

NORTH MAHARASHTRA UNIVERSITY, JALGAON

M. Sc. (Part-II) ZOOLOGY

New Syllabus 2015-2016

Pattern 80-20

Semester I

	UA + CA	Hours
ZOO 301: Special Paper Entomology – I		
(A) Insect Taxonomy and Morphology - I	40 marks + 10	30
(B) Insect Taxonomy and Morphology - II	40 marks + 10	30
ZOO 301: Special Paper Animal Physiology – I		
(A) Animal Physiology section – I	40 marks + 10	30
(B) Animal Physiology section – II	40 marks + 10	30
ZOO 301: Special Paper Reproductive Physiology – I		
(A) Reproductive Physiology – I	40 marks + 10	30
(B) Reproductive Physiology – II	40 marks + 10	30
ZOO 302: (A) Freshwater Zoology	40 marks + 10	30
(B) Skills in scientific communication and writing research report	40 marks + 10	30
ZOO 303: (A) Medical physiology / Insect Anatomy	40 marks + 10	30
(B) Animal Biotechnology	40 marks + 10	30
ZOO 304: Practical 301 (A) + 301(B) +302(A)	80 marks + 20	60
Six practicals corresponding to 301 (A) (30 marks)		
Six practicals corresponding to 301 (B) (20 marks)		
Four practicals corresponding to 302 (A) (30 marks)		
ZOO 305: Practical 302(B) + 303(A) + 303(B)	80 marks + 20	60
Four practicals corresponding to 302 (B) (20 marks)		
Six practicals corresponding to 303 (A) (30 marks)		
Six practicals corresponding to 303 (B) (30 marks)		

Semester II

	UA + CA	Hours
ZOO 401: Special Paper Entomology – II		
(A) Insect Taxonomy and Morphology - I	40 marks + 10	30
(B) Insect Taxonomy and Morphology - II	40 marks + 10	30
ZOO 401: Special Paper Animal Physiology – II		
(A) Animal Physiology section – I	40 marks + 10	30
(B) Animal Physiology section – II	40 marks + 10	30
ZOO 401: Special Paper Reproductive Physiology – II		
(A) Reproductive Physiology – I	40 marks + 10	30
(B) Reproductive Physiology – II	40 marks + 10	30
ZOO 402: (A) Systematic and evolutionary biology	40 marks + 10	30
(B) Advanced methods in biology	40 marks + 10	30
ZOO 403: (A) Fundamental processes and advanced tool in biology	40 marks + 10	30
(B) Forensic Zoology	40 marks + 10	30
ZOO 404: Practical 401 (A) + 401 (B) + 402(A)	80 marks + 20	60
Six practicals corresponding to 401 (A) (30 marks)		
Six practicals corresponding to 401 (B) (30 marks)		
Four practicals corresponding to 402 (A) (20 marks)		
ZOO 405: Practical 402(B) + 403(A) + 403(B)	80 marks + 20	60
Four practicals corresponding to 402 (B) (20 marks)		
Six practicals corresponding to 403 (A) (30 marks)		
Six practicals corresponding to 403 (B) (30 marks)		

M. Sc. Zoology Part II : Semester III

ZOO 301: Special Paper

ZOO 301 (A) Insect Taxonomy and Morphology – I

Unit	Particulars	Hours
1.	Introduction to Entomology : Definition, Origin, Evolution and Inter relationship of insects with other arthropods.	05
2.	General outline of Classification and Phylogeny of insects.	08
3.	Classification of following insects orders upto families – A) Apterygota – i) Ectognatha – 1) Thysanura, ii) Endognatha – 1) Diplura, 2) Protura, 3) Collembolla, B) Pterygota - Exopterygota i) Palaeopteran orders – 1) Ephemeroptera, 2) Odonata, 3) Plecoptera, 4) Grylloblattoidea. ii) Polyneopteran orders – 1) Orthoptera – Tettigonidae, Gryllotalpidae, Acrididae, 2) Phasmida, 3) Dermaptera, 4) Embioptera, 5) Dytioptera - Blattidae, Mantidae, 6) Isoptera, 7) Zoraptera. iii) Paraneopteran orders – 1) Psocoptera, 2) Mallophaga, 3) Siphunculata, 4) Hemiptera – a) Suborder – Homoptera - Flugoridae, Cicadidae, Aphididae, b) Suborder – Heteroptera – Cimidae, Pyrochoridae, Pentatomidae, Belostomidae, 5) Thysanoptera.	12
4.	Integument and its derivatives	05
	Total	30

Practicals related to ZOO 301 (A) Insect Taxonomy and Morphology – I

1. Collection and preservation techniques of insects
2. Classification of insects upto orders and families
3. Pictorial Collection and Identification of 25 insect species related to different orders and families
4. Culturing/rearing of any suitable insect/s (Eg. Housefly/ drosophila)
5. Compulsory visit to Agriculture College or University or institute.

References

- Imm's Text book of Entomology by O.W. Richards and R.G. Davis (Methuen London 1977) Vol. I and II.
- The Text book of Entomology by H. H. Ross, (John Wiley & Sons) Inc. New York 3rd Ed. 1965.
- General Applied Entomology by K. K. Nayar, T. N. Anantha Krishan and B. V. David (Tata McGraw Hill, New Delhi, 1976).
- Modern Entomology by D. B. Tembhare (Himalaya Publishing House, 2012).

ZOO 301 (B) Insect Taxonomy and Morphology - II

Unit	Particulars	Hours
1.	Classification of following insects orders upto families – Pterygota – Endopterygota – Oligoneopteran orders – 1) Neuroptera, 2) Mecoptera, 3) Lepidoptera - Nymphalidae, Pieridae, Papillionidae, Geometridae, Sphingidae, Noctuidae, Saturniidae, 4) Trichoptera, 5) Diptera – a) Suborder – Nematocera - Culicidae, Chironomidae b) Suborder - Brachaeocera – Tabanidae c) Suborder – Cyclorrhapha - Syrphidae, Muscidae, Hippoboscidae, Glossinidae 6) Siphonoptera 7) Hymenoptera – a) Symphyta – Tenthredinidae b) Apocrita - Ichneumonidae, Braconidae, Apidae. 8) Coleoptera – a) Suborder - Adephaga - Carabidae, Dyticidae b) Suborder – Polyphaga - Hydrophilidae, Staphylinidae, Scarabidae, Buprestidae, Cantharidae, Dermastidae, Coccinellidae, Tenebrionidae, Meloidae, Curculionidae 9) Strepsiptera	08
2.	Comparative study of head and its appendages	07
3.	Comparative study of thorax and its appendages	07
4.	Comparative study of abdomen and its appendages	08
Total		30

Practicals related to ZOO 301 (B) Insect Taxonomy and Morphology - II

1. Classification of insects up to orders and families
2. Pictorial Collection and Identification of 25 insect species related to different orders and families
3. Histology of integument and its derivatives (D)
4. Comparative study of head capsule – any four (adults or larvae) from local area
5. Study of types of mouthparts and antennae
6. Study of types of legs, wings and wing venation
7. Study of abdominal appendages
8. Compulsory visit to Agriculture College or University or institute.

References

- The Insects – Structure and function by R. F. Chapman (ELBS) London 1972.
- Imm's Text book of Entomology by O.W. Richards and R.G. Davis (Methuen London 1977) Vol. I and II.
- Principles of insect morphology by R.E. Snodgrass (Tata Mc Graw Hill Bombay 1978)
- General Applied Entomology by K. K. Nayar, T. N. Anantha Krishan and B. V. David (Tata McGraw Hill, New Delhi, 1976).
- Modern Entomology by D. B. Tembhare (Himalaya Publishing House, 2012).
- Introduction of Comparative Entomology by R. M. Fox and J. W. Fox (Reinhold, New York).

ZOO 301 (A) Animal Physiology – I

Unit	Particulars	Hours
1.	Introduction: Importance of physiology; Branches of physiology	04
2.	Chemical foundation of physiology: Osmosis; Diffusion; pH and Buffer	05
3.	Physiological and Biochemical effects: Deficiency manifestation and daily dosage	05
4.	Digestion <ul style="list-style-type: none">• Feeding Pattern- Suspension; Large partial Feeding, Fluid or soft tissue Feeding, Surface nutrient absorption• Generalize structure & function of alimentary tract-digestive pattern in the various regions of the gut.• Specialized digestive system – Cellulose; Chitin; Wax; Algal Farming; Symbiont transfer• Nutrition- Amino acid ,fatty acids ,steroids, vitamins, regulation of nutritional intake	08
5.	Excretion <ul style="list-style-type: none">• Excretory organs: epithelial exchange; Tubular excretion; Water and solute excretion• Lower invertebrate annelids, mollusc, arthropods, cephalochordates and urochordates, vertebrates.• Nitrogen metabolism – amino metabolism; Nucleic acid metabolism• Other nitrogenous waste products; Pattern of nitrogen excretion	08
Total		30

Practicals corresponding to Animal Physiology section I

1. Units of measurements buffers, normal solutions and normalities, physiological saline solution
2. To demonstrate the principle of dialysis
3. To demonstrate the principle of Osmosis
4. Determination of Salivary digestion and Pancreatic digestion
5. Determination of GFR
6. Determination of nitrogenous excretory product – Uric acid

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

ZOO 301 (B) Animal Physiology – II

Unit	Particulars	Hours
1	Metabolism Inter relation between the metabolism of carbohydrates fats and proteins	07
2	Detoxification mechanism and role of microsomal enzymes in Detoxification.	07
3	Circulatory system Blood Volume; Fluid pressure and flow; Pressure in open circulatory system; Pressure in closed circulatory system; Hydrostatic system; Types of hearts: Pattern of blood flow; Chambered hearts; Tubular Hearts, pulsating vessels, ampular hearts; Heart rate and output; Pace maker, myogenic & neurogenic hearts; Crustacean heart ganglion; Nervous regulation of heart; Properties of heart muscles Lymphatic system Lymphocytes, Lymphatic vessels, compositions of lymph	08
4	Nervous System Nervous tissue- Neurons, glia; Integrative Neurophysiology- Interneurons, neural circuits; Nerve Networks- Primitive nervous system, Nerve nets, Nerve cords and Brains, chordate nervous system; Memory and Learning; Biological clocks- circadian rhythms, Lunar rhythms, Circannual rhythms.	08
	Total	30

Practicals corresponding to 301Animal Physiology section II

1. Antioxidant activity of any suitable material. (Any two antioxidants)
2. Determination of Calcium in given sample of blood plasma or serum
3. Reflexes in man
4. Estimation of plasma proteins by copper sulphate specific gravity method any colorimetric method
5. Estimation of Blood Glucose level. (any suitable animal)
6. computer-based program for attention and memory problems.

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

ZOO 301(A) Reproductive Physiology – I

Unit	Particulars	Hours
1.	Puberty and delayed puberty	04
2.	Cellular structure of anterior pituitary gland and their hormones	04
3.	History of adrenal gland and role of steroid hormones in reproduction	05
4.	Male Reproductive organs (testis). i) Histology of Testis (Seminiferous tubules and interstitial cells). ii) Spermatogenesis iii) Spermiogenesis, maturation and storage of sperm. iv) Motility, capacitation and fate of spermatozoa. v) Control of testicular activity.	06
5.	Chemistry, biosynthesis, mode of action and functions of androgens	05
6.	Histological structure and functions of male accessory reproductive organs i) Epididymis ii) Seminal vesicle iii) Prostate gland iv) Bulbourethral gland v) The penis	06
	Total	30

Practicals corresponding to ZOO 301(A) 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 continuous breeder's rat/mice/human.
3. Study of different stages of estrous cycle.
4. Histological structure of adrenal gland.
5. Histological structure of male accessory reproductive organs.
6. Histological structure of female accessory reproductive organs.
7. Cellular structure of anterior pituitary gland.

References

- 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

ZOO 301 (B) Reproductive Physiology – I

Unit	Particulars	Hours
1.	Semen and composition of human semen	04
2.	Reproductive cycles- estrous and menstrual cycles	04
3.	Hormonal control of normal menstrual cycle	04
4.	Female reproductive organ (Ovary). i) Premenstrual, postmenstrual and postmenopausal ovary ii) Histology of ovary (follicles, maturation and ovulation) iii) Formation, histological structure and fate of corpus luteum iv) Cyclic nature of ovarian function v) Hormonal control of ovulation and oogenesis.	05
5.	Chemistry, biosynthesis, mode of action and functions of oestrogens	04
6.	Chemistry, biosynthesis, mode of action and functions of progesterone	04
7.	Histological structure of female accessory reproductive organs. -3 i) Fallopian tube ii) Uterus (Endometrium).	05
	Total	30

Practicals corresponding to ZOO 301 Reproductive physiology-I (Any six)

1. Study of different types of sperms (grasshopper, frog, human, rat/mice).
2. Total Count of sperms from semen of continuous breeder's rat/mice/ human.
3. Demonstration of surgical operation-orchietomy in rat/mice.
4. Demonstration of surgical operation-ovariectomy in rat/mice.
5. Estimation of protein in liver and testis/ovaries of rat by Lowry's method.
6. Estimation of ascorbic acid in testis/ovaries of rat by using phenyl hydrazine reagent.
7. Effect of adrenaline administration on glycogen content of testis/ ovaries of rat.
8. Estimation of total gonadal (Ovary) cholesterol from rat/mice.

References

- Wilfred M. Copenhaver, Douglas E. Kelly and Richard L. Wood – Bailey's text book of histology, Williams and Wilkins, Baltimor/London.
- Chandi Charan Chatterjee, 1985 – Human Physiology Vol.II Tenth Edition, Medical Allied Agency, Calcutta, India.
- Arthur J. Vander, James H. Sherman and Dorothy S. Luciano – Human Physiology,
- Mcgraw-Hill International Editions, Biological Sciences Series.
- Nalbandov, A. V.- Reproduction Physiology.

ZOO 302 (A) Freshwater Zoology

Unit	Particulars	Hours
1	Types of Aquatic environment: Lotic Habitat : Major river systems in India / rapid and slow moving rivers. Lentic Habitat: Lakes, Ponds and Swamps, Bogs lakes and succession of lakes. Ephemeral water bodies (Temporary habitat).	05
2.	Physical conditions of water: movement of water, Depth, Viscosity, Density, Buoyancy, (surface film and surface film animals), Temperature and light, Transparency and turbidity.	04
3.	Chemical conditions of water: Dissolved oxygen and Carbon di-oxide, phosphates, Nitrates. Acidity and alkalinity, Mg-hardness, Ca-hardness, dissolved solids, organic Matter, Importance of chemical conditions to aquatic life.	04
4.	Physiological and protective adaptations of the following. Protozoa, Rotifera, Crustaceans, Fishes.	03
5	Diagnostic features and life cycle of temporary rainwater pool animals: Fairy shrimps and Tadpole shrimps.	04
6	Respiratory and Locomotory adaptations in freshwater insects and their larvae.	04
7	Economic importance of freshwater molluscs (snails and bivalves) - as a food & medicine. Biological changes in freshwater due to sewage pollution (with reference to rivers) and its effect on freshwater animals.	06
	Total	30

Practicals corresponding to ZOO 302 (A) Freshwater Zoology (Any Six)

1. To prepare and maintain a culture of paramecium, Daphnia and Hydra.
2. Comparative study of physico-chemical parameters-pH, Temperature, DO, CO₂, Hardness, Chloride, Turbidity, etc of above said ecosystem.
3. Estimation of primary productivity with dark and light bottle method.
4. Study of aquatic and semiaquatic adaptations in amphibians and reptiles.
5. Study of locomotory and respiratory adaptations in aquatic insects and their
6. larvae (Ranatra, Notonecta, Gerris, Bellostoma, Dytiscus).
7. Identification of commercially important freshwater fishes and crustaceans.
8. Visit to freshwater body for the study of aquatic ecosystem.

References

- Ruttner, F. Fundamentals of Limnology. University of Toronto Press, 1968.
- Welch, P.S. Limnological Methods. McGraw Hill Book Company, New York.
- Aquatic pollution: Edward A.(2000) Laws. 3rd edition. John Wiley and Sons. New York.
- Life in Lakes and Rivers: T.T.Macan and Worthington E.B.(1951) COLLIN, London.
- Limnology: by Alexander Home, Charles Goldman.
- Limnology: Lake and River Ecosystem, Robert G. Wetzel 3rd edition.
- Fundamentals of Limnology: franz Ruttner. 3rd Edition. University of Toronto Press,
- The Ecology of Running water: Hugh Bernard Noel Hynes.
- Fresh water animals of India (An Ecological Approach) : G.T.Tonapi
- Trivedi & Goyal : Chemical and biological methods for water pollution studies

ZOO 302 (B) Scientific Research Report Writing

Unit	Particulars	Hours
1.	Nature and scope of communication: theory, concept and meaning of communication, objectives of communication, effective communication, global communication	03
2.	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,	04
3.	Listening: definition, personal characters and effective listening, introduction to modern communication media	03
4.	Conferencing - introduction, importance techniques, media	03
5.	Oral communication: effective communication, characteristics of verbal or oral communication, speaking skill and group discussion	03
6.	Presentation skill: i) planning, audience, purpose, time subject pattern ii) preparing drafting talk iii) practicing vi) presentation to different group	03
7.	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	08
8.	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	03
Total		30

Practical corresponding to ZOO 302 (B) Scientific Research Report Writing (Any Six)

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.

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

ZOO 303 (A) Insect Anatomy

Unit	Particulars	Hours
1	Comparative anatomical and histological study of the following: <ul style="list-style-type: none">• Alimentary canal and associated glands• Circulatory system• Respiratory system• Excretory system and fat bodies• Nervous system• Sense organs and exocrine glands• Reproductive system	20
2	Light and sound producing organs	10
	Total	30

Practicals related to Zoo 303 A Insect Anatomy

1. Dissection of Grasshopper to study the following systems –
 - a) Digestive system
 - b) Reproductive system – Male and Female
 - c) Nervous system
2. Mountings from Grasshopper – Spiracles, Tympanum and Genitalia.
3. Dissection of Red cotton bug, Beetle, Butterfly, House fly, Honeybee to study following systems (any Three insects)
 - a) Alimentary canal
 - b) Reproductive system
 - c) Nervous system
 - d) Mounting of Halter
4. Histology of different organs of –
 - a) Alimentary canal
 - b) Tracheae
 - c) Heart
 - d) Muscle
 - e) Blood of insects
5. Visit to different entomological institutions or agriculture college

References

- The Insects – Structure and function by R. F. Chapman (ELBS) London 1972.
- The Text book of Entomology by H. H. Ross, (John Wiley & Sons) Inc. New York 3rd Ed. 1965.
- Imm's Text book of Entomology by O.W. Richards and R.G. Davis (Methuen London 1977) Vol. I and II.
- Principles of insect morphology by R.E. Snodgrass (Tata Mc Graw Hill Bombay 1978)
- 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).
- Introduction of Comparative Entomology by R. M. Fox and J. W. Fox (Reinhold, New York).

ZOO 303 (A) Medical Physiology

Unit	Particulars	Hours
1.	Digestive System: Liver Disorders, pancreatic disorder, Stomach disorder and role of digestive hormones	06
2.	Excretory system: Normal and abnormal constituents and their significance, renal function test, Nephrotoxicity, nephritic syndrome	06
3.	Circulation and Respiratory system: Biochemistry of blood clotting, clotting factors, intrinsic and extrinsic pathways, Congenital and congestive heart failure, myocardial infarction, thrombosis, symptoms and remedies. Factors affecting on lung function, respiratory disorders asthma, bronchitis, swine flu, emphysema	06
4.	Nervous system: Disorders related to Nervous system – Alzheimer, Parkinson's	06
5.	Reproduction and Endocrinology: Sterility and Infertility, <i>in vitro</i> fertilization, immunological approach of fertility. Clinical applications in relation to hormonal disorders of pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Ovary and Testis	06
	Total	30

Practicals corresponding to ZOO 303 (A) Medical Physiology

1. Recording of lung volumes and capacities by spirometry
2. Estimation of SGOT/SGPT from given biological sample and study of it at different conditions
3. Determination of Acetyl Cholinesterase from given biological sample
4. Perform Semen analysis (Motility, sperm count, Morphology of sperm)
5. Study of blood clotting and bleeding time, RBC and WBC counting.
6. Determination of GFR

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

ZOO 303 (B) Animal Biotechnology

Unit	Particulars	Hours
1.	Animal Cell - Introduction of animal tissue culture and terminologies used in animal biotechnology, Primary and established cell line cultures, Biology and characterization of the cultured cells, Principle, Merits and Demerits of Animal cell/tissue culture	06
2.	Equipments and Media for Cell Culture - Infrastructure for cell culture: Equipments, culture vessel and materials, Media for culturing cells and tissues; natural and defined media, Preparation of various tissue culture media, Chemical, physical and metabolic functions of media constituents, Sterilization of culture media, equipments and apparatus	06
3.	Techniques of Cell Culture-I - Measurement of viability and cytotoxicity, Measurement of growth parameters, Basic techniques of mammalian cell culture <i>in vitro</i> ; disaggregation of tissue and primary culture, maintenance of cell culture, cell separation, Cell synchronization, Scaling-up of animal cell culture	06
4.	Techniques of Cell Culture-II - Cell transformation, <i>In vitro</i> culture of oocytes/embryos, Cell/embryo cryopreservation, Measurement of cell death, apoptosis, Cell cloning and micromanipulation, Risks and safety in the animal cell culture	06
5.	Applications of biological products - Application of Recombinant DNA in manufacture of biological products, insulin production, Human growth Hormone production, Interferon and interleukins, B) Immunological products, Vaccines general- killed, live vaccines, microbial products as vaccines, examples of various vaccines- polio, Rabies, Hepatitis B, Mums, measles, Influenza, Rubella. C) glandular products- pituitary, adrenal, pancreatic and thyroid extracts	06
	Total	30

Practical corresponding to ZOO 303 (B) Animal Biotechnology

1. Construction of an ideal animal cell culture laboratory, and study of necessary equipments/ instruments
2. Preparation of cell culture media for animal cell culture
3. Cell counting and testing cell viability
4. Assessment of glandular product for its biological activity
5. Preparation of single cell suspension from spleen of any suitable animal
6. Induction of super ovulation in any suitable animal

References

- Culture of animal cells (3rd Edition) by Freshney R.I. Wiley-Liss.
- Genes VIII by Lewin. Pearson Education International, NJ, USA, 2004.
- Animal Cell Culture – Practical Approach Edited by John RW. Masters, Oxford.
- Cell Growth and Division: A Practical Approach edited by Basega R, IRL Press.
- Animal Cell Culture Techniques edited by Martin Clynes, Springer.
- Methods in Cell Biology Vol.57, Animal Cell Culture Methods edited by Mather JP and Barnes D, Academic Press.

M. Sc. Zoology Part II : Semester IV

ZOO 401: Special Paper

Zoo 401 (A) Insect Physiology

Unit	Particulars	Hours
1.	Penetration of substances through cuticle	03
2.	Nutritional requirement and mechanism of digestion	03
3.	Circulation	03
4.	Excretion	03
5.	Respiratory Mechanisms	03
6.	Physiological Properties of Insect Muscle	05
7.	Locomotion- Terrestrial, Aerial and Aquatic	03
8.	Neural Integration and Sense Organs	04
9.	Role of Hormones in Reproduction, Metamorphosis and Regeneration	03
	Total	30

Practical Corresponding to Zoo 401 (A) Insect Physiology

1. Detection of chitin in insects
2. Detection of CaCO_3 in Malpighian tubules of cockroach
3. Study of haemocytes in insect haemolymph
4. Detection of Uric acid in Malpighian 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
7. Study of effect of drugs, temperature on Heart beats
8. Recording of ventilatory movements of suitable insect using kymograph
9. Mode of locomotion in aquatic insects.

References

- 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)

Zoo 401 (B) Applied Entomology

Unit	Particulars	Hours
1.	General biology of important pests of crops cultivated in Maharashtra in particular and India in general. : a. Agricultural Crop pests : Sugercane, 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	06
2.	Important pests of forest tree sand steps taken to check their infestation : Termites, Forest defoliators, borers, sap suckers	06
3.	Medical and Veterinary entomology with reference to important 4 Vectors and their control measure (Mosquito, Housefly, Flea, Sandfly)	06
4.	Household and stored grain pests their control (Rice weevil, Pulse beetle, Tribolium, Rice moth)	06
5.	Integrated pests Management (I.P.M.)	06
	Total	30

Practical Corresponding to Zoo 401 (B) Applied Entomology

- Study of insect pests of agricultural importance - I
 - Agricultural crop pests: Jawar, Maize, Paddy, Sugarcane etc.
 - Pests of Vegetables: Bhendi, Brinjal, Cabbage Pea, Chillies, Onion etc.
 - Pests of Fiber Crops: Cotton and Jute etc.
- Study of insect pests of agricultural importance - II
 - Pests of Fruit Plants: Lemons, Mango, guava Ber, Cucurbita etc.
 - Pests Oil Seeds: Ground nut, Castors Sesamum, Soyabean etc.
- Study of insect vectors of man : Mosquitoes, House fly, Bedbug, Fleas, Head louse, Sand fly, Eye fly etc.
- Study of insect pest of cattle and domestic animals.
- Study of stored grain pests and Household pests : Flow beetle, rice weevil, pulse beetle, cockroach, silver fish.
- Study of forest pests : Termites, Borers, defoliators etc.
- Study of useful insect of economics importance : Honeybees, Lac insect.
- Effect of pesticides on pests.
- Compulsory Field Trip - To visit Agriculture University, Institute etc.

References

- 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. W. A. 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).

ZOO 401(A) Animal Physiology – II

Unit	Particulars	Hours
1.	Water relation and ionic regulation Role of membranes in osmotic and ionic regulation; Role of body fluid; Adaptation to marine habitat; Adaptation to brackish water habitat. Adaptation to Fresh water habitat; Adaptation to terrestrial habitat.	08
2.	Support and location Support Material properties, skeleton joints; Terrestrial, aquatic, aerial and comparison of locomotory costs.	07
3.	The physiology of movements Contractile system in non-muscle cells; Neuromuscular function , excitability of muscle tissue, muscle contraction, theories of contraction, chemical basis of contraction, Biogenesis, Bio-luminescence, colourproduction, mechanism of action of chromatophores.	08
4.	Respirations Respiratory pigments; Structure and chemistry of Hb; Role of Hb in O ₂ and CO ₂ transport; Temperature regulation; Normal body temp.; Temperature regulation in endotherm; Temperature regulation in Poikilotherm; Accliation and acclimatization and Heat exhaustion and heat stroke.	07
	Total	30

Practicals corresponding to ZOO 401(A) Animal Physiology – II

1. Study of adaption in brackish water habitat. Adaptation to Fresh water habitat; Adaptation to terrestrial habitat, marine habitat.
2. Effects of various osmolarity on human red blood cells
3. Determination of oxygen consumption of any suitable animal.
4. To demonstrate some physiological properties of smooth muscles and the direct action of some autonomic and musculotrophic damages
5. Study of different types of joints (Mammalian).

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
- Harper, Physiological chemistry

ZOO 401 (B) Animal Physiology – II

Unit	Particulars	Hours
1	REPRODUCTIVE SYSTEM Functional morphology: Diploid and sex; Reproductive mechanism: -Sub alternative to sex; Functional morphology of reproductive organ	08
2	Endocrine System Mechanism of hormone action ;Invertebrate Endocrine System - Lower Invertebrate, Annelids, Molluscs, Crustacea, Insects, Echinoderms; Chordate Endocrine System - Hypothalamus-Hypophysical axis, pineal gland, urophysis, Thyroid gland, Parathyroid gland, Ultimobranchial gland, corpuscles of stannius, gastroenteropancreatic cells , chromaffin tissues ,Steroid hormone	07
3	Integumentary system Structure of skin a) epidermis- Keratenocytes and melanocytes b) Dermis c) Hair ; Chemical composition - a) Epidermal protein b) Lipids c) Carbohydrates	08
4	Sensory Physiology Sensory coding - Transduction, relationship between stimulus intensity & response, central control of sensory reception; Chemo reception - Gustation and olfaction; Thermoreceptors & infrared reception; Mechanoreception - Mechanotransduction - Invertebrate and vertebrate Mechanoreceptors - Muscles spindle, Acoustico lateralis system, Echolocation; Electro reception; Magnatoreception	07
	Total	30

Practicals corresponding to ZOO 401 (B) Animal Physiology – II

1. Super-ovulation in Rat
2. To study the estrous cycle in a mammal by vaginal smear method
3. Assessing skin sensitivity - locating different receptors
4. Study of structure and function of Skin and Hair with the help of Slides/ Photographs (any suitable animal)
5. Study of Endocrine glands with the help of Slides/ Photographs
6. Qualitative estimation of hCG

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
- Harper, Physiological chemistry

ZOO 401(A) Reproductive Physiology – II

Unit	Particulars	Hours
1.	Fertilization i) Ovum transport ii) Sperm transport iii) Sperm capacitation and activation iv) Entry of sperm into ovum v) Early development	06
2.	Implantation i) Morphological and physiological relationship between blastocyst and uterus during implantation. ii) Abnormal implantation iii) Hormonal changes during pregnancy	06
3.	Ectopic pregnancy and pseudo pregnancy	03
4.	Fetal Membranes: Types and structure in various mammals	03
5.	Placenta i) Mammalian placenta ii) Formation and development iii) Histological structure iv) Endocrine functions - Placental hormones v) Interrelation of steroid hormone biosynthesis and metabolism in the foetus and placenta.	06
6.	Parturition i) Properties of uterine muscles ii) Process and factors involved in parturition	06
	Total	30

Practicals corresponding to ZOO 401 (A) 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 of Mammalian sperms.

References

- 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.

ZOO 401 (B) Reproductive Physiology – II

Unit	Particulars	Hours
1.	Breast and lactation i) Development of mammary gland and its histology ii) Lactogenesis	06
2.	Advantages and disadvantages of male and female contraceptives	06
3.	Male and female sterility	06
4.	Remedies of population control	06
5.	Artificial insemination in farm animals	06
	Total	30

Practicals corresponding to ZOO 401(B) Reproductive physiology-II

1. Surgical Permanent preparations of histological slides from male and female reproductive organs.
2. Pregnancy test (immunological)
3. Estimation of total gonadal (testis) cholesterol from rat/mice.
4. Estimation of total adrenal cholesterol from rat/mice.
5. Study of instruments used in artificial insemination of farm animals.
6. Animal house- design breeding and Maintenance of animals.

References

- Chandi Charan Chatterjee, 1985 – Human Physiology Vol.II Tenth Edition, Medical Allied Agency, Calcutta, India.
- Arthur J. Vander, James H. Sherman and Dorothy S. Luciano – Human Physiology,
- Mcgraw-Hill International Editions, Biological Sciences Series.
- Nalbandov, A. V.- Reproduction Physiology.

ZOO 402 (A) Systematics and Evolutionary Biology

Unit	Particulars	Hours
1.	Principles and methods of taxonomy: Concepts of species and hierarchical taxonomy, biological nomenclature, classical and quantitative methods of taxonomy of animals	06
2.	Levels of structural organization: Unicellular, colonial and multicellular forms; levels of organization of tissues, organs and systems; comparative anatomy	06
3.	Outline classification of animals: Important criteria used for classification in each taxon; classification of animals; evolutionary relationships among taxa	06
4.	Natural history of Indian subcontinent: Major habitat types of the subcontinent, geographic origins and migrations of species; common Indian mammals, birds; seasonality and phenology of the subcontinent	06
5.	Organisms of health importance: Common parasites and pathogens of humans (bacterial, viral, protozoan, nematodes, Platyhelminthes, Ascihelminthes, Arthropods, fungal) domestic animals, Host parasite relationship.	06
	Total	30

Practicals corresponding to ZOO 402 (A) Systematics and Evolutionary Biology

1. Identification of any suitable animal by using Keys.
2. Study of level of structural organization.
3. Study of criteria used for classification.
4. Study of common parasites and pathogens of human
5. Study of common parasites and pathogens of domestic animals.
6. Demonstration of endoparasites in frog/cockroach with the help of photographs

References

- Hyman L.H. : The Invertebrate Volume 1 to 8, MacGraw Hill Co. New York
- Barrington E.J.W.: Invertebrates, Structure and function, homes Nelson and Sons Ltd., London
- Russel Hunter : A Biology of higher invertebrates, MacMillon Co. Ltd. London
- Kotpal R.L.: Protozoa to Echinodermata Series,

ZOO-402 (B) Advanced methods in biology

Unit	Particulars	Hours
1.	Microbial fermentation and production of useful macromolecules	03
2.	Application of immunological principles (vaccines,).	03
3.	Tissue and cell culture methods for animals	03
4.	Transgenic animals, molecular approaches to diagnosis and strain identification. Genetically modified Organisms (GMO)	04
5.	Introduction to Genomics and Proteomics, its application to health and agriculture, including gene therapy. 4	03
6.	Biodiversity and Introduction to DNA Bar coding.	04
7.	Breeding in animals, including marker assisted selection	03
8.	Bioremediation and Biosensors	04
9.	Epigenetics	03
	Total	30

Practical corresponding to ZOO-402 (B) Advanced methods in biology

1. Production of Citric acid by fermentation
2. Isolation of IgG immunoglobulin by ammonium sulphate precipitation
3. Determination of rate of metabolism of citric acid
4. Study of instruments and their principles used in Animal Cell Culture
5. Determination of Antigen and Antibody reaction by using any suitable method
6. Study of Biosensors (any Five example)

References

- Molecular Cloning: A Laboratory Manual: J. Sambrook, E. F. Fritsch and T. Maniatis, New York.
- Introduction to Practical Molecular Biology: P.D. Dabre, John Wiley and Sons Ltd, New York.
- Nicolas, C: Price and Lewis Steven s, 1993. Fundamentals of Enzymology 2nd edn.
- Oxford University Press, New York. Foster, R. L. Essentials of enzymology, 1980, Croom Helm London.
- Samuel Delvin, Enzyme, Istedn. 2000, Sarup & Sons, New Delhi.
- Pummer, L: Practical Biochemistry Tata McGraw-Hill.
- Bullock, J. D., Kristiansen, B.- Basic Biotechnology, 1987, academic press, New York.
- Prave, P. Faust, V., Sitting, W & Sukatsch, D.A.- Fundamental of Biotechnology, VCL Publishers, New York. 1987.
- Spier, R. E. and Griffins, J.B.- Animal Cell Biotechnology, Vol. I&II, Academic Press, Orlando, 1985.
- Schook, L.B.- Monoclonal Antibody Production Techniques and Applications. Marcel, Dekker, New York, 1986.
- Trevan, M. D., Boffey, S., Godulding, K. H.-Biotechnology Principles. Tata McGraw Hill Publishing Company Ltd. New York, 1987.
- Gupta, P. K.- Elements of Biotechnology. Rustogi and Company Publishing, 1996

ZOO 403 (A) Fundamental Processes and Tools in Biology

Unit	Particulars	Hours
1.	Microscopic techniques: Microscope: Light, phase contrast, interference, fluorescence, polarization, Inverted and electron microscopy (principle, parts and its application)	07
2.	Photometry: Basic principal UV-Vis spectrometry and colorimetry instrumentation and its application Fluorimetry: Principal, Instrumentation and application	07
3.	Electrophoresis: Principal, types and applications of agarose gel electrophoreses, starch gel and SDS and PAGE electrophoresis Radioactivity: Radioisotopes, half life units, Geiger Muller counter, gamma counter and scintillation, safety guidelines	08
4.	Centrifuge: Basic principle, type analytical and preparative centrifuges, different density gradient centrifuge and analytical with its application Incubator, hot air oven and autoclave: Principle, instrument and its application. PH meter: Principle types, types of electrodes and application Freezers, coolers, platelet agitators, cryo thawing baths	08
	Total	30

Practicals corresponding to ZOO 403 (A) Fundamental Processes and Tools in Biology

1. Calibration of pH meter.
2. Study of image processing methods in microscopy.
3. Determination of Lamberts and Beers Law.
4. Cell fractionation by using density gradient centrifuge (any suitable gradient)
5. To record ECG (Demonstration) from Human
6. Determination of Molecular Weight of DNA by electrophoresis

References

- Plummer, L: Practical Biochemistry Tata McGraw-Hill.
- Bullock, J. D., Kristiansen, B.- Basic Biotechnology, 1987, academic press, New York.
- Prave, P. Faust, V., Sitting, W & Sukatsch, D.A.- Fundamental of Biotechnology, VCL Publishers, New York. 1987.
- Spier, R. E. and Griffins, J.B.- Animal Cell Biotechnology, Vol. I&II, Academic Press, Orlando, 1985.
- Keshav Trehan- Biotechnology. Wiley Estern Limited, Bangalore, 1990.
- D. B. Tembhare- Techniques in Life Sciences, Himalaya Publishing House.
- T. Poddar, S. Mukhopadhyay, S. K. Das- An Advanced Laboratory Manual Of Zoology, MACMILLAN.
- Keith Wilson, John Walker Principles and Techniques of Practical Biochemistry (Wilson, Principles and Techniques of Practical Biochemistry)

ZOO 403 (B) Forensic Biology

Unit	Particulars	Hours
1.	Forensic Science : Definitions, History and Development	06
2.	Forensic Science Laboratories And Facilities: Growth of Forensic Science Laboratories in India – Central and State level laboratories; Educational setup in Forensic Science in India; Services and functionalities provided by various FSLs	06
3.	Biological Evidences Collection and Packaging: Protection of Biological Evidences; Documentation; Recognition of Biological evidences encountered in various cases; Search & Collection of Biological Evidences; Packaging & transportation of Biological Evidences	06
4.	Analysis of Biological Fluid Saliva; Semen; Vaginal Fluid; Urine; Sweat; Serological Concepts; Antigen / Antibodies; Polyclonal antibodies; Monoclonal antibodies; Antiglobulins; Human & Animal Hair morphology; Blood Grouping – Human & Non-human; Analysis of Skeletal Remains	06
5.	Forensic Entomology Basic Principle of Insect Biology; Life Cycle; Estimation of Time of Death; Preservation of Sample	06
	Total	30

Practicals corresponding to ZOO 403 (B) Forensic Biology

1. Microscopic Comparison of Animal Hair and Human Hair
2. Confirmatory Tests for Blood by Crystallization Assays
3. ABO Grouping and Rhesus Factor
4. Species Identification from various biological fluids a. Electrophoresis b. Acid Phosphatase test for semen
5. Microscopic examination for spermatozoa
6. Detection of Alpha Amylase activity by Starch-Iodine Assay
7. DNA Extraction and Quantification by colorimetric methods.
8. Microscopic examination of Zooplankton.

References

- Nanda, B.B. and Tewari, R.K. (2001) : Forensic Science in India : A vision for the twenty first century Select Publisher, New Delhi.
- James, S.H and Nordby, J.J.. (2003) Forensic Science : An introduction to scientific and investigative techniques CRC Press, USA.
- Barnett (2001) : Ethics in Forensic Science.
- O'Hara & Osterburg : Introduction to Criminalistics, 1949, The MacMillan Co., 1964.
- Saferstien : Forensic Science, Handbook, Vol. I, II & III, Prentice Hall Inc. USA.
- Saferstein : Criminalistics, 1976, Prentice Hall Inc., USA.
- Nickolas : Scientific Criminal Investigation
- Deforest, Gansellen & Lee : Introduction to Criminalistics.
- Sharma, B.R. : Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974.
- Kirk : Criminal Investigation, 1953, Interscience Publisher Inc. New York

**Skills, Knowledge and Job opportunities related to various courses of
M.Sc. II Zoology Sem III and IV**

- Zoology is closely related to human Medicine as, well as, pharmaceutical, biological and animal sciences. Thus its study is of importance in understanding public health and ecological problems. With this background and education, the Zoologist has many employment opportunities. Some of the exiting career opportunities in Various Faculties are as follows:
- **Government Services:**
 - District Malaria Officer (DMO)
 - Regional Forest Officer (RFO)
 - Pest Control Officer in Railway
 - Lab Technicians
 - Food Inspector
 - Various post in Sericulture Department
 - Various post in Fishery Department
 - Various post in Apiculture Department
 - Various post in Poultry Department
 - Various post in Health Ministry
- **Self Employment after Zoology Graduation**
 - Poultry Farm
 - Aquaculture
 - Pest Control Firm
 - Honey Production
 - Pig Farm
 - Goat Farm
 - Vermiculture
 - Dairy Firm
 - Animal Supplier
 -
- Federal, State or Local Governments with assignments in food animal production, disease control and eradication; meat inspection, public health, animal disease research and administrative positions.
- **Public health:** Veterinarians are employed by several agencies for formulating and reforming many food and sanity laws related to public and animals.
- **Teaching and Research:** Veterinarians are employed in various veterinary and Medical faculties Research Institutes. Veterinary / Biological production and Animal Research institutes, Veterinary Biological product and animal diseases investigation centres and in schools training livestock diseases, investigation centres and in School training Livestock Assistance farm personnel.
- **Industry:** Those dealing with development and production of pharmaceuticals and food to both human use as well as in their quality control and marking employed veterinarians.
- **Private Practice:** With increase in number of companion animals (dogs, cats, birds) being reared by Nigerians, performance animals (horse) and commercial

livestock production in private and public sectors, private veterinary practice has become the most lucrative avenue for self-employment of veterinarians in Nigeria.

- **Extension Veterinarians:** Mostly employed by Federal or State Ministries for disseminating the research findings of veterinary faculties and research institutes to livestock and poultry farmers, as well as identifying the problems in the field that can be solved by the above faculties and research institutes.
- **Fish, Zoo and Wild Life Medicine:** With the establishment of more wild game reserves and zoos and fish ponds there is increased scope of employment for veterinarians in these areas.
- **Police Force:** With increase in the number of mounted troops and police dogs, more veterinarians are recruited by the Nigerian Police Force to cater for the welfare of these animals.
- **Nigeria Army:** The Nigerian Armed Forces also recruit Veterinarians as Officers to cater for the welfare of animals used by mounted troops.
- **Medical Representative in Pharmaceutical Industries**

NORTH MAHARASHTRA UNIVERSITY, JALGAON

M. Sc (Part –II) ZOOLOGY

Equivalence for old Syllabus 2010

Semester – III

Old Course 2010		New Course 2014	
Paper code	Title of paper	Paper code	Title of paper
ZOO 301	Special paper Entomology-I Animal physiology-I Reproductive physiology-I	ZOO 301	Special Paper Entomology – I (A) Insect Taxonomy and Morphology - I (B) Insect Taxonomy and Morphology – II Special Paper Animal Physiology – I (A) Animal Physiology section – I (B) Animal Physiology section – II Special Paper Reproductive Physiology – I (A) Reproductive Physiology – I (B) Reproductive Physiology – II
ZOO 302	a) Enzymology b) System physiology – Animal	ZOO 302	(A) Freshwater Zoology (B) Skills in scientific communication and writing research report
ZOO 303	a) Applied Biology b) Skill in scientific communication and writing a research report	ZOO 303	(A) Medical physiology / Insect Anatomy (B) Animal Biotechnology
ZOO 304	Practical 301+ 302(a)	ZOO 304	Practical 301 (A) + 301(B) +302(A)
ZOO 305	Practical 302(b) + 303(a) + 303(b)	ZOO 305	Practical 302(B) + 303(A) + 303(B)

Semester – IV

Old Course 2010		New Course 2014	
Paper code	Title of paper	Paper code	Title of paper
ZOO 401	Special paper Entomology-II Animal physiology-II Reproductive physiology-II	ZOO 401	Special Paper Entomology – II (A) Insect Taxonomy and Morphology - I (B) Insect Taxonomy and Morphology – II Special Paper Animal Physiology – II (A) Animal Physiology section – I (B) Animal Physiology section – II Special Paper Reproductive Physiology – II (A) Reproductive Physiology – I (B) Reproductive Physiology – II
ZOO 402	a) Systematic and Evolutionary biology b) Animal biotechnology	ZOO 402	(A) Systematic and evolutionary biology (B) Advanced methods in biology
ZOO 403	a) Methods in biology b) Fundamental processes and tools	ZOO 403	(A) Fundamental processes and advanced tool in biology
ZOO 404	Practical 401+ 402(a) + 402(b)	ZOO 404	Practical 401 (A) + 401 (B) + 402(A)
ZOO 405	402(b) + 403(a) + 403(b) + Project	ZOO 405	Practical 402(B) + 403(A) + 403(B)