NORTH MAHARASHTRA UNIVERSITY, JALGAON M. Sc. (Part-II) ZOOLOGY
New Syllabus with effect from 2018-2019
Pattern 60-40

Semester III

Paper Code	Paper	UA + CA	Hours
ZOO 301	(A) Entomology – I	60 marks + 40	60
	OR		
	(B) Animal Physiology – I	60 marks + 40	60
	OR		
	(C) Reproductive Physiology – I	60 marks + 40	60
	OR		
	(D) Helminthology – I	60 marks + 40	60
ZOO 302	Immunology and Molecular Biology	60 marks + 40	60
ZOO 303	Genetics	60 marks + 40	60
ZOO 304	ZOO 304: Practical 301 + 302	60 marks + 40	60
ZOO 305	ZOO 305: Practical 302 + 303	60 marks + 40	60

Semester IV

Paper Code	Paper	UA + CA	Hours
ZOO 401	(A) Entomology – II	60 marks + 40	60
	OR		
	(B) Animal Physiology – II	60 marks + 40	60
	OR		
	(C) Reproductive Physiology – II	60 marks + 40	60
	OR		
	(D) Helminthology – II	60 marks + 40	60
ZOO 402	Systematic and evolutionary biology	60 marks + 40	60
ZOO 403	Skill in Communication and Writing research Paper	60 marks + 40	60
ZOO 404	ZOO 304: Practical 401 + 402	60 marks + 40	60
ZOO 405	ZOO 305: Practical 402 + 403	60 marks + 40	60
ZOO 406	Project Work	60 marks + 40	60

M. Sc. Part II: Semester III
ZOO 301 (A) Entomology I

Unit	Particulars			Hours	Marks
	Insect Taxonomy and Anatomy				
1	Classification of following insect orders up to families			**30**	**30**
	A)	Apterygota – Thysanura, Collembolla			
	B)	Pterygota-			
		1.	Odonata		
		2.	Orthoptera – Tettigonidae, Gryllotalpidae, Acrididae		
		3.	Dyctioptera- Blattidae, Mantidae		
		4.	Isoptera		
		5.	Mallophaga		
		6.	Siphanuculata		
		7.	Hemiptera-		
			a) Suborder- Homoptera - Flugoridae, Cicadidae, Aphididae		
			b) Suborder- Heteroptera – Cimiadae, Pyrrochoridae, Pentatomidae, Belostomidae		
		8.	Coleoptera -		
			a) Suborder- Adephaga- Carabidae, Dysticidae		
			b) Suborder- Polyphaga- Hydrophilidae, Scarabidae, Bupristidae, Tenebrionidae, Curcurlionidae		
		9.	Diptera-		
			a) Suborder- Nematocera- Culicidae, Chironomidae		
			b) Suborder- Brachaeocera- Tabanidae		
			c) Suborder- Cyclorrhapha- Syrphidae, Muscidae, Hippoboscidae, Glossinidae		
		10.	Lepidoptera- Nymphalidae, Papillionidae, Sphingidae, Noctuidae		
		11.	Hymenoptera-		
			a) Symphyta- Tenthreadinidae		
			b) Apocrita- Apidae, Ichnnemonidae		
2	**A**	Integument and its derivatives :		**08**	**08**
	B	Comparative study of –			
		1.	Head and its appendages,		
		2.	Thorax and its appendages and		
		3.	Abdomen and its appendages		
3	Comparative anatomical and histological study of the following			**20**	**20**
	A	Alimentary canal and associated glands			
	B	Circulatory system			
	C	Ventilatory system			
	D	Excretory system and fat bodies			
	E	Nervous system and sense organs			
	F	Reproductive system			
4	Light and sound producing organs			**02**	**02**
			Total	**60**	**60**

Practical corresponding to ZOO 301 (A) Entomology I

1. Collection and preservation techniques of insects
2. Classification of insects upto orders and families as per syllabus
3. Pictorial Collection and Identification of 25 insect species related to different orders and families
4. Culturing/rearing of any suitable insect/s (Housefly/ Drosophila)
5. Histology of integument and its derivatives with the help of Slides (D)
6. Comparative study of head capsule – any four (adults or larvae) from local area
7. Study of types of mouthparts and antennae
8. Study of types of legs, wings and wing venation
9. Study of abdominal appendages- pre genital and post genital
10. Study of Bugs, Beetles, House Fly with reference to following systems (Any 2 insects)
    a. Digestive system
    b. Reproductive system
    c. Nervous system
11. Study of mounting of Halter of Housefly.
12. Histology of different organs of -
    a. Alimentary canal,
    b. Trachea,
    c. Heart,
    d. Muscle,
    e. Blood of suitable insects
13. Compulsory visit to Agriculture College or University or Research institute.

Reference Books

- Imm's text book of entomology by O. W. Richards and R. G. Davies (Mathuem and com, London 1977) vol. I and II
- Principles of insect morphology by R.E. Snodgrass (Tata Mc Graw Hill Bombay 1978)
- Introduction to comparative Entomology by R. M .Fox and J. W. Fox (Reinhold, New York 1964)
- The Insect- Structure and Function by R. E. Chapman (ELBS and EUP London, 1972)
- The Text book of Entomology by H. H. Ross, (John Wiley & Sons) Inc. New York 3rd Ed. 1965.
- Modern Entomology by D. B. Tembhare (Himalaya Publishing House, 2012).
- General Applied Entomology by K.K. Nayar, T.N. Anantha Krishan and B.V. David (Tata McGraw Hill, New Delhi, 1976).

M. Sc. Zoology Part II: Semester III
ZOO 301 (B) Animal Physiology – I

Unit	Particulars	Hours	Marks
1.	**Introduction:** a) Importance and scopes of physiology b) Branches of physiology	02	02
2.	**Chemical foundation of physiology:** a) Diffusion and Osmosis, b) Body Buffer system: Buffer, Bicarbonate Buffer system c) Significance of buffers	05	05
3.	**Thermoregulation:** a) Homeostasis; b) Classification of Animals Based on Thermoregulation; c) Vants Hoff law; Lethal temperature; d) Effect of cold Acclimation; e) Thermoregulatory Mechanisms; f) Thermoregulation in Camel	05	05
4.	**Nutrition** a) Types of nutrition; Ingestion; Feeding mechanism; Digestion; Enzymes; b) Physiology of digestion; Absorption; Assimilation; Egestion or defaecation, c) The evolution of digestive mechanism: Phagocytosis; A digestive cavity (Intracellular digestion), d) Organization of Vertebrate Digestive System, e) Functional Adaptations of the Alimentary Canal, f) Types of Digestion	08	08
5.	**Excretion** a) Definition of Excretion; Types of excretory Products, b) Excretory organs in animals: In Invertebrates and Vertebrates, c) General Structure of Nephron, d) Metabolism of Nitrogen, e) Osmoregulation in Invertebrates, f) Osmoregulation in Vertebrates	08	08
6.	**Metabolism** a) **Carbohydrate Metabolism**: Intermediary Metabolism; Glycogenesis; Glycogenolysis; Glycolysis Krebs cycle, Electron transport system; Respiratory chain; Oxidative phosphorylation; Energetics of Glucose; Metabolism; Pasteur effect; Gluconeogenesis; Cori cycle or lactic acid cycle; Uronic acid pathway; Crabtree effect, b) **Lipid metabolism**: Metabolism of lipids; Oxidation of Glycerols; Fatty Acid, Oxidation; β-Oxidation; Ketogenesis; Ketosis; Ketolysis; Biosynthesis of Fatty Acids; Biosynthesis of Triglycerides, c) **Protein Metabolism**: Deamination; Transamination; Decarboxylation; Ornithine cycle; Krebs Cycle, Citric Acid Cycle; Catabolism of the Carbon; Skeleton of amino acids; Pyruvic acid; Amino acids entering by α-Ketoglutaric Acid;	14	14

	Amino Acids entering by Succinyl Co-enzyme A; Catabolism of Amino Acids that are both Ketogenic and Glucogenic; Anabolism of Proteins; Energetics of amino Acids Oxidation		
7.	**Detoxification** Mechanism and role of Microsomal Enzymes in Detoxification	02	02
8.	**Circulatory system** a) Introduction; Functions of Circulatory system in Vertebrates; Closed and open Circulatory system; b) Types of Circulation: a)Systemic circulation b)Pulmonary circulation, c)Advantages of Double Circulation; c) Types of Heart: Pulsating Heart, Tubular Heart, Chambered Heart, Accessory heart d) Physiological types of Hearts: Neurogenic heart and Myogenic heart, e) ECG; Heart Sound; Cardiac cycle; Cardiac output; f) General plans of Circulation: Annelid plan, Amphioxus plan, Gill plan of fishes, Lung plan of Mammals; g) Blood vessels: i) Arteries and arterioles ii)Veins and Venules, iii)Microcirculation	08	08
9.	**Nervous System** a) Nervous Co-ordination; Brain; Spinal cord; b) Neurons or Nerve cells; Nerve Fibres; Neuroglea; Nerve impulse; Neuromuscular junction; c) Neurotransmitters; Nerve reflexes; Reflex arc; Types of Reflexes; d) Evolution of nervous system; e) EEG	08	08
	Total	**60**	**60**

Practical corresponding to ZOO 301 (B) Animal Physiology - I

1. Preparation of Phosphate and Bicarbonate Buffers, given Normality solutions, Physiological Mammalian Saline Solution
2. To demonstrate the principle of dialysis
3. To demonstrate the principle of Osmosis
4. Determination of Salivary Enzyme digestion and Effect of Temperature on Enzyme Activity
5. Determination of GFR
6. Determination of Nitrogenous Excretory Product – Uric acid
7. Estimation of SGOT/SGPT from given biological sample.
8. Antioxidant activity of any suitable material.
9. Determination of Fatty acids and Amino Acid from Lipid and Protein Digestion respectively.
10. Reflexes in man.
11. Estimation of plasma proteins by copper sulphate specific gravity method.
12. Estimation of Blood Glucose level.

References

- G. J. Tortora: Principle of Anatomy and Physiology
- Hoar: General and Comparative physiology
- Dr. P.V. Jabade: General Physiology
- B. K. Berry: Animal Physiology
- C. C. Chatterjee: Human Physiology
- Goel and Shastri: Textbook of Animal Physiology
- K.S. Nelson: Animal Physiology
- Holurn: Principles of Physiology and Biochemistry
- Bell and Davidson: Textbook of Physiology and Biochemistry
- Withers: Comparative Animal Physiology
- Mohan P. Arora: Animal Physiology
- R. C. Sobti; Animal Physiology

M. Sc. Zoology Part II: Semester III
ZOO 301 (C) Reproductive Physiology – I

Unit	Topics	Hours 60	Marks 60
1	Introduction Reproductive Physiology	02	02
	Male reproductive tract anatomy and histology of testis	12	12
2	Female reproductive tract anatomy and histology of ovary	12	12
3	Sexual differentiation of the male and female	06	06
4	Endocrinology of Reproduction, Biosynthesis, mode of action and functions of Androgens, Estrogen and Progesteron	10	10
5	Puberty and delayed puberty	04	04
6	Reproductive cycles in the female	10	10
7	Hormone manipulation and Artificial insemination	04	04

Practical corresponding to ZOO 301 (C) Reproductive Physiology - I

1. Demonstration of rat/mice endocrine glands with the help of figure/chart/model.
2. Histological structure of male and female reproductive organs in rat/mice/human.
3. Study of different stages of estrous cycle.
4. Microscopic observations of spermatozoa / ova from suitable mammal
5. Histological structure of male accessory reproductive organs.
6. Histological structure of female accessory reproductive organs.
7. Cellular structure of anterior pituitary gland.

References

- Prakash S Lohar, 2012 – Endocrinology Hormones and Human Health, MJP Publishers, Chennai
- P. J. Hogarth, 1978- Biology of Reproduction Wiley, New York.
- J. S. Perry, 1971- The Ovarian cycle of animals, Oliver and Boyed.
- C.R. Austin and R. V. Short, 1972 Reproduction in Mammals, Vol. 1-8, Cam.Uni. Press.
- P. Gibian and E.J. Platz, eds, 1970- Mammalian Reproduction, Springer Verlag.
- Robert H. Williams, 1981 – Text book of Endocrinology, W. B. Saunders Company

M.Sc. Zoology Part II: Semester III
Zoology 301(D): Helminthology I

Unit No.	Name of Topic	Hours	Marks
01	1. Introduction to Parasitology, 2. Origin and evolution of parasites. 3. Inter-specific biological relationships phoresis, symbiosis, Commensalisms and parasitism. 4. Adaptation in parasites.	06	06
02	1. Advantages and Disadvantages in parasitic life. 2. Types of Parasites. 3. Factors influencing Parasitism; Influence of season, host age and other phonological factor on parasitic population (prevalence, intensity etc.). 4.Types of hosts- Definitive and intermediate, primary secondary specific host, Paratenic, Carrier, Susceptible, Resistant, Accidental, Vectors etc.	06	06
03	1. History and scope of Helminthology. 2. General organization and Classification of Platyhelminthes up to order level. Cestodes (Cestodarians and Eucestodes), Trematodes (Monogenea, Aspidobothria and Digenea) 3. Functional anatomy of Reproductive system a. Trematodes (Digeneans) b. Cestodes (Pseudophyllideans & Cyclophyllideans). c. Egg shell formation, chemistry of egg shell formation, factor influencing embryonation & hatching.	10	10
04	1. Intramolluscan stages and their effect on molluscan hosts, Effect on foot, haepatopancreas, Reproductive system and general metabolism. 2. Types of Cercaria. 3. Different types of larvae in cestodes and their pathogenicity. 4. Holdfast organs with its adaptations in cestodes	08	08
05	1. Life cycle patterns of Digenetic Trematodes a) Single intermediate host life cycle. b) Two intermediate host life cycles 2. Life cycle patterns in Cestodes a) No intermediate host life cycle b) Single intermediate host life cycle c) Two intermediate host life cycles.	10	10
06	Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment & prevention of the following Trematodes *a)* ***Monogenea***: *Polystoma integrrimum* *b)* ***Aspidobothria***: *Aspiodogastar conchicola* *c)* ***Digenea*****:** 1. *Pragonimus westermani* 2. *Fasciolopsis buski* 3. *Gastrodiccoides hominis.*	10	10
07	Geographical distribution, habitat, morphology (Structure), life cycle, pathogenicity, diagnosis, treatment and prevention of the following Cestodes,	10	10

	1) Amphilina *2) Diphyhidium canium* *3) Diphyllobothrium latum* *4) Echinococcous granulosus* *5) Taenia saginata*		
	Total	**60**	**60**

Practical corresponding to Zoology 301 (D) Helminthology I

1. Study of different types of animal associations with suitable examples.
2. Study of different Hold fast organs in Helminthes.
3. Collection, fixation and preservation of metacercaria from fish
4. Collection, fixation and preservation of Cestodes, trematodes from locally available hosts.
5. Collection and examination of molluscan hosts for larvae of Trematodes.
6. Staining and identification of collected trematode & cestodes, and preparation of their permanent slides
7. Histopathology of host tissue caused by parasites ex. Cestode/ Trematode any host tissue, to study host parasites relation.
8. Study of different/ important endoparasites of poultry, fish and goat /sheep.
9. Study of different trematodes and cestodes from permanent slides (At least, 10 from cestodes & 10 from trematodes).
10. Examination of ova in fecal samples of any suitable animal.
11. Submission of five permanent slides at the time of practical examination.

Reference books

1. Medical Parasitology by Markell, Voge and John, 8thed. W.B. Saunders Co.
2. The Biology of animal parasites, Cheng T.C. (1964)-Saunders International Student Edition.
3. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
4. Text book Medical Parasitology Jaypee Brothers, - Medical Publishers, New York. - Panikar C.K.J (1988)
5. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
6. Parasitology (Protozoology and Helminthology) -SoodPamnik (1993) CBS Publication and Distrubution, Delhi.
7. Human helmintology Manual for Clinical, Sanitarians Medical Zoologists – Faust, EmerestCaroll.
8. SystemaHelminthum Vol. IV Monogenea and Aspidobothria - Yamaguti S. (1963) Inter-Science Publishers, London.
9. Synopsis of Digenetic Trematodes of Vertebrates - Yamaguti S. (1971) Vol. I & II Keigaku Publishing Co., Tokyo, Japan.

M.Sc. Zoology Part II: Semester III
ZOO 302 Immunology and Molecular Biology

Unit	Topics	Hours	Marks
1	**Immunology**		
	Development of different cell types of the immune system from stem cell to a fully immuno competent effector cell	2	2
2	Central cell types of the immune system: T and B lymphocytes, the NK cells, the neutrophilic, basophilic and eosinophilic granulocytes and the macrophages.	4	4
3	Types, structure, and function of molecules: immunoglobulins, T-cell receptors, MHC molecules, complement proteins, a few key cytokines and chemokines and their receptors.	4	4
4	Principles of generation of immunoglobulins and T-cell receptors at a genetic level	4	4
5	Defense against as bacteria, fungi, virus and parasites	4	4
6	Mechanisms behind several immunological diseases, as hypersensitivity reactions, allergies, autoimmunity and immuno deficiencies.	4	4
6	Mechanisms of action of certain immunosuppressive drugs as glucocorticoids and cyklosporin.	4	4
7	Immunological methods: ELISA, Western blot, production of monoclonal and polyclonal antibodies	4	4
	Molecular Biology		
8	DNA topology and different forms of DNA	2	2
9	Chromatin and its effects on DNA metabolism	2	2
	How do organisms copy and protect their genomes	2	2
10	DNA replication and its regulation	4	4
11	DNA damage and repair mechanisms	4	4
12	Mechanisms of transcription in bacteria & eukaryotes	4	4
13	RNA splicing and processing	4	4
14	The genetic code and process of translation	4	4
15	Regulation of gene expression by small RNAs	4	4
	Total	**60**	**60**

Practical corresponding to ZOO 302 Immunology and Molecular Biology

1) Chemistry of immunoglobulin molecules, classes and physiological importance.
2) Use of ELISA technique (HIV) or any suitable method.
3) Isolation and purification Bovine serum immunoglobulin G (IgG) fraction by suitable method
4) Study of agglutination reaction and its significance performing WIDAL test.
5) Determination of Antigen and Antibody reaction by using any suitable method
6) Isolation and estimation of DNA
7) Isolation and estimation of RNA
8) Determination of Thermal melting point (Tm) of nucleic acid.
9) Gene expression in prokaryotic organism (bacteria)

Reference Books

- Immunology (6 th Edition) by Roit IM, Brostoff J and Male D. Mosby, An imprint of Elsevier Sci Ltd., 2002.
- Kuby Immunology (4 th Edition) by Golds RA, Kindt TJ, Osborne A. W.H. Freeman and Co. Ltd., New York, USA, 1994.
- Textbook on Principles of Bacteriology, Virology and Immunology, 5 Volumes (9 th Edition) by Topley and Wilson. Edward Arnold, London, 1995.
- Basic and Clinical Immunology, by Stites DP. Appleton & Lang Press.
- Immunology, by Weissman and Wood. Benjamin Cummings.
- Fundamentals of Immunology, by Coleman RM, Lombard MF, Sicard RE and Rencricca NJ. Wm. C. Brown Publishers, 1989.
- Du Praw E.J.: Cell and Molecular biology •
- J.d.watson: Molecular Biology of the gene •
- Prakash S. Lohar : Cell and Molecular Biology, MJP Publishers, Chennai •
- J.R.Baker: Cytological techniques •
- Gerald Karp: Cell and Molecular Biology, John Wiley and SonsInternational, London

M.Sc. Part I : Sem. III
ZOO 303: Genetics

Unit	Particulars	Hours	Marks
1	**Introduction:** a) Concept of gene, b) Mendel's laws with examples c) Allele - Multiple alleles, Pseudoallele	**06**	**06**
2	**Extensions of Mendelian principles:** a) Co-dominance and Incomplete dominance, b) Gene interactions, c) Pleiotropy, d) Genomic imprinting, e) Penetrance and expressivity, f) Phenocopy, g) Linkage and crossing over, h) Sex linkage, sex limited and sex influenced characters.	**08**	**08**
3	**Gene mapping methods:** a) Linkage maps, b) Tetrad analysis, c) Gene mapping with molecular markers, d) Gene mapping by using somatic cell hybrids, e) Development of mapping population in *Drosophila*.	**08**	**08**
4	**Population genetics** a) Basic concepts in population genetics b) Gene pool c) Gene frequency and genetic drift. d) Hardy Weinberg equilibrium and its significance	**08**	**08**
5	**Mutation:** a) Types, causes and detection, b) Mutant types – Lethal, Conditional, Biochemical, c) Mutant types – Loss of function, Gain of function, d) Germinal verses somatic mutants, e) Insertional mutagenesis.	**08**	**08**
6	**Structural and numerical alterations of chromosomes:** a) Deletion, Duplication, Inversion, Translocation, b) Ploidy and their genetic implications	**08**	**08**
7	**Genetic disorders in human beings** a) Hereditary diseases and disorders b) Haemoglobin disorders: Thalassemia and Sickle cell anaemia. c) Inborn errors of metabolism: Albinism, Phenylketonuria and Alkaptonuria	**06**	**06**
8	**Recombination:** a) Homologous and non-homologous recombination b) Transposition, c) Site-specific recombination	**08**	**08**
	Total	**60**	**60**

Practicals corresponding to ZOO 303 Genetics

1. Calculation of gene frequency of PTC tasting in the given human population
2. *Drosophila* morphology, sexual dimorphism- Normal and Abnormal
3. Study of Monohybrid Cross ratio using colour beads
4. Study of Dihybrid Cross ratio using colour beads
5. Study of Sex linked character in *Drosophila*-White, Bar and Sepia Eye
6. Study of Drosophila culture by using any suitable method.
7. Calculation of gene frequency of ABO blood group in human population.
8. To detect synaptic pairing of chromosomal Aberration in meiotic stages (Prophase-I) of Grasshopper/insect.
9. Gene expression in prokaryotic organism (bacteria)

Reference books

- Dobzhansky, T.: Genetics of the Evolutionary process, Columbia Press
- C.B. Pawar : Genetics Vol - I and II, Himalaya Publishing House, Mumbai
- M.W.Stricberger : Genetics, 4th Edition, Mc Millon publication Com. Inc, New York
- B. Lewin : Genes Xth edition, Wiley Eastern Limited, New Delhi
- A. M. Winchester : Genetics
- Sinnot Dunn and Dobzhansky: Principles of Genetics
- Kotpal and Kshetrpal: Concept of Genetics

M. Sc. Part II: Semester IV
ZOO 401 (A) Entomology II

Unit	Particulars	Hours	Marks
	Insect Physiology and Applied Entomology		
	Insect Physiology		
1	Penetration of substances through cuticle	**03**	**03**
2	Nutritional requirement and mechanism of digestion	**03**	**03**
3	Circulation : a) Circulatory Mechanisms in Terrestrial and Aquatic insects b) Control of Heart beat	**03**	**03**
4	Excretion in Terrestrial and Aquatic insects	**03**	**03**
5	Respiration : a) Diffusion theory of respiration b) Respiratory Mechanisms in Terrestrial and Aquatic insects	**03**	**03**
6	Physiological Properties of Insect Muscle	**05**	**05**
7	Locomotion - Terrestrial, Aerial and Aquatic	**03**	**03**
8	Neural Integration and Sense Organs	**04**	**04**
9	Role of Hormones in Reproduction, Metamorphosis and Regeneration	**03**	**03**
	Applied Entomology		
10	General biology of important pests of crops cultivated in Maharashtra in particular and India in general :	**06**	**06**
	a Agricultural Crop pests : Sugarcane, Paddy, Maize, Jawar.		
	b Fiber crop pests: Cotton, Jute.		
	c Vegetable pests: Bhendi, Brinjal, Cabbage, Pea, Chillies, Onion.		
	d Fruit pests: Lemon, Mango, Guava, Ber-cucurbita.		
	e Oil seed plant: Ground nut Castor, Soyabean, Mustard, Sesamum		
11	Important pests of forest trees and steps taken to check their infestation :	**06**	**06**
	a) Termites, b) Forest defoliators, c) Borers and d) Sap suckers		
12	Medical and Veterinary entomology with reference to important Vectors and their control measure :	**06**	**06**
	a) Mosquito, b) Housefly, c) Flea and d) Sand fly		
13	Household and stored grain pests their control :	**06**	**06**
	a) Rice weevil, b) Pulse beetle, c) Tribolium and d) Rice moth		
14	Integrated pests Management (I.P.M.), Role of insects in forensic science	**06**	**06**
	Total	**60**	**60**

Practical Corresponding to ZOO 401 (A) Entomology II

Practical Corresponding Insect Physiology

1. Detection of chitin in insects
2. Detection of $CaCO_3$ in Malphigian tubules of cockroach
3. Study of haemocytes in insect haemolymph
4. Detection of Uric acid in Malphigian tubules of cockroach
5. Estimation of amylase activity in alimentary canal of cockroach
6. Counting of Heart beats of cockroach by using normal insect saline and effect of drugs, temperature on Heart beats

Practical Corresponding to Applied Entomology

1. Study of insect pests of agricultural importance
   a. Agricultural crop pests: Maize, Sugarcane
   b. Pests of Vegetables: Bhendi, Brinjal, Cabbage
   c. Pests of Fiber Crops: Cotton and Jute
   d. Pests of Fruit Plants: Lemons, Mango, guava.
   e. Pests Oil Seeds: Ground nut, Soyabean
2. Study of insect vectors of man: Mosquitoes, House fly, Bedbug, Head louse
3. Study of insect pest of cattle and domestic animals: Mite, Horn fly, Horse fly
4. Study of stored grain pests and Household pests : Flour beetle, Rice weevil, Pulse beetle
5. Study of forest pests : Termites, Borers, Defoliators etc.
6. Study of forensic insects: Flesh fly, Blow fly,
7. Compulsory Field Trip - To visit Agriculture University, Institute etc.

Reference books

- The principles of Insect Physiology by V. B. Wigglesworth (Chapman and Hall Ltd. London. 7th Ed. 1972).
- An Introduction to Insect Physiology By E. Bursell (Academic Press Inc. New York, 1978)
- The Physiology of Insects by M. Rock stein Vol. I- VI (Academic press London 1973-76).
- Fundamental of Applied Entomology by R.E. Pfadt (Mac Millan, New York, 2nd Ed.1971).
- Introduction to Applied Entomology by JRI Short (Longmans Green London 1963).
- Entomology by D. N. Roy and A WA Brawn. The Banglore Printing and Publ. Co. Ltd. 1970.
- Insects and other Arthropods of Medical importance by KGV Simi Trustees of Britmus London, 1973.
- Crop pests and how to fight them- Govt. of Maharashtra Pub. Bombay.
- Insect pests of crop by S. Pradhan (NBY, New Delhi 1969).

M. Sc. Part II: Semester IV
ZOO 401 (B) Animal Physiology – II

Unit	Particulars	Hours	Marks
1.	**Water Relation and Ionic Regulation** a) Role of membranes in osmotic and ionic regulation; Role of body fluid; b) Adaptation to marine habitat; Adaptation to brackish water habitat; Adaptation to Fresh water habitat; Adaptation to terrestrial habitat	08	08
2.	**Physiology of Muscles** a) Types: a) Phasic muscles b) Tonic Muscles c) Striated Muscles d)Smooth muscles e) Cardiac muscles ; b) Chemical Composition of Muscle: Water; Proteins; Actin; Myosin; Tropomyosin; Troponin; Actinin; c) Neuromuscular junction; Motor unit; Membrane excitation; d) Mechanism of muscle contraction; Sliding filament theory; e) General properties of Muscles; Properties of Voluntary muscles; Physical and Chemical aspects of muscle contraction; Molecular basis of Muscle contraction; Control of Muscle contraction; f) Role of Regulator proteins and calcium in muscle contraction; Changes during muscle contraction; Single muscle twitch; Latent phase or period; Contraction phase; Relaxation phase; g) Invertebrate muscle, h) Tetanus	14	14
3.	**Respiration** a) Introduction; b) Mechanism of respiration in man; c) Tidal volume and Vital capacity; d) Control of respiration; e) Respiratory pigments: a) Hemoglobin, b)Haemocyanin, c) Haemoerythrin, d) Chlorocruorin, e) Molpadin, f) Pinnaglobin, g) Vanadium, h) Echinochrome; f) Haemoglobin as an Oxygen Carrier; Transport of Gases- Oxygen transport: Oxygen, Dissociation Curve; Bohr's effect; Respiratory Quotient; g) Carriage of Carbon dioxide in the blood; Dissociation Curve of Carbon dioxide; Chloride shift; h) Anaerobiosis	10	10
4.	**Reproductive System** a) Patterns of Animal Reproduction i)Asexual reproduction-Fission, Budding, Spore, Formation, Fragmentation, Parthenogenesis, Gynogenesis and Androgenesis ii)Sexual Reproduction; Male Reproductive System- Spermatogenesis, Transportation of sperm, Composition of Semen; Female Reproductive System- Puberty; Oogenesis; Graafian Follicles; Menstrual cycle; Ovulation; Fertilization; Implantation; Oestrus Cycle: b) Hormonal Control of Reproductive Cycle; Menopause; c) Hormonal Control of Pregnancy; Parturition; d) Hormonal Control of Lactation	08	08

5.	**Endocrine System** a) Properties and types of Hormones, Mechanism of Hormone action b) The Pituitary Gland: Pituitary Gland in Different Chordates, It Hormones, c) Gigantism, Acromegaly, Dwarfism; d) Thyroid Gland: Cretinism, myxoedema, exophthalmic Goitre; e) Parathyroid Gland: Functions of PTH, Disorders of parathyroid; f) Pancreas: Islets of Langerhans: Diabetes g) Adrenal Gland: Addison's disease, Cushing's syndrome; h) Thymus Gland: Thymosin; i) The pineal Gland: Melatonin, j) Reproductive glands; Testes; Prostate gland, Ovary; Placenta; k) Gastrointestinal hormones; Renal Hormones; Prostaglandins; l) Endocrine Glands in Invertebrates: Neurosecretory cells and Neurosecretion; Neurosecretion in Insects; Pheromones	12	12
6.	**Sensory Physiology** a) Sensory coding - Transduction, Relationship between Stimulus Intensity and Response, Central control of Sensory Reception; b) Chemoreception - Gustation and Olfaction; c) Thermoreceptors and Infrared reception; d) Mechanoreception, Mechanotransduction - Invertebrate and vertebrate Mechanoreceptors - Muscles spindle, e) Acoustico lateralis System, f) Echolocation; g) Electroreception; h) Magnatoreception	08	08
	Total	**60**	**60**

Practical Corresponding to ZOO 401 (B) Animal Physiology – II

1. Study of adaption in brackish, Fresh, marine water and terrestrial habitat.
2. Recording of lung volumes and capacities by spirometry
3. Determination of oxygen consumption of any suitable animal.
4. Study of different types of muscles.
5. Super-ovulation in Rat
6. To study the estrous cycle by vaginal smear method.
7. Assessing skin sensitivity - locating different receptors
8. Study of Endocrine glands with the help of Slides/ Photographs
9. Qualitative estimation of hCG
10. Perform Semen analysis (Motility, Sperm count, Morphology of sperm)
11. Isolation of Haemoglobin

References

- Prakash S Lohar: Endocrinology-Hormones and Human Health, MJP Pulishers, Chennai
- G. J. Tortora: Principle of Anatomy and Physiology
- Hoar: General and Comparative physiology
- Dr. P.V. Jabade: General Physiology
- B.K. Berry: Animal Physiology
- C.C. Chatterjee: Human Physiology

- Goel and Shastri: Textbook of Animal Physiology
- K.S. Nelson: Animal Physiology
- Holurn: Principles of Physiology and Biochemistry
- Bell and Davidson: Textbook of Physiology and Biochemistry
- Harper, Physiological chemistry
- Mariakuttikan N. Arumugam: Animal Physiology
- Itta Sambasiviah, A. P. Kamalakara Rao, S. Augustiane Chellappa: A Textbook of Animal Physiology and Ecology

M. Sc. Part II: Semester IV
ZOO 401 (C) Reproductive Physiology – II

Unit	Topics	Hours	Marks
1	Follicular phase of the estrous cycle, follicular waves, oogenesis, ovulation	06	06
	Luteal phase of the estrous cycle and the menstrual cycle	06	06
	Estrous Synchronization (Induction of Ovulation)	04	04
2	Spermatogenesis	06	06
	Epididymal maturation, ejaculation and semen	04	04
	Estrus and endocrine disruption	04	04
3	Sexual behavior	04	04
	Gamete transport, Sperm Capacitation and Acrosome Reaction; Fertilization	06	06
	Hormonal Control of female cycles	04	04
4	Gametogenesis at the chromosomal level: mitosis and meiosis	02	02
	Semen collection, semen evaluation, cryopreservation Human Contraception and Human reproductive Technologies	10	10
5	Placentation, Gestation, Parturition, Lactation	04	04
	Total	**60**	**60**

Practical Corresponding to ZOO 401 (C) Reproductive Physiology – II

1. Study of various stages of development of mammalian egg, cleavage, blastula,gastrula.
2. Study of histological slides of placenta.
3. Study of types of contraceptives.
4. Demonstration of surgical operation in rat/mice- tubectomy.
5. Demonstration of surgical operation in rat/mice- vasectomy.
6. Collection and preservation of Mammalian sperms.

References

- Prakash S. Lohar (2012) Endocrinology, MJP Publishers, Chennai
- P. J. Hogarth, 1978- Biology of Reproduction Wiley, New York.
- J. S. Perry, 1971- The Ovarian cycle of animals, Oliver and Boyed.
- C.R. Austin and R. V. Short, 1972 Reproduction in Mammals, Vol. 1-8, Cam. Uni. Press.
- P. Gibian and E.J. Platz, eds, 1970- Mammalian Reproduction, Springer Verlag.
- Robert H. Williams, 1981 – Text book of Endocrinology, W. B. Saunders Company
- Wilfred M. Copenhaver, Douglas E. Kelly and Richard L. Wood – Bailey's text book of histology, Williams and Wilkins, Baltimor/London

M.Sc. Zoology Part II: Semester IV
Zoology 401 (D): Helminthology - II

Unit No.	Name of Topic	Hours	Marks
01	1. Habitat and Environment of different parasites. Host parasite system. 2. Host reaction to parasites, Pathogenicity of endo parasites. 3. General control measure of endo-parasites. Chemical, Biological, Physical/ Mechanical, Culture and Legislative. 4. Economic importance of parasites, direct or indirect effect on human, animal, farm animals and agriculture, poultry and fisheries pathogenicity.	**08**	**08**
02	1. Parasite and global public health. 2. General pattern of parasitic transmission. 3. Parasitic zoonosis. 4. Bioterrorism threats.	**08**	**08**
03	Study of medically and veterinary important Parasitic Nematodes. a. Intestinal nematodes infective in egg stage. b. Intestinal nematodes infective in larval stage. c. Blood & tissue dwelling nematodes	**10**	**10**
04	1. Feeding and nutrition's in Nematodes. 2. Essential foods, blood feeding by Hookworms and other nematodes. 3. Reproductive system in male, female, fertilization, development and hatching of eggs. 4. Moulting and Development in nematodes.	**10**	**10**
05	1. Different life cycle patterns in Nematodes. 2. Morphology, life cycle, pathogenicity, control and prevention of following types. *a. Strongyloides stercoralis* *b. Wuchereria bancrofti* *c. Trichenella spiralis* *d. Trichuris trichura*	**08**	**08**
06	1. General organization and Outline classification of plant Nematodes. 2. Feeding habits and modifications in anterior region. 3. Reproductive systems. 4. Ecology of nematodes.	**08**	**08**
07	1. Symptoms of Nematode injuries to plants (above ground. below ground) 2. Controlling nemic diseases of plants (Cultural, biological, chemical, physical, legislative) 3. Life cycle studies of followings *a.* Root knot Nematodes (*Meloidogyne)* b. Citrus Nematodes (*Tylenchulus)* c. Bud and leaf Nematodes (*Aphelenchoides)* *d.* Seed gall Nematodes (*Anguina)*	**08**	**08**
	Total	**60**	**60**

Practical corresponding to Zoology 401 (D) Helminthology – II

1. Techniques for collection and Fixation of nematodes from various hosts.
2. Basic techniques of preservation and mounting of Nematodes.
3. Identification of collected nematodes.
4. Sketching of the nematodes with the help of Camera Lucida.
5. Examination of faecal sample of sheep, goat and chicken for different helminthes ova and their identification.
6. Study of permanent whole mount slides: (At least 8).
7. Techniques of collection, fixation, mounting and identification of Plant nematodes.
8. Study of prevalence & intensity of parasites from locally available hosts.
9. Demonstrate / study the effect of season/ phonological factors as the prevalence and intensity of parasites.
10. Submission of permanent slides at the time of examination.
11. Visit to veterinary and medical parasitology laboratory

Reference books

1. The Invertebrates Vol.II - Hyman L. H.
2. The Trematode - Dausese B
3. Text book of medical Parasitology - Dey
4. Text book of medical Parasitology - Sawitz
5. Parasitology - Nobel and Nobel
6. Structure of Nematode - Allen bird
7. An introduction to Nematodology - Chitwood
8. Organization and Biology of nematodes -Crool
9. Physiology of nematodes - Lee
11. Principal of Nematodology - Throne
12.Clinical Parasitology - Craig Faust
13. Applied Parasitology - Hiware, Jadhav and Mohekar
14. Biochemistry of parasitism - Von Brand
15. Physiology of nematode parasite - Smith
16. Helminth, Arthropod and Protozoa of domesticated animal -Solbsy E.J.W
17. Practical exercise in Parasitology - Halton, Behave, Marshall.
18. Animal Nematodes from Indian Mammals - Nama, Shinde and Jadhav.
19. Cestodes from Indian fishes - Baba Jadhav.
20. Parasitology (Protozoology and Helminthology) -Chatterjee K. D. (1969)
21. The Zoology of Tapeworm. - Wardle and Mcleod (1952)
22. The advances in the Zoology of tapeworm from Wardle and Mcleod (1952)
23. Systema Helminthum Vol. II Cestoda. – Satyu Yamaguti (1959)
24. The Physiology of Cestodes. - J.D Smyth
25. Vertebrate Nematodes - York and Mapelston
26. Clinical Parasitology - Beaver, Jung & Cupp
27. An Introduction to Parasitology - Chandler and Read
28. Modern Parasitology - Cox
29. Essential Parasitology -Schmidt
30. Parasitism - Cameron
31. Animal Parasitism - Read
32. Parasitism and Symbiology - Read
33. Physiology of nematode parasites - Bee
34. Nematodes Parasites of domestic animal - Levine
35. Structure of Nematodes -Allen Bird

36. Medical Parasitology (Protozoology and Helminthological) - Chatterjeei K. D
37. Laboratory Methods for work with plant and soil Nematodes. – Southey
38. Parasitology - Nobel and Nobel
39. Biology of nematode - Crool
40. Physiology of cestode parsitology - Smith
41. Chatterjee K. D. (1969) -Parasitology (Protozoology and Helminthology)
42. Cheng T.C. (1964)-The Biology of animal parasites, Saunders International Student Edition.
43. The Invertebrates Vol II, McGraw Hill, New York.- Dawes B. (1946).
44. Text book Medical Parasitology of Jaypee Brothers, - Panikar C.K.J (1988) Medical Publishers, New York.
45. The Parasitology of Trematodes Oliver and Boyd Ltd. Edinburgh - Smyth J.D (1977)
46. The advances in the Zoology of tapeworm from - 1970- Wardle and Mcleod
47. Systema Helmenthum Vol. II Cestoda – Satyu Yamaguti (1959)
48. The Physiology of Cestodes. - J.D Smyth
49. Clinical Parasitology - Beaver, Jung &Cupp
50. An Introduction to Parasitology - Chandler and Read
51. Essential Parasitology -Scmidt
52. Animal Parasitism - Read
53. Structure of Nematodes - Bird

M.Sc. Zoology Part II: Semester IV
ZOO 402: Systematic and Evolutionary Biology

Unit	Particulars	Hours	Marks
1.	Definition and basic concepts in Systematics : a) Alpha taxonomy b) Beta taxonomy c) Gamma taxonomy I) Microtaxonomy II) Macrotaxonomy a) Phenetics (or Numerical taxonomy), b) Cladistics (Phylogenetic systematics) and c) Evolutionary taxonomy (or Evolutionary systematics).	6	6
2.	Newer trends in systematic: a) Chemotaxonomy b) Cytotaxonomy c) Molecular systematics d) DNA bar coding.	8	8
3.	Taxonomic procedure : a) Taxonomic collections- types of collections, value of collections b) Curation- preservation of collection in field and laboratory c) Recording of field data, storage of collection, labelling and cataloguing of collections d) Identification- Methods of identification	8	8
4.	Taxonomic keys: a) Types of taxonomic keys, their merits and demerits b) International code of Zoological nomenclature. Its operative principles, interpretation and application of important rules. c) Zoological nomenclature, formation of names and various taxa	8	8
5.	Natural Selection: a) Mechanism of natural selection - Directional, disruptive and stabilizing selection b) Natural selection in Islands. c) Sexual selection; Intrasexual and intersexual selection	6	6
6.	The Mechanisms: a) Co-evolution; b) Microevolution, c) Macroevolution. Convergent (homoplasy) –divergent-parallel evolution. d) Gradualism e) Punctuated equilibrium.	8	8
7.	Molecular evolution: a) Neutral theory of molecular evolution; b) Molecular divergence. c) Molecular drive. d) Molecular clocks- genetic equidistance e) Human mitochondrial molecular clock.	8	8

8.	Evolutionary trends: a) Biochemical evolution- Collapse of Orthogenesis. b) Stages in primate evolution including Homo: dry and wet nosed primates, prosimians and simians. c) Communication, speech, language and self-awareness in primates.	8	8
	Total	**60**	**60**

Practicals corresponding to ZOO 402 Systematics and Evolutionary Biology

1. Classification of Invertebrates specimens: one example from each phylum (preserved/Digital Image /Models/chart)
2. Classification of Vertebrates specimens: one example from each Class (preserved/ Digital Image/Models/chart.)
3. Method of collection, Preservation, and Curetting of any insect Specimen.
4. Identification of animals with the help of keys- Butterflies/ Earthworm/ Any suitable Invertebrate animal.
5. Identification of animals with the help of keys- Fish/ Birds/ any available species
6. Study of convergent evolution.
7. Study of divergent evolution.
8. Taxidermy of any suitable animal.
9. Study of Phylogenetic tree
10. Visits to Scientific Institute like Zoological Survey of India and Report writing

References books

1. Mayr, E (1969) Principles of Systematic Zoology . McGraw Hill Book Campny, Inc., NewYork.
2. Narendran, T.C (2008) An introduction to Taxonomy . Zoological survey of India.
3. Sneath P.H. A. (1973): Numerical Taxonomy: The Principles and Practice of Numerical Classification, W H Freeman & Co.
4. David, M. H, Craig Moritz and Barbara K. M. (1996) Molecular Systematics. Sinauer Associates, Inc.
5. Futuyama, D. (1997). *Evolutionary Biology*. 3rd ed. Sinauer Associates, INC.
6. Futuyama, D. (2005). *Evolution.* Sinauer Associates, INC.
7. Strikberger, M.W. (2005) Evolution, Jones and Bartett Publishers, London
8. Motoo Kimura (1983). The neutral theory of molecular evolution. Cambridge University Press.

M.Sc. Zoology Part II: Semester IV
ZOO- 403 Skills in Scientific communication and Writing research report

Unit No.	Particulars	Hours	Marks
1.	Nature and scope of communication: theory, concept and meaning of communication, objectives of communication, effective communication, global communication, Techniques to improve communication: speaking (phonetics), writing communication –definition characteristics, objectives, structure of communication effective written communication, reading, reading skills, techniques of improving retention, with reading strategy,	10	10
2.	Listening: definition, personal characters and effective listening, introduction to modern communication media Conferencing - introduction, importance techniques, media Oral communication: effective communication, characteristics of verbal or oral communication, speaking skill and group discussion Presentation skill: i) planning, audience, purpose, time subject Pattern ii) preparing drafting talk iii) practicing vi) presentation to different group	10	10
3.	Writing a research report: purpose of writing research report of dissertation and thesis, style and structure of research report, preliminary section, main body of the report, - introduction, review of literature, methods of study, results and analysis of data, summary, suggestion and conclusion of data, reference section, general precautions, editing and correction, final evaluation of research report, IMMRAD pattern of research report	10	10
4	Use of visual aid for effective presentation synopsis, summary, abstract, tables, graphs, power point presentation Poster presentation: title, author, affiliation, introduction material and methods, results, summary selection of appropriate Font size, table, figure etc	10	10
5	Introduction to Bioinformatics: Over view of bioinformatics resources on the web. Proteomics and Genomics : Definition Biological Databases- Concept and types of databases Database retrieval System PubMed, ENTREZ, SRS, PIR, ExPAsy, Ensembl.	10	10
6	Sequence alignment: Global alignment and Local alignment, Significance with example BLAST, types and applications. FASTA, format and application	12	12
	Total	**60**	**60**

Practical corresponding to ZOO- 403 Skills in Scientific communication and Writing research report

1. Prepare a protocol of any experiment (Give- i) Principle, ii) Requirement, iii) Procedure, iv) Observation, v) Tables and vi) Inference
2. A close study of research article published in any of the foreign research journals with reference to i)Title, ii) Abstract, iii) Introduction, iv) Materials and Methods, v) Observations/ result, vi) Tables/ Graphs (Histograms, Bar graph) and its interpretation, vii) Discussion, viii) References and x) Summary
3. Preparation of Tables and Graphs from the given hypothetical data
4. Communication skill – narration of any scientific news from any science report (sequence of facts, results, conclusions) and group discussion
5. Effective reading – read a passage (Pay attention to stress, pause, rhythms and style)
6. Paragraph writing – characteristics of good paragraphs, study of some good paragraphs having some scientific information. Find out difficult words and know their meanings. Underline the key sentences. Give abstract of the passage. Suggest suitable title to the passage
7. Effective writing communication skill. Drafting a letter for, procurement of animals, purchasing of chemicals, requesting for financial assistance for research project for Government agencies, sending a research paper to editor for publication
8. Evaluation of similarity percentage using sequence alignment tool
9. Using NCBI resources find out nucleotide database of any one gene
10. Visit to the research laboratory/Institute

References

- Dr. Nageshwar Rao and Dr. Rajendra P. Das: Communication Skills, Himalaya Publishing House 2005
- Margerson, J.E.: The Art of effective communication, Excel Books New Delhi
- Richard, W. Clark and Barbara, L. Clinton: Effective Speech Communication, MacMillan, Mac Graw Hill, New York, 1999
- N. Gurumani, Research Methodology for biological sciences, MJP publishers, Chennai
- Gopen, G.D. and Swan J.A. The Science of Writing, American Scientist, 1990
- Hall, G.M. How to write a paper, By Word publication, 1996

North Maharashtra University, Jalgaon
M. Sc. (Part II) Zoology
Equivalence for old syllabus 2015

Paper code	Old course – 2015	Paper Code	New course – 2018
Semester III			
ZOO 301	Special Paper Entomology – I (A) Insect taxonomy and Morphology - I (B) Insect taxonomy and Morphology - II	ZOO 301	Special Paper (A) Entomology – I
			OR
ZOO 301	Special Paper Animal Physiology - I (A) Animal Physiology section - I (B) Animal Physiology section - II	ZOO 301	Special Paper (B) Animal Physiology – I
			OR
ZOO 301	Special Paper Reproductive Physiology - I (A) Reproductive Physiology – I (B) Reproductive Physiology – II	ZOO 301	Special Paper (C) Reproductive Physiology – I
			OR
		ZOO 301	Special paper (D) Helminthology – I
ZOO 302	(A) Fresh water zoology (B) Skills in scientific communication and writing research report	ZOO 302	Immunology and Molecular Biology
ZOO 303	(A) Medical physiology / Insect Anatomy (B) Animal Biotechnology	ZOO 303	Genetics
ZOO 304	Practicals 301 (A) + 301 (B) + 302 (A)	ZOO 304	Practical 301 + 302
ZOO 305	Practicals 302 (B) + 303 (A) + 303 (B)	ZOO 305	Practical 302 + 303
Semester IV			
ZOO 401	Special Paper Entomology – II (A) Insect Physiology (B) Applied Entomology	ZOO 401	Special Paper (A) Entomology – II
			OR
ZOO 401	Special Paper Animal Physiology - II (A) Animal Physiology section - I (B) Animal Physiology section - II	ZOO 401	Special Paper (B) Animal Physiology – II
			OR
ZOO 401	Special Paper Reproductive Physiology - II (A) Reproductive Physiology – I (B) Reproductive Physiology – II	ZOO 401	Special Paper (C) Reproductive Physiology – II

			OR
		ZOO 401	Special paper (D) Helminthology – II
ZOO 402	(A) Systematic and evolutionary biology (B) Advanced methods in biology	ZOO 402	Systematic and evolutionary biology
	(A) Fundamental processes and advanced tool in biology (B) Forensic zoology	ZOO 403	Skill in Communication and Writing research Paper and Project report
ZOO 404	Practicals 401 (A) + 401 (B) + 402 (A)	ZOO 404	Practical 401 + 402
ZOO 405	Practicals 402 (B) + 403 (A) + 403 (B)	ZOO 405	Practical 403 + Project work

NOTE:

1. Zoological excursions are compulsory for each semester.
2. Each theory course consists of total 60 periods of 45 minutes each.
3. Each theory course requires 05 periods and 1 tutorial per week.
4. Each practical course requires 02 practicals per week and each practical requires 04 hour duration.
5. Figures to the right hand side indicate number of periods and marks to the respective Units.
6. (a) Project work for Sem- IV is compulsory with weightage of 30 marks on which the final examination will be conducted.
   (b) The work load of the project will be equivalent to 16 practicals in semester IV.
   (c) There shall be maximum 05 students in each project batch, with a common topic of project.
   (d) Soft and hard copies of each project shall be deposited to the Department of Zoology of respective colleges.
   (e) Power-point presentation at the time final examination (IV Semester) is compulsory.