction to worksheet, worksheet basics, building a worksheet, moving within worksheet, entering data into worksheet, saving & quitting worksheet, opening and moving around in an existing worksheet
- Working with Formulae:** cell referencing, use of formulae, auto sum, copying formulae, absolute & relative addressing, working with ranges- creating, editing and selecting ranges
- Previewing & Printing Worksheet:** page setting, print titles, adjusting margins, page break, headers and footers.

Unit-III

- Graphs and Charts:** using wizards, various charts type, formatting grid lines & legends, previewing & printing charts.

- **Data processing using excel:** Pivot table, use multiple pivot tables and pivot charts to create dashboard, connect multiple slicers to the pivot tables, filter the data shown in the pivot, using formulas in pivot tables.

Unit-IV

- **MS-Power Point 2010:** Introduction to MS Power Point, presentation overview, power point elements, exploring power point menu, entering information, presentation creation. Opening and saving presentation, slide view, slide sorter view, notes view, outline view, printing slides, formatting and enhancing text formatting.

PRACTICALS:

- 1) Anatomy of MS Word
- 2) Different methods of Creating Table in MS Word
- 3) Introduction to Page Formatting
- 4) Printing in MS Word
- 5) Mail Merge
- 6) Page Layout
- 7) Creating Slide Presentation in MS PowerPoint
- 8) Viewing the Slideshow
- 9) Adding Images in MS PowerPoint
- 10) Inserting Sound and Videos in MS PowerPoint
- 11) Introduction to MS Workbook
- 12) Creating different worksheets in MS Excel
- 13) Inserting Charts in MS Excel
- 14) Introduction to various functions in MS Excel

Books Prescribed:

1. Sinha, P.K. (2004). Computer Fundamentals. BPB Publications, New Delhi.
2. Peter Norton's (1998). Introduction to computers, Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Anshuman Sharma (Fifth edition 2016). A Book of Fundamentals of Information Technology, Lakhanpal Publishers.

COURSE OUTCOMES

CO-1	Understand the components of window screen
CO-2	Use word processors, spreadsheets, presentation software.
CO-3	Describe the features and functions of the categories of application software
CO-4	Understand the dynamics of an office environment.

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-551

COURSE TITLE: PRACTICAL-I (Based on ZooC-501)

Total Hours/wk.: 2 hr.

Maximum Marks: 25

Total Hours: 30

Theory: 19

Total Credits: 1 hr.

Internal Assessment: 06

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Periods per week: 3

Examination Time: 3 hrs.

Course Objectives

1	Paper will teach anatomy of digestive, respiratory, excretory and circulatory systems in different animals
2	Students will learn structural differences among invertebrates and vertebrates
3	Provide an understanding of different organs and their histological characteristics
4	Students will learn comparative systems like respiratory, reproductive and cardiovascular systems
5	Students will have a better understanding of internal systems and their functions

1. Study of permanent slides

- **Mouth parts:** honey bee, housefly, cockroach, butterfly, mosquito, and bug
- Salivary glands
- Blood of animals
- Radula of Pila and jaws of Leech
- **Histology** of ovary, oviduct, uterus, testis and placenta in different groups of invertebrates and vertebrates.

2. Digestive system: Anatomy of gut in relation to food and feeding habits of detritivores, carnivores, herbivores, omnivores and sanguivores.

3. Circulatory system: Different kinds of Heart and blood vascular system in animals.

4. Respiratory structures: Gills (Crustaceans, Bivalves, Cephalopods, and Fish); Book Lungs (Scorpion); Trachea and spiracles (Cockroach).

5. Excretory system:

- Nephridia in annelids (Earthworm),
- Green glands in crustaceans,
- Malpighian tubules in Cockroach.
- Excretory systems of frog, lizard, bird and rat.

6. Reproductive organs in:

- Hydra, Flatworm, Earthworm, Cockroach, Pila, Fish, Frog, Lizard, Bird and Rat.

*Minor changes in practical syllabus can be done as per the availability of materials.

*Use slides/charts/models/videos for experiments 2 to 6.

*Dissections should strictly be done in accordance with the UGC guidelines and after getting approved from the Dissection monitoring committee of the respective institution.

Course Outcomes

CO-1.	Understand various systems like digestive, nervous and muscular system
CO-2.	Compare and contrast the systems of invertebrates and vertebrates
CO-3.	Have an insight on the internal systems and their functions
CO-4.	Have a better understanding about histological characteristics of different organs
CO-5.	Understand comparative systems like respiratory and cardiovascular systems

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-552

COURSE TITLE: Practical-II (Based on ZooC-502 & ZooC-503)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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0 0 2

Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	Preparation of acid-base solutions, buffers, standards and reagents
2	Isolate and estimate biochemical from biological source by suitable method
3	To perform experiments related to microtomy techniques
4	Perform various cytochemical techniques: carbohydrates, nucleic acids, proteins, lipids and enzymes
5	Students will study various tissues using permanent slides & cell organelles through electron micrographs

Practical based on ZooC-502

1. Quantitative analysis of proteins by Lowry/ Bradford method.
2. Quantitative analysis of Lipids from plant seeds.
3. Determination of acid value of a fat.
4. Determination of iodine number of a fat.
5. Determination of saponification value of a fat.
6. Estimation of Carbohydrates from blood and urine.
7. Preparation of buffer solutions and estimation of their pH.
8. Preparation of Titration curve of weak acids and strong base & calculations of pKa value.
9. Study of absorption spectra of coloured solutions.
10. Estimation of enzyme activity and the effect of temperature and pH on their activity.

Practical based on ZooC-503

1. Microscopy:

- a. Principles of compound, phase contrast and electron microscope.
- b. Use and care of Light compound microscope.
- c. Lens aberrations

2. Study of Cells:

- a. Prokaryote cells: *Lactobacillus*, *E. coli*. Blue green algae (preparation of temporary mount).
- b. Eukaryote cells: Testicular material for studies of spermatogenesis (using permanent slides).

3. Microtomy:

- a. Introduction of the instrument– its use and care.
- b. Preparation of permanent slides: Principles and procedures– Section cutting of tissues and staining of tissues with Haematoxylin/Eosin method.

4. Study of permanent slides of various tissues (gut region, liver, lung, spleen, kidney, pancreas, testis, ovary, tongue, skin etc.).

- 5. Study of electron micrographs of various cell organelles-** Plasma membrane, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum (smooth and granular), Cilia, Centriole, inclusion bodies like glycogen, lipids etc.

*Minor changes in practical syllabus can be there as per the availability of materials. As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014), the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

COURSE OUTCOMES

CO-1.	Students can get hand on training about biochemical reaction taking place inside the cell
CO-2.	Quantitative and qualitative analysis of proteins, carbohydrate, fats etc.
CO-3.	Students have scope in pharmaceutical and research laboratories
CO-4.	Prepare acid and base solutions of desired strength
CO-5.	Get familiarized with basic principle and working of compound, phase contrast and electron microscope
CO-6	Develop understanding about the use and care of Light compound microscope and Lens aberrations.
CO-7	Study different cell types including prokaryote cells: Lactobacillus, E. coli. Blue green algae and Eukaryote cells: Testicular material (for studies of spermatogenesis).
CO-8	Get demonstrations regarding microtomy: Introduction of the instrument - its use and care along with the preparation of permanent slides: Principles and procedures - Section cutting of tissues and staining of tissues with Hematoxylin/Eosin method.
CO-9	Study various tissues (gut region, liver, lung, spleen, kidney, pancreas, testis, ovary, tongue, skin etc.) through permanent slides & cell organelles through electron micrographs.
CO-10	Perform various cytochemical techniques: carbohydrates, nucleic acids, proteins, lipids and enzymes.

M.Sc. Zoology Semester-I
COURSE CODE: ZooC-553

COURSE TITLE: Practical III (Based on ZooC-504 & ZooC-505)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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0 0 2

Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	To understand the methods of insect collection and preservation
2	To acquaint students with the different characters of insect orders with examples
3	To introduce the students to various structure and function of insect systems
4	To study various methods of controlling the insect pests and related appliances used
5	To enable the students to understand the basic concepts in parasitology
6	To acquaint students with the different types of host parasite interactions, immune response generated during parasitic infections and transmission of the parasites.
7	To enable students to understand the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.
8	To learn about the prevention and control of various parasitic diseases

Practical related to ZooC-504

1. Methods of collection and preservation of insects.
2. Types of insect antennae, mouthparts and legs.
3. Wing venation, types of wings and wing coupling apparatus.
4. Types of insect larvae and pupae.
5. Dissection of digestive system in insects (Grasshopper).
6. Dissection of male and female reproductive systems in insects (Grasshopper).
7. Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera.
8. Insecticides and their formulations.
9. Types of Insecticide sprayers and their maintenance.

Practical related to ZooC-505

1. To study the protozoans and helminth parasites infecting frogs, toads and common household insects through slides/charts.
2. To study the helminth parasites infecting the gut of the sheep and goat obtained from the slaughter house.
3. To study the parasites from permanent stained blood smears - *Leishmania*, *Plasmodium* and *Trypanosoma*.
4. To study the vectors of different parasitic infections (Mosquito, ticks, sand fly etc.).
5. Identification of cyst of human intestinal parasites through slide/ photograph.
6. Identification of helminth egg in stool of man through slide/ photograph
7. Isolation of nematodes from soil
8. Isolation of parasitic nematodes from plants.

COURSE OUTCOMES

CO-1.	Understand the different aspects of insects
CO-2.	Have a better understanding of classification, morphology and physiology of insects.
CO-3.	Have an insight on the sensory systems and their functions
CO-4.	Understand the physiological aspects of various developmental stages of insects
CO-5.	Have a comprehensive knowledge about the insect-pest management using different strategies.
CO-6	Understanding of the basic concepts in parasitology
CO-7	Students will be acquainted with the different types of host parasite interactions, immune response generated during parasitic infections and transmission of the parasites.
CO-8	Understanding the different vectors involved in transmission of parasitic diseases and various aspects involved in their diagnosis.
CO-9	Learning about the prevention and control of various parasitic diseases

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-601

COURSE TITLE: FUNCTIONAL ORGANIZATION OF ANIMALS- II

Total Hours/wk.: 4 hr.

Maximum Marks: 100

Total Hours: 60

Theory: 75

Total Credits: 4 hr.

Internal Assessment: 25

L T P

3 1 0

Periods per week: 6

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2.5 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answer should not exceed 5 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This topic will provide a thorough knowledge about the evolution of invertebrates and vertebrates
2	Provides a better knowledge of human body and its systems
3	Understand the various anatomical aspects of different animals
4	Students will learn physiological aspects regarding various organ systems
5	Students will learn an insight of the internal systems and their functions

Unit - I

• **Integumentary and muscular system**

- General features and functions of integument
- Evolution of skin among different vertebrates
- Specializations of integument
- Classification of muscles
- Organization of skeletal muscles and mechanism of muscle contraction
- Muscle mechanics: Muscle fibres, Muscle organ, Muscle Tension Length Curves, Bone-muscle lever systems

Unit-II

• **Skeletal System**

- Exo- and endoskeleton among Invertebrates
- Basic components of appendicular skeleton among vertebrates
- Evolution of appendicular system among vertebrates
- Form and Function (Swimming, Terrestrial and Aerial locomotion), Gaits

Unit – III

• **Endocrine and neuroendocrine systems**

- Structure and functions of endocrine organs (special reference to pituitary, thyroid and pancreas)
- Neurohumours and neurosecretions
- Neuroendocrine regulations of body functions among non-chordates
- Nerve nets
- Giant fibre systems
- Evolution of functional anatomy of brain among vertebrates

Unit-IV

• **Sensory System**

- General sensory organs and mechanism of perceiving stimulus
- Free and encapsulated sensory receptors
- Morphology and physiology of a typical human eye and ear
- Proprioceptors, chemoreceptors, radiation receptors, mechanoreceptors and electroreceptors

Suggested Reading Material:

1. Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
2. Brusca, R. C. and Brusca, G. J. (2003), Invertebrates Second Edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
3. Cooper, G. M. (2004), The Cell: A Molecular Approach, IIIrd edition, ASM Press, Washington, D.C.
4. Engemann, J. G. and Hegner, R. W. (1981), Invertebrate Zoology (3rd ed.) Macmillan, New York.
5. Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
6. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal Physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusetts, USA.
7. Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
8. Karp, G.(2005), Cell and Molecular Biology; Concepts and Experiments (4th ed.), Hoboken, John Willy and Sons, New York.
9. Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
10. Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books Seller & Publishers, Agra.
11. Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
12. Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ., Philadelphia.
13. Willmer, P., Stone, G. and Johnston, I (2000). Environmental Physiology of Animals, Blackwell Science.
14. Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.

COURSE OUTCOMES

S. No.	Course Outcomes
CO-1.	Have an insight of the internal systems and their functions
CO-2.	Have a better understanding of our body
CO-3.	Understand various anatomical aspects of different animals
CO-4.	Understand the physiological aspects of various organ systems
CO-5.	Have knowledge about the evolution among different invertebrates and vertebrates
CO-6.	Have an insight on the internal systems and their functions

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-602

COURSE TITLE: METABOLIC REGULATION OF CELL

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

L T P

2 1 0

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

Course Objectives

1	Understand the fundamental chemical principles that govern complex biological systems.
2	To perform, analyze & report an experiments and observations in physiology and biochemistry
3	To appreciate the chemical foundation of life processes. To understand the structure and metabolism of biologically significant molecules
4	Biochemical understanding through scientific enquiry into the nature of mechanical, physical, and biochemical functions of humans, their organs, and the cells of which they are composed

Unit – I

• **Bioenergetics and metabolism**

- Brief introduction to bioenergetics and laws of thermodynamics
- Glycolysis: Fates of pyruvate under aerobic and anaerobic conditions, Regulation of glycolysis
- Pentose phosphate pathway (HMP shunt)
- Glycogenesis
- Gluconeogenesis

Unit – II

• **Bioenergetics and metabolism (Contd.)**

- Citric acid cycle and its Regulation
- **Oxidative phosphorylation:** Electron transport chain in mitochondria, Shuttle system in mitochondria, Regulation of oxidative phosphorylation
- Glyoxalate Cycle

Unit – III

• **Generation and storage of metabolic energy-**

- β oxidation of fatty acids
- Biosynthesis of saturated fatty acids

• **General reactions and metabolism of amino acids**

- Pathways of amino acid degradation
- Nitrogen excretion and the urea cycle
- Formation and oxidation of ketone bodies

Unit – IV

• **Nucleic Acid Structure:**

- Watson and Crick model of double DNA helix
- Structure of Nitrogenous bases: Purine and Pyrimidine
- Synthesis of Nucleotides (de Novo and Salvage Pathways)
- Chemical Synthesis of Oligo-Nucleotides

Suggested Reading Material:

1. Conn, E.E., Stump. P.K. Bruening, S. and Doi R.H. (1987) Outlines of Biochemistry 5th edition John Wiley and Sons Inc., New York.
2. Fischer, J. and Arriold, J.R.P. (2001). Instant notes in Chemistry for Biologists Viva Books Pvt. Ltd.
3. Harper, H.A. (2000): Harper's Biochemistry 25th ed.
4. Holde, K.E.V., Johnson, W.C. and Shing, P. (1998). Principles of Physical Biochemistry Prentice Hall, Inc., USA.
5. Lehninger, A (2000). Principles of Biochemistry. 3rd Edition. Kalyani Publishers.
6. Lehninger A.D. Nelson D.L. & Cox M.M. (1993) & (2000), Principles of Biochemistry, 2nd and 3rd ed. Worth Publishers, New York.
7. Morris, H. Best, L.R., Pattison, S., Arerna, S. (2001). Introduction to General Organic Biochemistry. 7th Ed. Wadsworth Group. Rawn, J.D. (1989). Biochemistry, Niel Patterson Publication U.S.A. North Carolina
8. Sheehon, D (2000). Physical Biochemistry: Principles and Applications – John Wiley & Sons Ltd., England.
9. Stryer, L. (1988). Biochemistry, 3rd edition San Francisco W.H. Freeman

COURSE OUTCOMES

CO-1	The scope of biochemistry is applied in medicine, nutrition and agriculture
CO-2	Students investigate the causes and cure of diseases and effect of nutritional deficiencies
CO-3	Students have scope of career in research laboratories
CO-4	Biochemistry also cover genes, their inheritance and expression

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-603
COURSE TITLE: MOLECULAR CELL BIOLOGY

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

L T P

2 1 0

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper is aimed to introduce molecular aspects of cell as a basic unit of life.
2	Provides knowledge about cell properties like cell-cell interactions and cell-matrix adhesion.
3	Explain the cell cycle and its regulation, including the Various cell cycle check points
4	Discuss the mechanisms of cell to cell signaling, including intracellular second-messenger pathways
5	Demonstrate an understanding of molecular pathways that are altered in cancers, including oncogenes, tumor suppressors, and angiogenesis.
6	Provide knowledge about cell cycle and its regulation.
7	Familiarize the students about programmed cell death and biology of ageing.

Unit-I

• **Cell-Cell adhesion and communication**

- Ca^{++} dependent homophillic cell-cell adhesion
- Ca^{++} independent homophillic cell-cell adhesion
- Gap junctions and connexins

• **Cell matrix adhesion**

- Overview of Extracellular Interactions
- Components of the Extracellular Matrix
- Collagen, Proteoglycans, Fibronectin, Laminin, Integrins, Non-collagen components

Unit – II

• **Cell Signalling and Signal Transduction:**

- The Basic Elements of Cell Signalling Systems
- Extracellular Messengers and Their Receptors
- Signal Transduction by G Protein-Coupled Receptors
- Second Messengers: The Discovery of Cyclic AMP
- Phosphatidylinositol-Derived Second Messengers, Phospholipase C

Unit – III

- **Cell cycle**
 - Various cell cycle check points
 - Cyclin and cyclin dependent kinases
 - Regulation of CDK–cyclin activity
- **Apoptosis (Programmed Cell Death)**
 - The Extrinsic and Intrinsic Pathway
 - Necroptosis, Signalling Cell Survival

Unit – IV

- **Cancer: A Genetic Disorder**
 - An Overview of Tumor-Suppressor Genes and Oncogenes
 - Oncogenes That Encode Growth Factors or Their Receptors
 - Oncogenes That Encode Cytoplasmic Protein Kinases
 - Oncogenes That Encode Transcription Factors
- **Biology of ageing**
 - Theories of ageing
 - Cellular senescence and telomerase
 - Premature aging syndromes

Suggested Reading Material:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, M. & Walter, P. (2002), Molecular Biology of the Cell, 4th Edition Garland Science, New York.
2. Becker, W. M., Kleinsmith, L. J. & Hardin, J. (2000), The World of the Cell, B. C. Pub. Co., San Francisco.
3. Cooper, G. M. (2004), The Cell: A Molecular Approach IIIrd edition, ASM Press, Washington, D.C.
4. DeRobertis, M. D. & DeRobertis, M.D. (Jr.) (1995), Cell and Molecular Biology (8th ed.), B.I. Waverly Pvt. Ltd., New Delhi.
5. Karp, G.(2005), Cell and Molecular Biology; concepts and experiments (4th ed.), Hoboken, John Willy and Sons, New York.
6. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL & Darnell J. (2004), Molecular Cell Biology 5th Edition W. H. Freeman & Co. New York.
7. Pollard, T. D. & Earnshaw, W. C. (2000), Cell Biology, Saunders, U.S.A.
8. Sadava, D. E. (1993), Cell Biology Organelle Structure and Functions. H. Jones & Bartlett-Boston.

COURSE OUTCOMES

CO-1	Understand the cell properties like cell-cell interactions including Ca ⁺⁺ dependent and Ca ⁺⁺ independent homophilic interactions.
CO-2	Able to study the mechanisms of cell to cell signalling, including intracellular second-messenger pathways
CO-3	Understand about the cell cycle and its regulation and various cell cycle check points
CO-4	Familiarized about the pathways and mechanism of programmed cell death.
CO-5	Demonstrate an understanding of molecular pathways that are altered in cancers, including oncogenes, tumor suppressors, and angiogenesis.
CO-6	Develop the basic understanding about biology of ageing including various theories and premature ageing syndromes

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-604
COURSE TITLE: BIOSYSTEMATICS

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Course aims to introduce the students for the salient features of Taxonomy and the methodologies used in systematic
2	To understand the evidence that living species share descent from common ancestry and how this fact explain the traits of living species
3	To provide understanding of fundamental principles of systematics and how to classify animals according to their characters & the classification theories
4	Acquire a thorough knowledge of principles and practices of biosystematics
5	International rules of nomenclature and classification is studied

Unit-I

- **Introduction**
 - Terms / Definitions
 - History/Development of theories / kinds of classifications.
 - Importance of Biosystematics
- **Material basis of Biosystematics**
 - Different attributes or evidences
 - Character kinds
 - Character weighing
- **New aspects of Biosystematics**
 - Cytotaxonomy
 - Chemotaxonomy
 - Molecular taxonomy
 - Eco taxonomy
 - Behavioural taxonomy

Unit-II

- **Taxonomic Procedures**
 - Taxonomic collections
 - Preservation
 - Identification
 - Taxonomic keys (Different kind, salient features, merits and demerits)
- International Code of Zoological Nomenclature

- Nomenclature Principles, important rules, their interpretation and application in the scientific nomenclature.

Unit –III

- **Taxonomic Publications**
 - The Scientific publications
 - Systematic publications
 - Contents of publications
- **Taxonomic Hierarchy**
 - Species category and various concepts of species; Subspecies and other sub specific categories; Decision at species and sub species level
 - Hierarchy of categories- Lower and higher categories

Unit-IV

- History of Kingdom systems
- Resume of Whittaker’s system and other recent systems of classification
- An outline of classification of kingdom Animalia
- Salient features of minor phyla.

Suggested Reading Material:

1. Jaffery, C. (1973), Biological Nomenclature, Edward Arnold.
2. Kapoor, V.C. (1987), Theory and Practice of Animal Taxonomy, IPH Pb. New Delhi.
3. Kitching, I.J., Forey, P.L. Humpheries, C.J. & William, D. 1998. Cladistics: Theory and Practice of Parsimony Analysis, Oxford University Press.
4. Mayer, E. (1969), Principle of Systematic Zoology, McGraw Hill Book Co. London.
5. Mayer, E. & Aschhok (1991), Principles of Systematics, McGraw Hill Book Co. London.
6. Minell, A. (1993), Biological Systematics, The State of Art. Chapman & Hall, London.
7. Quicke, D.L.J, (1996), Principles & Techniques of Contemporary Taxonomy, BlackyAcademic & Professional, London, New York, Madras.
8. Sebh, Randall T. 2000, Biological Systematics: Principles & Applications Cornell University Press 256 pp.
9. Winston, J. 1999. Describing Species Practical Taxonomic Procedure of Biologists. Columbia University Press, Lincoln, R.J. Dictionary of Ecology, Evolution and Systematics.

COURSE OUTCOMES

CO-1	Illustrate the methodologies used in systematic
CO-2	Understand various theories relevant to biosystematics
CO-3	Acquire a thorough knowledge of principles and practices of biosystematics
CO-4	Knowledge of the diversity and inter-relationships of animals
CO-5	Develop a holistic appreciation on the phylogeny and adaptations in animals.
CO-6	Understand the importance of taxonomic keys and taxonomic character identification
CO-7	Acquire the skills of nomenclature of species and subspecies.
CO-8	Apply the International rules of Nomenclature for scientific naming of newly found animals
CO-9	Understand the gradual development and evolutionary history of different kinds of living organisms from earlier forms over several generations
CO-10	Differentiate between species, subspecies, sibling species, race and deme
CO-11	Justify the inclusion of a given organism in a given taxon

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-605
COURSE TITLE: ANIMAL ECOLOGY

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper introduce students to population ecology & environmental physiology
2	Imparts knowledge about various sampling techniques
3	Provides knowledge about biotic & abiotic world, habits & habitat and various adaptations for living in different environments
4	Students will learn about various protective mechanisms
5	Students will gain knowledge about various ecological interactions

Unit – I

- **Ecology: Definition and History**
 - Ecosystem: Structure and Functions
 - Types of ecosystems: Terrestrial (Grasslands, forests, deserts) and aquatic (Freshwater, marine, estuarine).
 - Energy flow and mineral cycles
 - Ecosystem energy budgets (Ecological efficiencies)
- **Weather**
 - Temperature, Moisture, Light, fire,
 - Environmental pollution: Air, water, soil, noise, radioactive.

Unit – II

- **Analysis of Environment**
 - Biotic and Abiotic Resources
 - Food, its distribution, relative and absolute shortages
 - Habitat
- **Community Structure:** Food chains, Food webs, biomagnification, Eutrophication
 - Ecological Niche: Concept of habitat and niche,
 - Ecological Succession
- **Types of interactions**
 - **Antagonism and Symbiosis**
 - Competition, Predation, Parasitism, Ammensalism, Protocooperation, Commensalism, Mutualism etc.

Unit- III

- **Adaptations**
 - Cave, deep sea, arboreal, aerial, and sub terrestrial.
 - Co-adaptations and adaptive resemblances (mimicry, warning colouration, seasonal polymorphism)
- **Population Ecology**
 - Characteristics of Population
 - Biotic potential and carrying capacity, dispersal and distribution, population growth and its regulations.
 - Life history strategies
- **Methods of sampling**
 - Life tables and longevity
 - Migration

Unit – IV

- **Applied Ecology**
 - Anthropogenic interferences
 - Bio monitoring of environment using animal species
 - Introduction of modelling and use of remote sensing (GIS) in ecology
 - Brief introduction of ecological basis of pest regulation
- **Bio Geography**
 - Bio Geographical zones (realms)
 - Island ecology (endemicity)

Suggested Reading Material:

1. Anderwartha, H.G. and Birch, L. C. (1970), The distribution and abundance of animals, University of Chicago Press, Chicago London.
2. Beeby, A. (1992), Applying Ecology Chapman and Hall Madras.
3. Begon, M., Harper J. L. and Townsend, C. R. (1995), Ecology – Individuals, populations and communities, Blackwell Science, Cambridge UK.
4. Brewer, R. (1994), The science of Ecology, Saunders College of Publishing, New York.
5. Chapman, J. L. and Resis, M. J. (1995), Ecology- Principles and applications, Cambridge University Press, Cambridge UK.
6. Kaeighs, S. C. (1974), Ecology with special references to animal and Man, Prentice Hall Inc.
7. Odum, E. P. (1983), Basic Ecology.
8. Putmann, R. J. and Wratten, S. D. (1984), Principles of Ecology, Crown Helm, London.
9. Salanki, J., Jeffery E. and Hughes G. M. (1994), Biological Monitoring of the Environment (A manual of Methods) CAB International, Wallingford UK.

COURSE OUTCOMES

CO-1	Student will learn about the relationship between biotic & abiotic world.
CO-2	Student will be able to learn about different habits and habitat of animal & plants
CO-3	Students will be able to learn about adaptations for different environments.
CO-4	Students will be able to gain knowledge about coloration, crypsis, mimicry and protection from predators.
CO-5	Students will gain knowledge about air, water and land pollution.

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-606
COURSE TITLE: BIOSTATISTICS

Total Hours/wk.: 2 hr.

Total Hours: 30

Total Credits: 2 hr.

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Maximum Marks: 50

Theory: 37

Internal Assessment: 13

Periods per week: 3

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 09 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (1.5 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 28 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 07 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

NOTE: 1. Non-programmable scientific calculator is allowed.

2. Normal Distribution table should be provided to the students.

COURSE OBJECTIVES:

1.	To help the students to solve Statistical problems using various measure of central tendency
2.	To enable the students to collect the data and present it diagrammatically
3.	To establish linear association between two variables by using Correlation.
4.	To help the students to use regression to predict the behavior of dependent variable.
5.	To use of chi square, t, F and z tests to solve problems related to different types of data.

UNIT-I

Statistical Methods- Collection of data, Frequency distribution and, Measures of Central Tendency, Dispersion.

Correlation and Regression- Relationship between variables, Covariance, Karl-Pearson's Correlation Coefficient, Spearman's rank Correlation Coefficient, Least square technique for regression lines (without proof), Regression Coefficients, Relationship between Correlation analysis and Regression Analysis.

UNIT-II

Probability- Mathematical definition of probability of an event, Use of permutations and combinations in calculations of Probability, Conditional probability, Additive and Multiplication law of Probability, Random Variables and its pmf, pdf, cdf, Mathematical expectation and variances.

Theoretical Distributions: Binomial, Poisson and normal, Properties of these distributions (applications only).

UNIT-III

Hypothesis Testing- Sample, Population, Statistics and Parameters, Null Hypothesis, Level of significance, Definitions of Chi-square, 't' and 'F' variates and their pdfs only, Applications of these distributions in testing of hypothesis.

UNIT-IV

Large sample test- Testing of significance of proportion in single population, Testing of equality of proportions in two populations, Testing of significance of mean in single population, Testing of equality of means in two populations.

Analysis of Variance- Meaning of analysis variance with linear models, Analysis of variance for one-way classified data, Analysis of variance for two-way classified data with one observation for cell.

Suggested Reading Material:

1. Bland, M. (2006). An Introduction to Medical Statistics. Oxford University Press, 3rd ed.
2. Finney, D.J. (1980). Statistics for Biologists. Chapman and Hall Ltd.
3. Hoel, P.G. (1971). Elementary Statistics. John Wiley and Sons, 3rd ed.
4. Ross, S.M. (2005). Introductory Statistics. Academic Press, 2nd ed.
5. Wayne, W, Daniel (1999). Biostatistics: A Foundation for Analysis in Health Sciences. John Wiley and Sons, 7th ed.
6. Woodworth, G. (2004). Biostatistics: A Bayesian Introduction. John Wiley and Sons

COURSE OUTCOMES

CO-1	Student will learn to solve Statistical problems using various measure of central tendency
CO-2	It will enable the students to collect the data and present it diagrammatically
CO-3	Students will learn to establish linear association between two variables by using Correlation
CO-4	Students will use regression to predict the behavior of dependent variable
CO-5	Students will learn to use t, chi square, F and z tests to solve problems related to different types of data.

M.Sc. Zoology Semester-II

COURSE CODE: ZooC-651

COURSE TITLE: PRACTICAL-IV (Based on ZooC-601)

Total Hours/wk.: 2 hr.

Maximum Marks: 25

Total Hours: 30

Theory: 19

Total Credits: 1 hr.

Internal Assessment: 06

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Periods per week: 3

Examination Time: 3 hrs.

Course Objectives

1	Course will provide an understanding of histological characteristics of different organs like skin, muscle fibers and endocrine glands
2	Students will learn to compare and contrast various invertebrate systems
3	Provides an understanding about insect morphology and insect wings
4	Students will gain knowledge about comparative anatomy of nervous system
5	Provides knowledge about comparative antennary and wing modifications of insects

1. Study of permanent slides:

- Skin of fish, frog, lizard, bird and mammal.
- Setae of Earthworm
- Spicules of Sponges and *Herdmania*.
- Internal ear of fish
- Tentorium of Grasshopper
- Muscle fibers, cartilage and bone
- Endocrine glands of vertebrates

2. Appendicular skeleton

3. Appendages of Prawn

4. Wing venation, coupling mechanisms and types of wings in insects

5. Modification of antenna in arthropods

6. Eye muscles of fish/mammal

7. Comparative anatomy of nervous system in Earthworm, Cockroach, Pila, Sepia, Fishes, Bird and Mammal.

*Minor changes in practical syllabus can be done as per the availability of materials.

*Use charts/models/videos/permanent slides for experiment no. 3 to 7.

**Dissections should be done in accordance with the UGC guidelines and after getting approved from the Dissection monitoring committee of the respective institution.

Course Outcomes

CO-1.	Have a better understanding of histological characteristics of different organs
CO-2.	Compare and contrast the systems of invertebrates
CO-3.	Have an understanding of insect morphology and wings
CO-4.	Understand various systems like nervous system
CO-5.	Understand comparative antennary and wing modifications of insects

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-652

COURSE TITLE: Practical-V (Based on ZooC-603 & ZooC-604)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	Separation and identification of various types of WBCs.
2	Understand viability testing of WBCs.
3	Get hands on training of DNA isolation and amplification.
4	Identify cellular abnormalities and their frequency
5	Identify museum specimen/pictures of various phyla
6	Classify animals on the basis of animal inter-relationships
7	Have in-depth knowledge of museology- placement and arrangement of animals depicting their classification and interrelationships. Categorize animals according to the phylogeny.
8	Understand the use of various kinds of keys to identify and classify animals
9	On-hand training of Collection and preservation techniques animal samples using common methods. Compare the methods of collection and preservation of insects
10	Write scientific report of field/institutional visit.

Practical based on ZooC-603

1. Separation of WBCs from human blood.
2. To check the viability of WBCs with trypan blue.
3. Isolation of DNA from human blood.
4. Isolation of DNA from buccal cells.
5. Amplification of DNA using PCR.
6. To study cellular abnormalities and their frequency.
7. To estimate nucleocytoplasmic ratio.
8. Demonstration of Comet assay for estimation of DNA damage.
9. Preparation of permanent slide of Giant chromosomes

Practical based on ZooC-604

1. Types and uses of various kinds of equipment required for collection of animals.
2. Demonstration of various kinds of equipment required for preservation of animals.
3. Various methods of collection and preservation of animals.
 - o Demonstration of various kinds of equipment used
 - o Demonstration through pictures/videos:-

-Alizarine preparation

-Raisin Embedding.

-Wet Mounting

-Dry Mounting

-Taxidermy

4. Methods of animal identification.

5. Kinds of keys and their use at higher and lower category levels:
 - a. Dichotomous keys
 - b. Polyclave keys
6. Classification flowcharts of various animal groups.
7. To study morphological features of various animal groups-
 - a. Arthropods: wing venation of insects
 - b. Pisces: fish scales
 - c. Reptiles: scales of poisonous & non-poisonous snakes; scutes of turtles.
 - d. Aves: beaks & claws
 - e. Mammals: hooves

COURSE OUTCOMES

CO-1	The students will learn methods of separation and identification of various types of WBCs.
CO-2	Will be able to perform viability testing of WBCs using Trypan Blue.
CO-3	Students will get hands on training of DNA isolation and amplification.
CO-4	Will be able to identify cellular abnormalities and their frequency
CO-5	Separation and identification of various types of WBCs.
CO-6	Provides students insight into maintaining healthy relationships with their opposite gender and allows them to make right choice about their life partner thus preventing congenital/consanguineal diseases.
CO-7	Competent enough to collect and preserve animal samples using studied methods.
CO-8	The students will be well equipped to pursue research or teaching fields after completion of this course
CO-9	Can be appointed as curator and archivist in museum for placement and arrangement of animals depicting their classification and interrelationships.
CO-10	Become competent enough to write scientific report

M.Sc. Zoology Semester-II
COURSE CODE: ZooC-653

COURSE TITLE: Practical-VI (Based on ZooC-605)

Total Hours/wk.: 2 hr.

Maximum Marks: 25

Total Hours: 30

Theory: 19

Total Credits: 1 hr.

Internal Assessment: 06

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Periods per week: 3

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	Students will acquire practical knowledge of collection methods for protozoans, nematodes and soil arthropods
2	To perform experiments related to population diversity indices
3	To study interactions between animals.
4	To study competitions between animals.
5	To study physicochemical parameters of water bodies.

Practical based on ZooC-605

1. Population estimations: Using Mark and Release method and to study the effect of migration on them (Using Moong and Mash beans).
 - a. Peterson method
 - b. Schnabel's method
2. Estimation of population:
 - a. Insect population using sweep net method.
 - b. Protozoans
 - c. Nematodes
 - d. Soil arthropods
3. Combined population studies using quadrates.
4. To determine diversity indices (richness, Simpson, Shannon-Wiener).
5. Intrapopulation distribution and Poisson distribution, construction of life table and survivorship curves from given data.
6. To study the biotic components of a pond. Make diagram of a pond ecosystem.
7. To measure physicochemical parameters of different water bodies.
8. To study inter-and intraspecific interactions.
9. To study competition of *Tribolium* species.
10. To study competition of *Paramecium* species.

*Minor changes in practical syllabus can be there as per the availability of materials.

As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014), the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

COURSE OUTCOMES

CO-1.	Estimate the population size of Insect population using sweep net method.
CO-2.	Perform combined population studies using quadrates.
CO-3.	Perform experiments to determine diversity indices/ richness using Simpson, Shannon-Wiener methods.
CO-4.	Study intra-population distribution and Poisson distribution, construction of life table and survivorship curves from given data.

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-701

COURSE TITLE: REPRODUCTIVE BIOLOGY

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	To understand the basic concept of developmental biology.
2	Students will gain knowledge about assisted reproductive technologies like IVF and ET.
3	Introduction about the morphology of sperm & ovum; process of fertilization
4	Outline and study the developmental stages in vertebrates

Unit – I

- **Gametogenesis and Parthenogenesis**
 - Spermatogenesis and spermiogenesis
 - Oogenesis and Vitellogenesis
 - Type of eggs and sperms in animals
 - Natural and artificial parthenogenesis.

Unit – II

- **Fertilization**
 - Egg and sperm interaction, Cell surface molecules in sperm-egg recognition in animals
 - Fertilization and Amphimixis
 - In vitro fertilization and embryo transplantation.

Unit – III

- **Cleavage & Blastulation**
 - Cleavage and its patterns and its relation to mitosis
 - Biochemical changes during cleavage, influence of male and female pronuclei during early development
 - What determines cleavage pattern
 - Blastula formation and its types

Unit – IV

• **Gastrulation & Differentiation**

- Gastrulation and morphogenetic movements
- Morphogenesis of germ layers
- Morphogenetic/ Embryonic field
- Extra-embryonic layers
- Types of placenta and its functions
- Differentiation
- Determination
- Transdetermination

Suggested Readings:-

1. Balinsky, B.I. (1981). An Introduction to Embryology, Saunders, Philadelphia.
2. Bellairs, R. (1971). Development Processes in Higher Vertebrates, University of Miami Press, Miami.
3. Berrill, N.J. (1971): Developmental Biology. McGraw Hill, New Delhi.
4. Browder, L. Developmental Biology, a Comprehensive Synthesis Plenum, New York.
5. Gilbert, F. (1985, 95 & 2000): Developmental Biology, Sinaur.
6. Grant, P. (1978): Biology of Developing System.
7. Karp, G. & Berrill, M.J. (1981): Development. McGraw Hill, New Delhi.
8. Loomis, W.F. (1986) Developmental Biology Macmillan, New York.
9. Miller, W.A. (1997). Developmental Biology Springer Verlag, New York.
10. Oppenheimer, J.M. and Willer, B.H. (1964): Foundation of Experimental Embryology, Prentice-Hall, New Delhi.
11. Pritchard, D.J. (1986): Foundation of Development Genetics, Taylor and Francis, London.
12. Saunders, J.W. (1982): Developmental Biology, Patterns, Principles, Problems, MacMillan, New York.
13. Spratt, N.T. Jn. (1971): Developmental Biology, Wordsworth, Belmont, Co.
14. Waddington CH. (1966): Principles of Development and Differentiation. MacMillan, New York.

COURSE OUTCOMES

CO-1	Learn the concepts of developmental biology, gametogenesis, the process of differentiation of eggs and sperms before fertilization
CO-2	Knowledge of assisted reproductive technologies like IVF and ET
CO-3	Understand the causes of infertility and can take preventive measures
CO-4	Understand the events that led up to and comprise the process of fertilization
CO-5	Know about macro-, meso- and micro-meres which form into specific cells in the embryo

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-702
COURSE TITLE: ANIMAL GENETICS

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Acquire a broad understanding of Genetics including the physical and chemical basis of heredity.
2	Understand genetic information in the DNA & its selective expression as functional protein
3	Understanding of Linkage, Crossing over and Chromosomal mapping, Mutations, Sex determination and sex linked inheritance
4	Acquire understanding of extra nuclear inheritance.
5	Understand the types and classification of mutations & mutagens and their underlying mechanism
5	Study of mechanisms of genetic recombination's in bacteria
6	Study of structure and infection cycles of eukaryotic viruses

Unit I

- **DNA-** The genetic material:
 - DNA: Structure and Properties
 - Packaging DNA into chromosomes
 - Prokaryote nucleoid structure.
 - Chemical composition of eukaryote chromosomes.
 - Euchromatin, Heterochromatin and banding pattern.
 - Repetitive DNA and sequence organization.

Unit II

- **Linkage and Chromosome Mapping**
 - Linkage and its types
 - Chromosome map, map unit,
 - Sex Linkage, Sex Linked Disorders
 - Sex determination
- **Crossing over**
 - Cytological basis of crossing over.
 - Two factors crosses, Three factor crosses and interference.
 - Experimental demonstration of crossing over: *Neurospora crassa* Experiment

Unit III

- **Extranuclear inheritance**

- Criteria for extranuclear inheritance
- DNA and drug resistance.
- Mitochondrial DNA and genetic diseases.
- **Mutations**
 - Introduction and classification of mutation.
 - Molecular basis of mutation.
 - Radiation and chemical induced mutation
 - Correlation between mutagenicity and carcinogenicity.
 - Mutation Frequency.
 - Practical applications of Mutations.

Unit IV

- **Bacterial Genetics**
 - Transformation, transduction and conjugation.
 - F mediated sexduction.
 - Mechanism of recombination in bacteria.
 - Plasmid, Episome, IS elements and Transposons.
- **Genetics of Viruses**
 - Organisation and expression of bacteriophage genomes
 - Structure and infection cycles of viruses of eukaryotes
 - Animal viruses and cancer.

Suggested Reading Material:

1. Snustad, D.P., Simons M.J., and Jenkis, J.B. (1997). Principles of Genetics. John Wiley and Sons, New York.
2. Brown, T. A. (2006) Gene cloning and DNA analysis and introduction (5th Edition), Oxford, Blackwell Publishers.
3. Lodish, H., Berk, A., Matsudaira, P., Kiser, C. A., Kriger, M., Scott, M. P., Zipursky, S.L. and Darnell, J. (2004) Molecular Cell Biology, 5th Edition W.H. Freeman and Company, New York.4.
4. Weaver, R.F. (2005) Molecular Biology,
5. Alberts, B., Johanson, A., Lewis, J. Raff, M., Roberts, M. and Walter, P. (2000) Molecular Biology of the cell, 4th Edition, Garland Science, New York.
6. DeRoberties, M. D. and DeRoberties, M.D. (Jr) (1995) . Cell and Molecular Biology (8th ed.) B.I. Waverly, Pvt. Ltd., ND.
7. Freifelder. D. (1993). Molecular Biology (2nd ed.) Narosa Publishing House, India

COURSE OUTCOMES

CO-1	The students will be able to acquire a broad understanding of Genetics.
CO-2	The students will be able to understand genetic information in the DNA
CO-3	The students will be able to understand Linkage, Crossing over and Chromosomal mapping, Mutations, Sex determination and sex linked inheritance
CO-4	The students will be able to acquire understanding of extra nuclear inheritance and mitochondrial DNA.
CO-5	The students will be able to understand the types and classification of mutations.
CO-6	The students will be able to learn the mechanisms of genetic recombination in bacteria

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-703

COURSE TITLE: APPLIED ZOOLOGY- I (INVERTEBRATES)

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper is aimed to introduce Apiculture, Lac culture, Sericulture, Prawn and Pearl culture
2	Students will teach economically important arthropod species and their significance
3	To understand the knowledge about the cultivation of Mulberry, maintenance of the farm, seed technology, silkworm rearing and silk reeling.
4	Students learn farm management, techniques and hatchery operations of prawn and pearl culture
5	Imparts knowledge about vermiculture and vermicomposting at domestic & commercial level

Unit – I

- **Arthropods (Important Species and their Economic Importance)**
 - Diplopods and Chilopods
 - Arachnids (other than plant pests)
 - Insects (other than insect pests of crops, parasite of man and domestic animals)
 - As pollinators
 - As bioindicators
 - In Biological pest management
 - As source of food (Entomophagy)
 - Venomous insects
- **Apiculture**
 - Honey bee and its kinds, social organization and colony nests
 - Life cycle of *Apis mellifera*
 - Bee keeping methods and precautions
 - Products of bee keeping
 - Honey composition, quality and importance
 - Bee enemies and diseases

Unit – II

- **Lac culture**
 - Lac insects: species, life cycle and host plants
 - Lac composition, properties & importance
 - Cultivation and harvesting of Lac
 - Enemies of Lac insect and its host plants
 - Lac industry in India
- **Sericulture**
 - Silk moth species
 - Life cycle of *Bombyx mori*
 - Silk composition, kinds and uses
 - Rearing, mounting, harvesting, treatment and disposal of cocoons
 - Silk reeling, twisting and weaving
 - Diseases & pests of silkworm
 - Sericulture and Rural Economy

Unit – III

- **Crustaceans**
 - Economic Importance of crabs and lobsters
 - **Prawn Culture**
 - Introduction to prawns and its species
 - Fresh water and Marine Prawn farming
 - Methods of Prawn farming.
 - Spoilage and its prevention.
 - Processing and preservation of prawns.
 - Enemies of Prawn industry
- **Mollusca**
 - **Pearl Culture**
 - Pearl oyster– species
 - Pearl formation, composition, quality and commercial value
 - Artificial culturing of pearls, synthetic pearl types and their manufacturing.
 - Methods of harvesting
 - Problems of pearl industry

Unit – IV

- **Economic Importance of :-**
 - **Protozoans**
 - Important Parasitic species, disease caused prevention and cure.
 - **Annelids**
 - Leeches
 - **Vermiculture-** Species of worms, Conditions for efficient vermiculture at domestic and commercial level
 - **Helminthes**
 - Liver flukes
 - Cestodes/ tapeworms
 - Roundworms (Animal and plant parasitic Nematodes)
 - **Echinoderms**
 - Sea cucumbers
 - Star Fish

Suggested Reading Material

1. Bhamrah, H. S. & Juneja, K. (2001), An Introduction to Mollusca. Anmol Publications Pvt., Ltd. New Delhi.
2. Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm; Vermiculture and Vermicomposting, Kalyani Publishers India.
3. Carter, G. A. (2004) Beekeeping, Biotech Books, New Delhi.
4. Fenemore, P. G. and Prakash, A. (1992), Applied Entomology, Wiley Eastern Ltd. New Delhi.
5. Ghorai, N. (1995), Lac Culture in India. International Books and Periodicals, New Delhi.
6. Jhingran, V. G. (1991) Fish and Fisheries of India, Hindustan Publishing Company India.
7. Kumar, A. and Nigam, P. M. (1989), Economic and Applied Entomology EMKAY Publishing Co. New Delhi.
8. Mishra, R. C. (1995), Honey Bees & their Management in India. ICAR, New Delhi.
9. Mustafa, S. (1990) Applied and Industrial Zoology. Associated Publishing Company, New Delhi.
10. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
11. Sathe, T. V. and Jadhav, A. D. (2001) Sericulture and Pest Management, Daya Publishing House, New Delhi.
12. Shimizu, M. (1972) Handbook of Silkworm Rearing (Agricultural Techniques Manual-1) Fuji Publishing Co. Ltd, Tokyo, Japan.
13. Singh, S. (1962), Bee Keeping in India, I. C. A. R. Publications, New Delhi.
14. Sobti, R. C. (1992), Medical Zoology, Nagin Chand & Co. Jalandhar.
15. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
16. Ullal, S.R. and Narsimhanna, M. N. (1981), A Handbook of Practical Sericulture, Central Silk Board, Bombay.

COURSE OUTCOMES

CO-1	Be familiar with the economically important arthropod species and their significance
CO-2	Develop a knowledge of farming of insects for increasing food production
CO-3	Understand importance of insects as pollinators and bio-control agents
CO-4	Utilize modern methods and economic aspects of apiculture, sericulture and lac culture
CO-5	Identify different species and casts of honeybees and species of silkworm.
CO-6	Analyze harvesting and marketing strategies of prawn and pearl culture
CO-7	Understand the significance of vermicomposting at domestic and commercial level.
CO-8	Identify economically important protozoans, helminthes and echinoderms

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-704
COURSE TITLE: ANIMAL BEHAVIOUR

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	To introduce wide variety of animal behaviors and their neurophysiology
2	Help understand response of animals to different instincts, communication & memory
3	This paper is aimed to teach quantitative Biology, Biodiversity and Wildlife
4	Awareness about the values of wild life, its habitat & management and conservation measures
5	Understand causes of biodiversity depletion, wildlife legislation, its amendments & implementation

Unit - I

- **Study of Behavioural patterns**
 - The Proximate/Ulimate Dichotomy, Approaches to the Study of Behaviour (Ethology, Comparative Psychology, Neurobiology)
- **Behavioural Patterns**
 - **Innate or Stereotyped Behaviour:**
 - Spatial orientation (Kinesis and Taxes), Reflexes, Instinct, Motivation
 - **Acquired Behaviour:**
 - Non-associative learning (Habituation, Sensitization)
 - Associative Learning (Classical Conditioning, Operant learning, Latent learning, Insight Learning, Phase Specific Learning & Memory)

Unit-II

- **Behaviour Ecology**
 - **Habitat Selection**
 - Definition of Habitat Selection, Factors restricting habitat use, territoriality, Dispersal
 - Habitat Choice and reproductive success
 - Determinants of habitat selection
- **Communication**
 - Communication & its types
 - Chemical, Visual, tactile and Audio communication
 - Song Specificity in Birds

Unit – III

- **Food Selection:**
 - Optimality Theory, Foraging Models, Techniques for Acquiring food, Foraging and social behaviour
 - Anti-Predator Behaviour
 - Host- Parasite Relation

- **Social Behaviour**
 - Brief account to Aggregations
 - Flocking in Birds
 - Schooling in Fishes
 - Advantages and disadvantages of living in groups
 - Kin selection, Altruism, Reciprocal altruism, Inclusive fitness
 - Social organization in primates

Unit – IV

- **Reproductive Behaviour**
 - Evolution of Sex and Reproductive strategies
 - Mating Systems
 - Courtship behavior
 - Parental care in animals
 - Sexual selection and Sperm competition
- **Genetic basis of Behaviour**
- **Hormonal Control of Behaviour**

Suggested Reading Material:

1. Alcock, J. (1998), Animal behaviour, An evolutionary approach Sinauer Assoc., Sunderland, Mass, USA.
2. Arora, M. P. (2003), Animal Behaviour, Himalaya Publishing House, Delhi.
3. Dethier, V.G., Stellar E. (1958), Animal Behaviour & Basis, Prentice-Hall of India (private) Ltd. New Delhi.
4. Dugatkin, L.A. (2014), Principles of Animal Behaviour 3rd Ed., W.W.Norton & Company, New York.
5. Drickamer, L. C. and Vessey, S. H. (1986), Animal Behaviour - Concepts, Processes and Methods. (2nd ed.), Wordsworth Publ. Co., California.
6. Huntingford F. (1984), The study of animal Behaviour, Chapman and Hall, London.
7. Manning, A, (2002), An Introduction to Animal Behaviour, Cambridge University Press.
8. Nelson, Randy J. (2000), An Introduction to Behavioural Endocrinology 2nd edi, Sinauar Associates, Inc, Sunderland.
9. Ranga M.M., (1994), Animal Behaviour, Agro Botanical Publishers, India.
10. Shukla J.P., (2010), Fundamental Animal Behaviour, Atlantic Publishers & Distributors (p) ltd.
11. Tinbergen N. (1970), Animal Behaviour, Time-Life International (Neederland) N.V.

COURSE OUTCOMES: the students will be able to

CO-1	Understand different behavioral patterns, communication & memory
CO-2	Analyze genetic, environmental, hormonal and neural controls of animal behaviour
CO-3	Have insight into our various social behaviors in insects and primates
CO-4	Understand on a variety of reproductive behaviors and their evolution

CO-5	Study faunal diversity and learn to implement conservation measures to save diversity
CO-6	Understand importance of wildlife and conservation for protected areas
CO-7	Learn causes of depletion of wildlife & conservation ethics
CO-8	To understand wildlife legislation its amendments and implementation

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-705

COURSE TITLE: WILDLIFE CONSERVATION

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper is aimed to teach Biodiversity and Wildlife
2	Awareness about the values of wild life, its habitat & management and conservation measures
3	Understand causes of biodiversity depletion, wildlife legislation, its amendments & implementation
4	Aware students regarding projects started by government for species conservation

Unit - I

• **Wildlife Studies**

- Wild life as natural resource in India,
- Values of wildlife & biodiversity
- Significance and scope of wildlife conservation
- Distribution of wildlife in India
- Indian wild fauna
- Wildlife byproducts and trade
- Losses and threats to biodiversity
- Wildlife diseases

Unit - II

• **Wildlife Conservation and Management Strategies**

- Need for wildlife conservation and management
- Conservation vs preservation
- **In Situ Conservation:** National Park, Wildlife Sanctuaries, Biosphere Reserves
- **Ex-Situ Conservation** (Botanical & Zoological Gardens, Gene Banks, Seed And Seedling Banks, Pollen Culture, Tissue Culture and DNA banks, Butterfly Gardening)
- Conservation breeding programs and their importance
- Environmental Impact Assessment (EIA)

Unit – III

• **Wildlife Protection Acts and Laws for Conservation**

- Forest Conservation Act; Wildlife Protection Act; Environment Protection Act;
- Role of National Conservation Authorities (National Biodiversity Authority and National Tiger Conservation Authority)
- Role of International Organizations (WWF, IUCN and UNEP)
- RAMSAR Convention, Convention on Biological Diversity
- Red Data Book; Categories of Endangered Wildlife Species.
- Important wildlife conservation sites in Punjab

Unit – IV

• **Conservation Projects**

- Wetlands of National Importance
- Important Bird Areas
- Coastal and Marine Biodiversity

• **Species conservation projects**

- Project Tiger
- Project Elephant
- Project Rhinoceros
- Project Hangul
- Project Snow Leopard

• **Status of Wildlife in Punjab- A brief account**

Suggested Reading Material:

1. Aggarwal, (2000), Wildlife of India.
2. Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
3. Gopal, R. (1992), Fundamental of Wildlife management Justice Home Allahabad.
4. Hosetti, B. B. (1997), Concepts in Wildlife Management, Chawla Press, Delhi.
5. Negi, S. S. (1995), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
6. Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay.
7. Saharia, V. B. (1982), Wildlife in India, Natraj Publisher, Dehradun.
8. Sharma, B. D. (1994), High Altitude Wildlife of India, Oxford IBH, New Delhi.
9. Sharma, B.D. (1999), Indian Wildlife Resources Ecology and Development. Daya Pub. House, Delhi.
10. Sharma, B.D. (2002), Man environment and wildlife animal. IBH Publishing Co., Pvt. Ltd. New Delhi.
11. Teague, R. D. (1987), A manual of Wildlife Conservation, Natraj Publishers, Dehradun.
12. Tirvedi, P.R. and Singh, U. K. (1996), Environmental Laws of Wildlife.

COURSE OUTCOMES

CO-1	Study faunal diversity and learn to implement conservation measures to save diversity
CO-2	Understand importance of wildlife and conservation for protected areas
CO-3	Learn causes of depletion of wildlife & conservation ethics
CO-4	To understand wildlife legislation its amendments and implementation

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-706
COURSE TITLE: SEMINAR/PROJECT

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions:

The students are required to present a seminar on a topic of relevance and importance from the subject of Zoology or carry out research project on the assigned topic and present a seminar. The seminar carries 56 marks (10 for material, 15 for presentation, 6 for discussion and 25 for the seminar based paper at the end of the semester).

COURSE OBJECTIVES

1	To inculcate knowledge regarding presentation techniques
2	To enhance the scientific writing skills including introduction, methodology, techniques, results, discussion, and bibliography.
3	To provide knowhow regarding project work/field study.

COURSE OUTCOMES

Sr. No.	Course Outcome
CO-1	Institutional cum field work study report emphasizes theoretical aspect development.
CO-2	Students are able to develop good presentation technique through the use of multimedia and other teaching aids.
CO-3	Students develop skills for collection and analysis of data.
CO-4	Evaluation of the project report enhances viva voce capabilities through open defense type interactions.

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-751

COURSE TITLE: Practical-VII (Based on ZooC-701 & ZooC-702)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	Comparative knowledge of spermatogenesis and oogenesis
2	Understand the structural & functional difference of egg & sperm.
3	Study of different developmental stages of vertebrates.
4	Prepare temporary slide of various cells to demonstrate the cell morphology and cell division, giant chromosome and pedigree analysis chart.
5	Determine the gene distance and order, genotype and phenotype ratios and allelic frequencies from the given data.
6	The students will be well equipped to become very competent in research or teaching fields after completion of this course

Practical based on ZooC-701

1. Study of Gonads through permanent slides–
 - a. Study of Ovary (rat/frog/bird/grasshopper)
 - b. Study of testis (rat/frog/ bird/grasshopper)
2. Study of Gametes/Gametogenesis through permanent slides–
 - a. Oogenesis in rat/frog/ bird/grasshopper
 - b. Spermatogenesis in rat/frog/ bird/grasshopper
3. Types of eggs and spermatozoa in animals through charts/photographs/models.
4. Study of whole mounts and sections of developmental stages of frog through permanent slides/Charts: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
5. Study of whole mounts and sections of developmental stages of Herdmania through permanent slides/Charts: Cleavage stages, blastula, gastrula, tail-bud stage, tadpole.
6. Study of whole mounts of developmental stages of chick through permanent slides/Charts: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation
7. Study of placenta through permanent slides.

Practical based on ZooC-702

1. To prepare and study the karyotype of human cell from meta phase pictures
2. To study the pedigree analysis of family.
3. To study blood groups in human beings.
4. Demonstration of Barr body in the oral epithelium of human beings.
5. To study different stages of mitosis in root tips of *Allium cepa*.
6. To study permanent slides of:
 - Mitosis in bone marrow cells of rat.
 - Stages of meiosis in testis of rat/grasshopper/*Allium cepa*.
 - Polytene chromosomes in third instar larvae of *Zaprionus paravittiger*
7. To study dermatoglyphics with palms of hands and fingertips.

8. To study inheritance of morphogenetic human characters.
9. Numerical based on Mendelian laws of inheritance and Linkage.

* **Minor changes in the practical syllabus can be done as per availability of the live material.** As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

COURSE OUTCOMES

CO-1	In-depth comparative knowledge of spermatogenesis and oogenesis
CO-2	Compare and contrast structure of sperm & egg.
CO-3	Provide complete & comprehensive knowledge about different developmental stages of vertebrates.
CO-4	Provides students insight into maintaining healthy relationships with their opposite gender and allows them to make right choice about their life partner thus preventing congenital/consanguial diseases.
CO-5	Become competent enough to write scientific report after completing this course

M.Sc. Zoology Semester-III
COURSE CODE: ZooC-752

COURSE TITLE: Practical-VIII (Based on ZooC-703 & ZooC-704)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	To teach and aware students about the applied aspects of zoology
2	To instill entrepreneurship among the students
3	To study different behavioral patterns using photographs
4	To study the influence of temperature on development and population build up in <i>Tribolium</i>
5	To investigate the locomotive, explorative and habituation behaviour in earthworm
6	To study geotaxis, humidity preference and photo taxis in various experimental animals
7	To teach students how to record their body rhythms

Practical based on ZooC-703

- External morphology and identification of-
 - Parasitic protozoans
 - Liver fluke, tapeworm and roundworms
 - Leech and earthworm
 - Honey bee, Silk moth, Lac insect and Prawn
 - Eulamellibranchs, Gastropods and Cephalopods
 - Sea cucumber and star fish
- To study the life history of-
 - Honey bee (*Apis mellifera*)
 - Lac insect (*Kerria lacca*)
 - Silk worm (*Bombyx mori*).
- Physico-chemical analysis of honey.
- Physico-chemical analysis of vermicompost.
- Study of various qualities of lac.
- Visit to apiary/ vermicomposting unit/ sericulture unit/ Prawn Farm and preparation of report
- Preparation of project proposal for the establishment of Apiary/ Sericulture unit/ Lac culture unit/ Prawn Farm/ Pearl culture/ Vermicomposting unit

Practical based on ZooC-704

- To study the influence of temperature on development and population built up of *Tribolium/Rhizopertha/Callosobruchus*.
- To study the food preference in different animals.
 - Tribolium/Rhizopertha*
 - Pierisbrassicae*.
- To investigate the locomotive, explorative, withdrawal and habituation behaviours in Earthworm/Slug
- To study the thigmotaxis response in *Callosobruchus/ Tribolium/ Rhizopertha*

5. To study the Geotaxis Responses in
 - a) *Tribolium*
 - b) Ant
6. To study the Humidity Preference in
 - a) *Drosophila/ Zaprionus*
 - b) *Tribolium*
 - c) *Callosobruchus*
7. To study the Phototaxis to point source and different colours of light.
 - a) Earthworm
 - b) *Zaprionus*
 - c) *Tribolium*
 - d) *Callosobruchus*
8. Use of videos to study the
 - a) Grooming and righting behaviour in cockroach.
 - b) Tarsal response in butterfly/housefly.
 - c) Equilibrium study on housefly.
 - d) Effect of temperature on opercular movement in fish
9. To Investigate the Chemosensory Responses in *Zaprionus/ Bactrocera*.
10. Study of body rhythms in human beings.
11. Study of animal behaviour patterns using photographs.

* Minor changes in the practical syllabus can be done as per availability of the live materials.

* As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

COURSE OUTCOMES

CO-1	Students can employ taught knowledge to enhance their working ability
CO-2	Students can analyze honey and vermicompost physico-chemically and grade its quality on the basis of it.
CO-3	Students visit to apiary/ sericulture unit/ vermicomposting unit/ Prawn farm
CO-4	Students further incorporate studied behaviour in live experiments
CO-5	Students explore the locomotive, explorative and habituation behaviour in earthworm
CO-6	Students employ geotaxis, humidity preference and photo taxis in various experimental works
CO-7	Students can employ the learnt practical knowledge in grabbing research projects

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-801

COURSE TITLE: DEVELOPMENTAL BIOLOGY

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

Course Objectives

1	To understand the basic concept of developmental biology. To acquire an in depth knowledge of the relationship between gene and development as well as environment and development.
2	Outline and study the developmental stages in vertebrates
3	Develop an understanding about regeneration and metamorphosis
4	Understand role of nucleus in development.
5	Know how genes control the process of development in animals.

Unit – I

- **Induction and Maturation**
 - Induction and organization
 - Competence and inductive response
 - Hierarchies of induction
 - principles of reciprocal action
- Concept of growth at cellular, subcellular and organ level

Unit – II

- **Metamorphosis:** morphophysiology and Control
 - in insects
 - in frog
- **Regeneration**
 - Stem cell mediated regeneration of flatworms
 - Morpholaxes in Hydra
 - Eplmorphic regeneration of salamander limb
 - Compensatory regeneration of mammalian liver
 - Histomorphological changes in regeneration of Vertebrate lens

Unit – III

- **Nuclear Control of Development**
 - Nuclear determination of developmental events.
 - Nucleus and cytoplasmic interactions during development.
 - Molecular basis of early embryonic development

Unit – IV

- **Genetic Control and molecular basis of Development**
 - Differential gene expression in development
 - Axis formation in different animals
 - Influence of extrinsic factors on genetic control

Suggested Readings:-

15. Bellairs, R. (1971). Development Processes in Higher Vertebrates, University of Miami Press, Miami.
16. Browder, L. Developmental Biology, a Comprehensive Synthesis Plenum, New York.
17. Dawnpart, Developmental Biology.
18. Gilbert, F. (1985, 95 & 2000): Developmental Biology, Sinaur.
19. Grant, P. (1978): Biology of Developing System.
20. Karp. G. & Berrill, M.J. (1981): Development. McGraw Hill, New Delhi.
21. Loomis, W.F. (1986) Developmental Biology Macmillan, New York.
22. Miller, W.A. (1997). Developmental Biology Springer Verlag, New York.
23. Oppenheimer, J.M. and Willer, B.H. (1964): Foundation of Experimental Embryology, Prentice-Hall, New Delhi.
24. Pritchard, D.J. (1986): Foundation of Development Genetics, Taylor and Francis, London.
25. Saunders, J.W. (1982): Developmental Biology, Patterns, Principles, Problems, MacMillan, New York.
26. Spratt, N.T. Jn. (1971): Developmental Biology, Wordsworth, Belmont, Co.
27. Waddigton CH. (1966): Principles of Development and Differentiation. MacMillan, New York.

COURSE OUTOMES

S. No.	Course Outcomes
CO-1.	Understand and appreciate the genetic mechanisms development
CO-2.	Understand the role of model organisms
CO-3.	Understand the causes of infertility and their preventive measures
CO-4.	Understand the significance of regeneration and metamorphosis
CO-5.	Find scope to do research in different developmental processes of animals
CO-6.	Explain the theories of preformation and concepts like growth, differentiation and reproduction
CO-7.	Know the inducer and inductor role in embryogenesis
CO-8.	Explain the concept of mesoderm induction and pattern formation with examples

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-802
COURSE TITLE: MOLECULAR GENETICS

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Understand genetic information in the DNA & Mechanism of Prokaryotic and eukaryotic DNA replication.
2	Understanding the mechanisms of DNA repair and Inherited human diseases due to defects in DNA Repair
3	Acquire a broad understanding of transcription among prokaryotes and eukaryotes
4	Understanding of Post-transcriptional Modifications in RNA
5	Understanding mechanism of translation and translational machinery in prokaryotes and eukaryotes
6	Acquire a broad understanding of mechanism of regulation of gene expression in prokaryotes and eukaryotes.
5	Study of Genetic Basis of Cancers including the role of Tumour inducing retroviruses' and viral oncogenes.
6.	Techniques of Molecular genetics; Recombinant DNA technology and Amplification of Recombinant DNA in cloning vectors

Unit – I

- **DNA replication**
 - Mechanism of Prokaryotic and eukaryotic DNA replication
 - Enzymes and accessory proteins involved in DNA replication.
- **DNA Repair Mechanisms**
 - Excision Repair
 - Mismatch Repair
 - Postreplication Repair
 - Inherited human diseases due to defects in DNA Repair

Unit – II

- **Transcription**
 - Prokaryotic Transcription
 - Eukaryotic Transcription
 - RNA polymerases
 - General and specific transcription factors
- **Post-transcriptional Modifications in RNA**
 - 5' –Cap formation

- Transcription termination
- 3' – end processing and polyadenylation
- Splicing , Editing
- Nuclear export of mRNA

Unit-III

- **Translation**
 - Properties of Genetic code
 - Prokaryotic and eukaryotic translation
 - The translational machinery: Mechanisms of initiation, elongation and termination
 - Co- and post translational modification of proteins
- **Regulation of gene expression**
 - Regulation of gene expression in prokaryotes:
 - Operon concept: Inducible and repressible operons, catabolite repression
 - Gene regulation in eukaryotes

Unit-IV

- **Genetic Basis of Cancers**
 - Gene expression and cancer: Tumour inducing retroviruses' and viral oncogenes
 - Cellular homologues of viral oncogenes
 - Genetic basis of human cancers: Cellular oncogenes and cancers
 - Role of Tumor suppressor genes
- **Techniques of Molecular genetics**
 - Basic Techniques used to clone genes
 - Restriction endonucleases
 - Recombinant DNA technology
 - Amplification of Recombinant DNA in cloning vectors

Suggested Reading Material:

1. Brown, T. A. (2006) Gene cloning and DNA analysis and introduction (5th Edition), Oxford, Blackwell Publishers.
2. Lodish, H., Berk, A., Matsudaira, P., Kiser, C. A., Kriger, M., Scott, M. P., Zipursky, S.L. and Darnell, J. (2004) Molecular Cell Biology, 5th Edition W.H. Freeman and Company, New York.
3. Weaver, R.F. (2005) Molecular Biology,
4. Alberts, B., Johanson, A., Lewis, J. Raff, M., Roberts, M. and Walter, P. (2000) Molecular Biology of the cell, 4th Edition, Garland Science, New York.
5. DeRoberties, M. D. and DeRoberties, M.D. (Jr) (1995) . Cell and Molecular Biology (8th ed.) B.I. Waverly, Pvt. Ltd., ND.
6. Freifelder. D. (1993). Molecular Biology (2nd ed.) Narosa Publishing House, India
7. Snustad, D.P., Simons M.J., and Jenkis, J.B. (1997). Principles of Genetics. John Wiley and Sons, New York

COURSE OUTCOMES

CO-1	The students will be able to understand genetic information in the DNA & Mechanism of Prokaryotic and eukaryotic DNA replication.
CO-2	They will learn about the mechanisms of DNA repair and Inherited human diseases due to defects in DNA Repair.
CO-3	Will be able to acquire a broad understanding of transcription among prokaryotes and eukaryotes
CO-4	Will develop understanding of Post- transcriptional Modifications in RNA
CO-5	Will understanding the mechanism of translation and translational machinery in prokaryotes and eukaryotes

CO-6	Students will acquire a broad understanding of mechanism of regulation of gene expression in prokaryotes and eukaryotes.
CO-5	Will be able to develop understanding of genetic Basis of Cancers including the role of Tumour inducing retroviruses' and viral oncogenes.
CO-6.	Will get acquainted about the techniques of Molecular genetics; Recombinant DNA technology and Amplification of Recombinant DNA in cloning vectors

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-803

COURSE TITLE: APPLIED ZOOLOGY- II (VERTEBRATES)

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	To train the students in a wide range with Applied Zoology to provide future careers
2	This paper introduced about aqua culture systems, induced breeding techniques and post harvesting techniques
3	Understands concepts of fisheries, fishing tools and site selection
4	Aqua culture systems, induced breeding techniques, post harvesting techniques
5	Develop a knowledge of farming of aquatic organisms for increasing food production and animals beneficial to human

Unit-I

• **Pisciculture**

- Economically important fresh water and marine fishes
- Fish Farming Technologies
- Factors affecting fish culture
- Induced breeding methods
- Products and by products from pisciculture

• **Poultry**

- Nomenclature and breeds of poultry birds
- Poultry Rearing / Farming of Chickens
 - Nutritional Requirements
 - Housing and equipment
- Poultry diseases
- Poultry products and by products
 - Egg quality, nutritive values, abnormalities in eggs, factors affecting size and egg processing
 - Broilers, meat processing

Unit - II

- **Fur Industry**
 - Fur producing animals
 - Fur farming, dressing, processing and dyeing
 - Fur industry in India
- **Leather Industry**
 - Animals of leather industry
 - Processing of skin, flaying, Curing, salting and tanning
 - Enemies of skin industry

Unit-III

- **Dairy Farming**
 - Breeds of milch animals (Cows and Buffaloes)
 - Housing and raising and Tools of management
 - Milk composition and dairy products
- **Wool Industry**
 - Animals of wool industry
 - Types, structure and physicochemical properties of wool
 - Processing of wool: shearing, clearing, drying, bleaching, dyeing, spinning and twisting.

Unit -IV

- **Piggery**
 - Important breeds of swine
 - Breed selection, management and housing; and nutritional needs
 - Products (Pork, Bristles, Lard, Sausages) and by products
 - Diseases of Pigs
- **Use of animals in vaccine production**

Suggested Reading Material:-

1. Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
2. Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, New Delhi.
3. Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
4. Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co. India.
5. Khanna, S. S. (1986), An Introduction to Fishes, Central Book Depot, Allahabad.
6. Sarkar, K. T. (1991), Theory and Practice of Leather manufacture. The Author, Madras.
7. Shami, Q. J. and Bhatnagar, S. (2002) Applied Fisheries .Agrobios India.
8. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
9. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
10. Toor, H. S. and Kaur, K. (1996), Fish Culture Manual. PAU, Ludhiana.
11. Yadav, M. (2003) Economic Zoology, Discovery Publication House, New Delhi.

COURSE OUTCOMES

CO-1.	Understand the concepts of fisheries, fishing tools, site selection, preparation and management of fish culture ponds
CO-2.	Study aqua culture systems, induced breeding techniques and post harvesting techniques
CO-3.	Develop knowledge of farming of aquatic organisms for increasing food production and animals beneficial to human

CO-4.	Observe culture techniques and farm management of piggery, poultry, fur, leather, wool and milk producing animals
CO-5.	Analyse harvesting and marketing strategies for fur, leather and wool industry
CO-6.	Understand the technique of fish preservation and water quality monitoring techniques
CO-7.	Get knowledge about various livestock specifically the farm animals
CO-8.	Have expertise of the housing system, feeding requirements, feeding habits and use of low-cost feed technology for better economic returns from various animals farms
CO-9.	Know the importance and contribution of livestock in the state and national economy
CO-10.	Understand the use of animals in vaccine production and pharmaceutical industry

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-804
COURSE TITLE: EVOLUTION

Total Hours/wk.: 3 hr.

Total Hours: 45

Total Credits: 3 hr.

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Maximum Marks: 75

Theory: 56

Internal Assessment: 19

Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This course helps students to gain fundamental knowledge about origin of life
2	Knowledge of evolutionary theories and evidences will be imparted
3	Topics related to natural selection and variations will be discussed
4	Students will learn about speciation and extinction
5	Students will learn topics related to quantitative and molecular aspects of evolution

Unit – I

- **Origin of cells**
 - Origin of Micro molecules and Macro molecules: Concept of Oparin Haldane; Experiment of Miller (1953)
 - Origin of Viruses
 - Genetic code and its origin
 - The first cell; Evolution of prokaryotes; Origin of Eukaryotes
 - Evolution of Unicellular eukaryotes and multicellularity
- **Organic Evolution: Emergence of evolutionary thoughts**
 - Theories: Lamarckism and Neo-Lamarckism, Darwinism, Mutation theory of evolution, Modern synthetic theory
 - Evidences: Homology, Analogy, Vestigial organ, Atavism, Embryology, Paleontology, Connecting link, Missing link

Unit –II

- **Variations**
 - Types and causes of variations
 - Mutation rates and directions
- **Natural Selection:**
 - Types of selection
 - r- and K-selection
 - Experimental demonstration of Natural selection
 - Industrial melanism and polymorphism
 - Sexual selection
 - Selection and non-adaptive characters

Unit-III

- **Origin of species**
 - Speciation: Allopatric, Sympatric, Peripatric, Parapatric, Alloparapatric
 - Isolation and its types
- **Distribution of Species**
 - Island, Ocean and Continental distribution
 - Theories of continental drift.
- **Evolutionary Time scale:** Eras, Periods and Epoch; Major events in evolutionary time scale
- **Extinction**
 - Types and causes of extinction
 - Great extinctions

Unit-IV

- **Quantitative and Molecular Aspects of Evolution**
 - Hardy- Weinberg law
 - Selection pressure
 - Mutation pressure
 - Genetic drift
 - Founder effect
 - Bottleneck phenomenon
 - Migration
 - Meiotic drive
 - Molecular clocks
 - Brief account of future Course of Evolution

Suggested Reading Material

1. Avers, C. J. (1989). Evolution Process and Pattern in Evolution Oxford University, Press, New York, Oxford.
2. Brookfield, A. P. (1986). Modern aspects of Evolution. Hutchinson London, Melbourne.
3. Freeman, S. and Herron, Jon C. (2007). Evolutionary analysis Pearson Prentice Hall, New Jersey.
4. Futuyma, D. J. (1998), Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
5. Meglitsch, P. A. (1991), Invertebrate Zoology (3rd edition), Oxford University Press.
6. Minkoff, E. C. (1983), Evolutionary Biology, Addison Wesley Pub. Co., London.
7. Wen-Hsiung Li (1997), Molecular Evolution, Sinauer Associates Inc. Pub. USA.

COURSE OUTCOMES

CO-1	Students will know about population genetics, human evolution, various concepts about origin of species, extinctions, phylogenetic tree making
CO-2	A student who has completed the course should have solid knowledge of fitness, the measure for selection, and how it can be measured empirically
CO 3	Upon completion of the course, a student should be able to counter arguments against evolution, critically evaluate popularized writings which take up evolutionary topic or use evolutionary argumentation.
CO-4	Upon completion of the course, a student should be able to better distinguish scientific from unscientific arguments
CO-5	After the course, a student should be able to see evolutionary biology as a powerful set of tools for approaching current changes in biodiversity & addressing future challenges.

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-805
COURSE TITLE: RESEARCH TECHNIQUES

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	This paper is aimed to understand systematic approach to research and also study of systematic approach to solving a research problem by applying appropriate research methods
2	Students will learn centrifugation, chromatography and spectroscopy
3	Students will develop an insight into electrophoretic techniques
5	To equip the learner to use the tools and techniques for project work research in biology.

Unit-I

- **Centrifugation**
 - Basic principle of Sedimentation
 - Different types of Centrifuges
 - Design and Care of Preparative Rotors
 - Separation Methods in Preparative Ultracentrifuges (Differential Centrifugation and Density Gradient Centrifugation)
- **Radioisotopic Techniques**
 - Basic concept and biological applications of Radioisotopy
 - Brief account of Scintillation Counters and Gieger Muller tube

Unit-II

- **Chromatography**
 - Introduction to Chromatography
 - Types of Chromatography
 - **Theory, principle and applications of**
 - Paper Chromatography
 - Thin Layer Chromatography
 - Column Chromatography
 - Ion-exchange Chromatography
 - Affinity chromatography
 - High Pressure Liquid Chromatography

Unit-III

• **Spectroscopy**

- An introduction to spectroscopy: Properties of electromagnetic radiation and interaction with matter
- Beer- Lambert Law, Theory & applications of single and double beam UV/Visible spectroscopy
- Fluorescence spectroscopy
- Infrared spectroscopy
- Nuclear Magnetic Resonance Spectroscopy (NMR)
- Electron Spin Resonance Spectroscopy (ESR)
- An introduction to Mass Spectroscopy

Unit-IV

• **Electrophoresis**

- Principle of Electrophoresis
- Support Media: Agarose Gels, Polyacrylamide Gels
- Principle, Theory and applications of SDS-PAGE
- Agarose Gel electrophoresis of DNA and RNA
- Iso-electric focusing technique
- 2-D gel electrophoresis
- Capillary electrophoresis

Suggested readings:

1. Freifelder, D (1982). Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd edition, W.H. Freeman & Company, San Fransisco.
2. Sawhney, S.K. and Singh, R. (2001). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
3. Slater, R.J. (1990). Radioisotopes in Biology- A Practical Approach, Oxford University Press, NY.
4. Tinoco Kenneth Saur and J.C. Wang. Physical Chemistry: Principles and Applications in Biological Sciences, 3rd edition.
5. Wilson, K and Goulding, K.H. (1991). Biologist's Guide to Principles and Techniques of Practical Biochemistry. 3rd., Edward Arnold, London.

COURSE OUTCOMES

CO-1	Develop a scientific approach among students to perform research work efficiently
CO-2	To develop an understanding regarding centrifugation and chromatographic techniques
CO-3	To teach each and every aspect of spectroscopy
CO-4	To develop an insight into electrophoretic techniques related to carbohydrates and proteins

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-806

COURSE TITLE: CONCEPTS OF IMMUNOLOGY

Total Hours/wk.: 3 hr.

Maximum Marks: 75

Total Hours: 45

Theory: 56

Total Credits: 3 hr.

Internal Assessment: 19

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Periods per week: 4

Examination Time: 3 hrs.

Instructions to the Paper setters: The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 8 compulsory very short answer questions of which 6 are to be attempted (2 marks each). Questions should cover the entire syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 4 pages. The questions should not have more than two subparts.

COURSE OBJECTIVES

1	Introduce the cellular and molecular basis of immune responsiveness
2	Impart in depth knowledge of tissues, cells & molecules involved in host defense mechanisms
3	To teach students cells and organs of the immune system & types of immunity
4	Interactions of antigens, antibodies, complements and other immune components
5	Understand immune mechanisms in disease control, vaccination, process of immune interaction

Unit-I

- **Introduction**
 - Types of immunity-innate and adaptive.
 - Features of immune response-memory, specificity and recognition of self and non-self.
- **Cells and Organs of the immune system**
 - Cells of immune system: Lymphoid cells, heterogeneity of lymphoid cells, T-cells, B-cells, Null cells, Monocytes
 - Primary and secondary lymphoid organs-thymus, Bursa of Fabricius, spleen, lymph nodes, lymphatic system, Mucosa Associated Lymphoid Tissue (MALT)
 - Lymphocytes traffic.

Unit-II

- **Humoral Immunity:**
 - Antigen-antibody interactions, affinity and avidity
 - Immunoglobulins-classes and structure
 - Molecular mechanism of generation of antibody diversity.
 - Complement fixing antibodies and complement cascade.
- **Cell Mediated Immunity**
 - Types of T-cells
 - T-dependent and T-independent antigens
 - Types and functions of MHC

Unit-III

- **Immunological Disorders**
 - Types of Hypersensitivity reactions
 - Etiological, diagnostic, prognostic and prophylactic aspects of Autoimmune disorders: Organ specific (Pernicious and Haemolytic anaemia, Thyroid disorder, Diabetes mellitus, Myasthenia gravis, Multiple sclerosis) and Non-Organ specific (SLE, RA)
 - AIDS (structure and life cycle of HIV)
- **Immuno-biotechnological approaches:**
 - **Hybridoma Technology:** Immunization of animals, isolation of stimulated spleen cells, Myeloma cell lines used as fusion partners. Fusion methods
 - Applications of monoclonal antibodies
 - Vaccines: Conventional vaccines, peptide vaccines, genetically engineered vaccines
 - Cytokines- Types, properties and functions

Unit-IV

- **Immunodiagnostic Procedures-**
 - Immunodiffusion
 - Immunoelectrophoretic
 - Immunoblot
 - ELISA
 - RIA
 - Agglutination of pathogenic bacteria
 - Haemagglutination and inhibition.

Suggested readings:

1. Kuby, J., Immunology W. H. Freeman and Company, New York, (1992).
2. Paul, W.E., Fundamental Immunology, 2nd edition, Raven Press, New York. (1989).
3. Paul, W.E.: Immunology; recognition and response. W.H. Freeman, New York. (1991).
4. Playfair, J.H.L.: Immunology at a glance, 5th edition, Blackwell Scientific Publications, Oxford. (1992).
5. Roitt, I. M. Brostoff, J and Male, D., Immunology, 2nd edition, Gover Medical Publishing, New York. (1989).
6. Roitt, I. M., Essential Immunology, 6th edition, Blackwell Scientific Publications, Oxford. (1988).

COURSE OUTCOMES

CO-1	Get opportunity to know about the immune system & Processes of organisms.
CO-2	Techniques to cure immunological diseases & a guide for a better health to the common people of the society.
CO-3	The most important role of immunology recently seen by the world in the time of Corona Pandemic where it is guiding and teaching that how to prevent Corona and rumors arising from it as well as in production of life saving Vaccines.
CO-4	They get opportunity of Job as Advisor, Teacher, Researcher, Technicians in the academics as well as research and pharmaceutical institutes.
CO-5	Act as Volunteers to assist the professionals and to guide the people to mitigate the pandemic.

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-851

COURSE TITLE: Practical IX (Based on ZooC-801 & ZooC-802)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	On-hand training of developmental stages of chick and frog, comparative knowledge of inducers.
2	Observe larval forms throughout the animal kingdom
3	Isolation of DNA from blood
4	Temporary mount of Barr body from buccal smear
5	Amplification of DNA using PCR
6	To study cellular abnormalities and their frequency
7	To estimate nucleocytoplasmic ratio.
8	To perform Comet assay for estimation of DNA damage
9	Double immune-diffusion for antibodies to a specific antigen
10	Preparation of Temporary mount of Giant chromosomes

Practical based on ZooC-801

1. Study of different larval forms across the animal Kingdom using charts/models/videos.
2. Developmental stages of chick and frog through slides/charts.
3. Study of Metamorphosis through charts/audio video means in frog and insect.
4. Study of regeneration through charts/audio video means in frog.
5. Study of growth (multiplicative; accretionary) through permanent slides.
6. Study the direct and indirect development through museum specimens/charts.

Practical based on ZooC-802

1. Isolation of DNA from human blood.
2. Temporary mount Barr body from buccal smear.
3. Amplification of DNA using PCR.
4. To study cellular abnormalities and their frequency.
5. To estimate nucleocytoplasmic ratio.
6. Comet assay for estimation of DNA damage.
7. Double immunodiffusion for antibodies to a specific antigen.
8. Temporary mount of Giant chromosomes.

* Minor changes in the practical syllabus can be there as per availability of the live materials.

COURSE OUTCOMES

S. No.	Course Outcomes
CO-1.	Study larval forms throughout the animal kingdom
CO-2.	Get hands on training and understanding of various developmental stages of chick and frog
CO-3.	Identify the developmental stages of chick embryo, cell structures and phases of

	cell division
CO-4.	The students will get hands on training of DNA isolation from blood and its amplification using PCR
CO-5.	Temporary mount of Barr body from buccal smear
CO-6.	Will understand the cellular abnormalities and their frequency
CO-7.	Will be able to estimate nucleocytoplasmic ratio.
CO-8.	Assessment of DNA damage using Comet assay
CO-9.	Double immune-diffusion for antibodies to a specific antigen
CO-10.	Preparation of Temporary mount of Giant chromosomes

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-852

COURSE TITLE: Practical-X (Based on ZooC-803 & ZooC-804)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

L T P

0 0 2

Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	To study morphology and identification features of breeds of fishes, milch animals, poultry, pig, etc.
2	To differentiate different varieties of wool and leather
3	To analyse quality of pond water and milk
4	Use regression, correlation and variance analysis for gene frequency
5	Have knowledge about Hardy-Weinberg law and its application on a population
6	Demonstration of evolutionary phenomenon

Practical based on ZooC-803

8. Study of morphology and identification of edible fresh water and marine fishes
9. Estimation of following chemical parameters of pond water
 - a. Temperature
 - b. pH
 - c. Dissolved oxygen
 - d. Phosphates
 - e. Total Dissolved solids
 - f. Hardness
10. Examination and identification of diseased fishes.
11. External morphology and identification of breeds of milching animals (Cow, Buffalo)
12. Physico-chemical analysis of milk.
13. External morphology and identification of breeds of egg layers and broilers.
14. External morphology and identification of breeds of pigs.
15. Study of different qualities of leather
16. Study of different qualities of wool.
17. Visit to poultry/ piggery/ dairy/ rabbit/ sheep/ fish farm/ meat processing/ leather industry/ wool industry and preparation of report. The report shall carry 5 marks in the practical examination.

Practical based on ZooC-804

1. Calculations for regression, correlation and variance of gene frequency and genetic equilibrium (taking pea pods).
2. Examination of principle of natural selection as a process related to evolution in a population (using colored marbles / beads).
3. Comparison of skeleton for listing evolutionary trends.
4. Comparison of molluscan shells to depict polyphyletic origin.
5. Comparison of homologous & analogous structures (e.g. insect antenna, legs, vertebrate limbs etc.).
6. Demonstration of kinds of mimicry in various groups of animals.

7. Mapping of geographic distribution of some birds, insects, fish etc.
8. Study of various evolutionary phenomenon using slides/ photographs.
9. Study of fossils.
10. Preparation of Phylogenetic tree using some Priory weight characters of 8-10 animals from various categories.

COURSE OUTCOMES

CO-1	To teach students physico-chemical analysis of milk, different qualities of leather and wool
CO-2	Students visit to poultry/ piggery/ diary/ rabbit/ sheep/ fish farm/ leather/ wool industry
CO-3	Use regression, correlation and variance analysis for gene frequency
CO-4	Hardy-Weinberg law and its application, phenomena of natural selection in a population
CO-5	Compare vertebrates skeleton to understand evolutionary trends
CO-6	Understand phylogenetic tree and polyphyletic origin of characters
CO-7	Map geographic distribution of animals
CO-8	Compare and contrast homology and analogy

M.Sc. Zoology Semester-IV
COURSE CODE: ZooC-853

COURSE TITLE: Practical XI (Based on ZooC-805 & ZooC-806)

Total Hours/wk.: 4 hr.

Maximum Marks: 50

Total Hours: 60

Theory: 37

Total Credits: 2 hr.

Internal Assessment: 13

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Periods per week: 6

Examination Time: 3 hrs.

COURSE OBJECTIVES

1	Exposure to a variety of advanced methods and principles which they could employ in research
2	To equip the learner to use spectrophotometers, rotors and centrifuges for research in biology
3	To develop a practical approach regarding electrophoretic and chromatographic techniques
4	Students will learn practical preparation of solutions, standards and standard curves
5	To understand systematic approach to research and also study of systematic approach to solving a research problem by applying appropriate research methods
6	To gain practical knowledge about different components of immune system.
7	To learn about interactions of antigens, antibodies and other immune components.
8	Learn the immune-diagnostic techniques like ELISA, Ouchterlony method.

Practicals based on ZooC-805

1. Paper chromatography
2. Thin layer chromatography
3. Column chromatography
4. Preparation of standard curve of BSA
5. Measurement of the transmission of light through different solutions or substances at different wavelengths of light.
6. Preparation of native polyacrylamide gel
7. Gel separation of proteins by native PAGE
8. Preparation of SDS-polyacrylamide gels
9. Separation of proteins by SDS-PAGE
10. Preparation of Agarose gels
11. Different types of centrifuges
12. Sedimentation using Swing out Rotor and Angle Rotor
13. Differential centrifugation.

Practicals based on ZooC-806

1. To demonstrate the agglutination reaction by typing of human blood into A, B, AB, O and Rh factor.
2. Perform differential leukocyte count (DLC) of the given blood sample.
3. Perform total leukocyte count (TLC) of the given blood sample.
4. Perform antigen-antibody reactions by Ouchterlony method (precipitation reaction) through kit.
5. To demonstrate dot ELISA through kit.
6. Study of histological section of lymphoid organs
7. To Study the Structure of Immunoglobins through photographs.

* Minor changes in the practical syllabus can be there as per availability of the live materials. As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

COURSE OUTCOMES

CO-1	To develop a practical approach regarding centrifugation and chromatographic techniques
CO-2	To teach students how to use spectrophotometers, rotors and centrifuges and their care
CO-3	To teach students the preparation of agarose and SDS-PAGE Gels
CO-4	Practical preparation of standard curves of BSA, and their application in spectroscopic techniques
CO-5	To gain practical knowledge about different components of immune system.
CO-6	To learn about interactions of antigens, antibodies and other immune components.
CO-7	Learn the immune-diagnostic techniques like ELISA, Ouchterlony method.