

# **COURSE CURRICULUM AND SCHEME OF EXAMINATION**

**Under  
Choice Based Credit System**

**For  
M. Sc. (Zoology)**

**(Effective from the Academic Session 2017 – 2018)**

**Chaudhary Devi Lal University, Sirsa – 125 055**

M.Sc. Zoology (1<sup>st</sup> Semester)

Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	ZOO-101	Biology of Invertebrates	CC	4	4	30	70	100	3
2	ZOO-102	Animal Cell Biology	CC	4	4	30	70	100	3
3	ZOO-103	Animal Physiology	CC	4	4	30	70	100	3
4	ZOO-104	Biotechniques	CC	4	4	30	70	100	3
5	ZOO-105	Economic Zoology-I	OEC	4	4	30	70	100	3
6	ZOO-106	Lab - I Pertaining to Theory Papers ZOO-102,103	CC	4	8**	--	100	100	6 Two sessions of 3 Hrs. each
7	ZOO-107A	Lab - II Pertaining to Theory Papers ZOO-101	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	ZOO-107B	Lab - II Pertaining to Theory Papers ZOO-104		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				28	44	120	480	600	

\*IA = 30 Marks (20 - Midterm examination; 5 - Assignment hand written; 5 - Attendance)

\*\*= Two groups of 20 students each

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Faculty of  
Life Sciences  
(members)

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4/10/17

M.Sc. Zoology (2 <sup>nd</sup> Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	ZOO-201	Biology of Vertebrates	CC	4	4	30	70	100	3
2	ZOO-202	Evolutionary Biology	CC	4	4	30	70	100	3
3	ZOO-203	Biosystematics and Biostatistics	CC	4	4	30	70	100	3
4	ZOO-204A	Medical Biotechnology	CEC (Any One)	4	4	30	70	100	3
	ZOO-204B	Animal Biotechnology		4	4	30	70	100	3
5	ZOO-205	Economic Zoology-II	OEC	4	4	30	70	100	3
6	ZOO-206	Lab – III Pertaining to Theory Papers ZOO-201	CC	4	8**	--	100	100	6 Two sessions of 3 Hrs. each
7	ZOO-207 A	Lab – IV Pertaining to Theory Papers ZOO-202, 204A	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	ZOO-207 B	Lab – IV Pertaining to Theory Papers ZOO-203, 204B		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				28	48	120	480	600	

\*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

\*\*= Two groups of 20 students each

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Faculty of  
Life Sciences  
members

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M.Sc. Zoology (3<sup>rd</sup> Semester)

Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	ZOO-301	Molecular Biology	CC	4	4	30	70	100	3
2	ZOO-302	Developmental Biology	CC	4	4	30	70	100	3
3	ZOO-303	Environmental Biology	CC	4	4	30	70	100	3
4	ZOO-304 A	Aquaculture	CEC (Any One)	4	4	30	70	100	3
	ZOO-304 B	Entomology		4	4	30	70	100	3
5	ZOO-305	Lab – V Pertaining to Theory Papers ZOO-301,302	CC	4	8**	--	100	100	6 Two sessions of 3 Hrs. each
6	ZOO-306 A	Lab – VI Pertaining to Theory Papers ZOO-303	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	ZOO-306 B	Lab – VI Pertaining to Theory Papers ZOO-304		4	8	--	100	100	6 Two sessions of 3 Hrs. each
Total				24	44	120	480	600	

\*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

\*\*= Two groups of 20 students each

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Faculty of Life  
Sciences members

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4/10/17



M.Sc. Zoology (4 <sup>th</sup> Semester)									
Sr. No.	Course ID	Subject	Type	Credit	Contact Hours per week	Internal Assessment (IA)*	External Exam	Maximum marks	Duration of Exam (Hours)
1	ZOO-401	Immunology	CC	4	4	30	70	100	3
2	ZOO-402	Molecular Endocrinology	CC	4	4	30	70	100	3
3	ZOO-403	Biosafety, Bioethics & IPR	CC	2	2	20**	30	50	3
4	ZOO-404A	Biodiversity & Wild Life	CEC (Any One)	2	2	20	30	50	3
	ZOO-404B	Parasitology		2	2	20	30	50	3
5	ZOO-405 A	Biochemistry	CEC (Any One)	4	4	30	70	100	3
	ZOO-405 B	Microbiology		4	4	30	70	100	3
6	ZOO-406	Lab – VII Pertaining to Theory Papers ZOO-401, 402	CC	4	8****	--	100	100	6 Two sessions of 3 Hrs. each
7	ZOO-407 A	Lab – VIII Pertaining to Theory Papers ZOO-404A, 405A	CEC (Any One)	4	8	--	100	100	6 Two sessions of 3 Hrs. each
	ZOO-407 B	Lab – VIII Pertaining to Theory Papers ZOO-404B, 405B		4	8	--	100	100	6 Two sessions of 3 Hrs. each
8	ZOO-408	Credit Seminar	CC	2	2	50	--	50	To be evaluated by a committee of two members
Total				26	48	180	470	650	

\*IA = 30 Marks (20 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

\*\*= 20 Marks (10 – Midterm examination; 5 – Assignment hand written; 5 – Attendance)

\*\*\*= Two groups of 20 students each

Dr. Boser members

Faculty of Life Sciences members

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**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**ZOO – 101 – Biology of Invertebrates (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Salient Features and classification up to classes with reference to diversity in animal form and function of Protozoa, Porifera

General account: Aquiferous and skeleton system in Porifera

**Unit II**

Salient Features and classification up to classes with reference to diversity in animal form and function of Coelenterate, Helminthes, Nematodes

General account: Polymorphism in cnidarians; parasitic adaptations in helminthes; Larval form and their significance.

**Unit III**

Salient Features and classification up to classes with reference to diversity in animal form and function of Annelid, Arthropoda

General account: Larval form and their significance in Arthropoda

**Unit IV**

Salient Features and classification up to classes with reference to diversity in animal form and function of Mollusca, Echinodermata

General account: Larval form and their significance in Echinodermata; Coelom; Torsion and detorsion in Mollusca; Ambulacral system

**List of Recommended Books:**

1. Kettle, D.S: Medical Veterinary Entomology (CAB International).
2. Boolotian and Stiles: College Zoology (Macmillan)
3. Campbell: Biology (Benjamin)
4. Marshall and Williams: Text Book of Zoology
5. Wolfe: Biology the Foundations (Wadsworth)
6. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
7. Prescott: Cell (Jones & Bartlett).
8. M.Kato. The Biology of Biodiversity, Springer.
9. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
10. E.O. Wilson. Biodiversity, Academic Press, Washington.



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**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**ZOO – 102 – Animal Cell Biology (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Structure of pro-and eukaryotic cells; Structure and function of cells and intracellular organelles of both prokaryotes and eukaryotes); Significance of intracellular compartments. Structure of nucleus; Genetic analysis in Cell Biology: Nucleus; Mitochondria and chloroplasts and their genetic organization; Evolution of aerobic respiration.

**Unit II**

Biomembranes: Molecular composition and arrangement functional consequences; Model membranes; Liposomes. Transport across cell membrane-Diffusion, active transport and pumps, uniports, symports and antiports; Membrane potential; Co-transport by symporters or antiporters; Transport across epithelia.

Cytoskeleton: Microfilaments and microtubules-structure and dynamics; Microtubules and mitosis; Cell movements-intracellular transport, role and kinesin and dynein; Cilia and Flagella

**Unit III**

Cell-Cell signaling: Signal transduction mechanisms; Cell surface receptors; Second messenger system; MAP kinase pathways; Cell-cell interaction.

Cell-Cell matrix, adhesion and communication, Ca<sup>++</sup> dependent & independent homophilic cell-cell adhesion; Gap junctions and connexins.

Cell matrix adhesion: Integrins, Collagen, Non-collagen components & Cellulose fibril synthesis and orientation.

**Unit IV**

Cell cycle: Mechanism of cell division including (mitosis and meiosis) and cell differentiation Cyclins and cyclin dependent kinases and Regulation of CDK-cyclin activity.

Biology of cancer, Biology of aging and Apoptosis-definition, mechanism and significance

**List of Recommended Books:**

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore, Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Garland Publishing Inc., New York.
3. Cell and molecular biology, Phillip Sheeler, Donald E. Bianchi Wiley, 1987
4. Cell and Molecular Biology 8<sup>th</sup> Edition, Robertis, EDP De & Robertis, EMF De (2002) lippincott Williams & Wilkins international student edition, Philadelphia.
5. Cell and Molecular Biology: concepts and experiments. Karp, Gerald (2012) John Wiley and sons, New York.

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**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**ZOO – 103 – Animal Physiology (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit-I**

**Nutrition:** Introduction, chemistry, metabolic role and sources of vitamins & deficiency diseases due to them. Biological significance and regulation of minerals and deficiency diseases due to them. Physiology of digestion & absorption. Malnutrition & under nutrition.

**Circulation:** Chemistry and composition of blood and their functional significance; biochemistry of hemoglobin and myoglobin; Mechanism of blood coagulation and homeostasis. Cardiac cycle and its regulatory mechanisms. Cardiac output and micro circulation, blood pressure and its regulation.

**Unit -II**

**Respiration:** Types of respiration, mechanism of breathing; biochemistry of respiratory gaseous exchange; Transport of respiratory gases; Regulatory mechanisms (humoral and neural) of respiration. Respiratory acidosis, alkalosis and regulation of pH.

**Unit -III**

**Excretion:** Types of excretion and nitrogenous wastes; functional anatomy of renal unit; biophysical and chemical mechanisms of ultrafiltration, reabsorption and secretion, transport mechanisms, urine formation & regulatory control of sugar, urea, Na<sup>+</sup> K<sup>+</sup>, and H<sup>+</sup>; Role of kidneys in regulation of acid-base balance and osmoregulation, counter current mechanism, Homeostasis.

**Unit -IV**

**Physiology of Muscles:** Types of muscles and their components; Molecular organization & interaction of myosin & actin. ATPase activity of myosin, power-stroke, ATP binding and hydrolysis; Role of troponin and tropomyosin and Ca<sup>++</sup> in regulation of muscle contraction. Contraction of smooth & cardiac muscles, role of phosphorylation, Ca<sup>++</sup> and kinases.

**Stress Physiology:** Physiological adaptations acclimatization & acclimation in response to high, low ambient temperature, physiological adaptation at high altitude and in deep sea environment.

**List of Recommended Books:**

1. Guyton, A.X., Text Book of Medical Physiology, 7th edition, Saunders Company (1986).
2. Best, J.P., Best and Taylor's Physiological basis of medical practice, 11th ed. William and Wilkins (1985).
3. Hoar, W.S., General and Comparative Physiology, Adaptation and Environment, 3rd ed. Cambridge University, Press (1985).
4. Vander, A.J., Sherman, J.H. and Luciano, D.S., Human Physiology, McGraw Hill Publ. Co.
5. Gillian Pocock and Christopher D. Richards. Human Physiology. The Basis of Medicine Oxford University Press (2001).



**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**ZOO – 104 – Biotechniques (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. X-ray diffraction, pH meter, Fixation and staining; cryotechnology and flow cytometry, Confocal Microscopy.

**Units II**

Spectroscopy: Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography, GCMS spectroscopy.

**Unit III**

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC). Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).

**Unit IV**

Molecular biology techniques: Sequencing of proteins and nucleic acids; southern, northern and western blotting techniques, polymerase chain reaction (PCR), ELISA, MALDITOF. Methods for measuring nucleic acid and protein interactions, Real time PCR and reverse transcriptase PCR.

**List of Recommended Books:**

1. Animal Cell Culture - A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. Shukla and Upadhyaya. Experimental Science
4. Randhir Singh. Practicals in Biochemistry
5. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.



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**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**ZOO – 105 – Economic Zoology – I (Open Elective Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Sericulture: Types of silk, species of silk moth (scientific names), Silkworms and their host plants, mulberry silk worm culture, agricultural aspects of mulberry plant cultivation, extraction and reeling of silk, natural enemies and diseases of silkworm and their control.

**Unit II**

Apiculture: Species of honey bees in India, life history of *Apis cerana indica*, agriculture techniques, bee products and their uses, natural enemies and diseases of honey bee and their control.

**Unit III**

Lac culture: lac insect (Scientific name), composition of lac, strains of lac insect, Life cycle and Host plants cultivation of lac host plants (in brief), processing of lac and uses of lac. Lac insects: species, Enemies of Lac insect and host plants, Lac industry in India

**Unit IV**

Integrated pest management

Pest Control: Principles and practices of pest control. Methods of pest control-Chemical Biological, Microbial, Integrated control. Organochlorine Insecticides, Organophosphorus insecticides, Acaricides, Nematicides, Rodenticides, Molluscicides and Botanical pesticides.

Crop Pests and their Management: Biology and control of following insect pests of agricultural importance: Termites, Rice weevils, castor hairy caterpillar, codling moth, mango mealy bug, Cotton white fly, citrus psylla and cabbage Caterpillar. Biology and control of some important Phytoparasitic nematodes: *Anguina*, *Xiphinema* sp *Meloidogyne* sp & *Heterodera* sp.

**Suggested Reading Material:**

1. Insect Pest Management by Dent, D.
2. Agricultural Entomology by Hill, D.S., Timber Press.
3. Entomology and Pest Management by Pedigo L. P. Prentice Hall, India
4. Agricultural Pests: Biology and Control Measures by B. M. Deoray and T. B. Nikam, Nirali Publication, Pune.
5. Concepts of Insect Control by Ghosh M. R. Wiley Eastern Ltd. New Delhi.
6. Jhingran, V.G. 1995. Fish and Fisheries of India, Hindustan Publ. Corp., New Delhi.

7. Lagler, K.F. Bardach, J.E. Miller, R.R. and Pasina, D.R. M. 1987. Inohtology John Wiley and Sons, New York.
8. Deshmann, R. F. 1992. Wild life biology. Wiley Eastern Publisher, New Delhi.
9. Sharia, V.B. 1995. Wildlife in India. Natral Publisher, Dehradun.
10. Verman, L.R. 19990 Beekeeping in integrated mountain development. Oxford & IBH Publ. Co., New Delhi.
11. Stine, K.E and Brown, T. M. 1996. Principles of Toxicology. Lewis Publishers London.
12. Atwal, A. S. 2000, Essentials. Of beekeeping & Pollination. Kalyani Publ. New Delhi.
13. Hassal, A.K. 1990. The Biochemistry and uses of Pesticides EELBS Editions
14. Atwal, A.S. and Dhaliwal G.S. 1997. Agriculture pests of South Asia and their management. Kalyani Publishers New Delhi.
15. Aruga, H. 1998. Principles of S ericulture. Oxford & IBH Publishing Co. New Delhi.
16. Harper, Physiological Chemistry
17. Karpati, G. Jones. D.H. and Griggs, R. c. Disorders of voluntary muscle, 7<sup>th</sup> edition. Cambridge Univ. Press.



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**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**Laboratory – I**  
**ZOO – 106 – Pertaining to Theory Papers ZOO-102,103 (Core Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. General Laboratory-safety and Bio-safety measures in Zoology laboratory.
2. Introduction to various instruments and their working principles used in Zoology laboratory.
3. Preparation of normal and molar solutions, serial dilution, buffers, pH setting etc.
4. To study various parts of microscope and demonstration of microscopic techniques
5. To discriminate between viable and non-viable cells using staining techniques
6. Effect of solution concentration on cells (RBCs)
7. To study the structural diversity of animal cells.
8. Cell division: mitosis and meiosis, Preparation of mitotic and meiotic chromosomes.
9. Microtomy
10. Histochemical techniques
11. To demonstrate that the optimum activity of salivary amylase is pH dependent.
12. Estimation of Hemoglobin.
13. Determination of TLC, DLC & RBC.
14. Determination of bleeding and clotting time.
15. Determination of blood groups.
16. Measurement of blood pressure.
17. Estimation of ESR.
18. To study the effect of exercise on cardiovascular and respiratory systems.
19. To estimate the glucose level in blood of mammal, Prothrombin test, Hematocrit.
20. To study the effect of insulin on blood glucose level of mammal.
21. Preparation of cell suspension culture.
22. Cell counting using haemocytometer.
23. Calculation of morphometric data and preparations of idiogram.
24. Determination of chiasma frequency and terminalization coefficient.
25. Preparation of polytene chromosomes and mapping.
26. Study of permanent slides of different types of cancer and their stages.
27. Qualitative tests for Carbohydrate (Starch, Sucrose, Maltose Fructose, Glucose), Protein (Albumin, Gelatin, Peptone), fat, uric acid (in Alkaline solution) and urea (Tests to be performed – Red Litmus Test, Hypobromite test, Biuret test, Millon's test, Iodine test, Benedict's test, Barfoed test, Seliwanof's test).

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**Suggested Reading Material:**

1. Culture of animal cells (2003). Freshney R.T. John Wiley and sons, New York.

2. Animal Cell Culture (1987). Freshney R.T. IRL Press Oxford, Washington.
3. Animal Cell Culture and Technology: Basics from background to bench. Butler M (2004). Taylor & Francis.
4. Recent reviews in scientific journals
5. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
6. Smith and Wood. Cell Biology, Chapman and Halls 1996



*John*

**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**Laboratory – II**  
**ZOO – 107A – Pertaining to Theory Papers ZOO-101 (Core Elective Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. Live demonstration of Amoeboidal movements, conjugation in paramecium and flagellar moments in euglena.
2. Slides and Museum specimens:
  - (a) PROTOZOA: *Gregarina*, *Monocystis*, *Ceratium*, *Euplotes*, *Didinium*, *Noctiluca*, *Radiolaria*, *Stentor*, *Opalina*.
  - (b) PORIFERA: Sectional view of *Sycon* (T.S., L.S.), *Grantia* (T.S.)
  - (c) CNIDARIA: *Obelia* polyp and Medusa, *Pennaria*, *Aurelia*-Tentaculocysts, *Virgularia*, *Spongodes*, *Zoanthus*, *Favia*.
  - (d) ANNELIDA: *Ozobranchus*, *Glossiphonia*, *Eunice*, *Chloea Flava*, *Polynoe*, *Terebella*.
  - (e) ARTHROPODA: *Cyclops*, *Daphnia*, *Chelifer*, section of *Peripatus*, *Balanus*, *Lepas*, *Palinurus*, *Uca*, *Pyna*, *Hippa*, *Gongylus*, *Bellostoma*, *Limulus*, *Squilla*, *Eupagurus*.
  - (f) MOLLUSCA: Museum specimens of *Dolabella*, *Pteria*, *Nertie*, *Sanguinolaria*, *Chicoreus*, *Ficus*, *Lambis*, *Tridacna*, *Onchidium*, *Olcia*, *Murex*, *Turritella*, *Bulla*, *Cardium*.
  - (f) ECHINODERMATA: Museum specimen of *Linckia*, *Echinodiscus*, *Holothuria*, *Antedon*.
  - (h) Study of Slides of *Bugula*, *Plumatella*, *Cristatella*, *Pectinatella*
3. Study of mouth parts of different insects.
4. Mounting: Trachea, Crustacean Larva, *Cyclops*, *Nauplius*, *Daphnia*, *Zoea*, *Mysis*, *Cercaria*.
5. Demonstration of dissection of Loligo/Sepia, grass-hopper, Prawn, Cockroach, Earthworm to expose various systems.

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**List of Recommended Books:**

1. Hyman, L.H. The invertebrates, Vol. I. Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltr J. London.
3. Jagerstein, G. Evolution of Metazoan life cycle, Academic Press, New York & London.
4. Hyman, L.H. The Invertebrates. Vol.2. McGraw Hill Co., New York.
5. Hyman, L.H. The Invertebrates. Vol.8. McGraw Hill. Co., New York.
6. Barnes, R.D. Invertebrate Zoology, IIIrd edition. W.B. Saunders Co., Philadelphia.
7. Russel-Hunter, W.D. A Biology of higher invertebrates, the Macmillin Co. Ltd. London.
8. Hyman, L.H. the Invertebrates smaller coelomate groups, Vol. V. McGraw Hill Co., NY.
9. Read, C.P. Animal Parasitism. Prentice Hall Inc., New Jersey.
10. Sedgwick, A.A. Student text book of Zoology. Central Book Depot, Allahabad
11. Parker, T.J., Haswell, W.A. Text book of Zoology, McMillan Co., London.





**M. Sc. (Zoology) – 1<sup>st</sup> Semester**  
**Laboratory – II**  
**ZOO – 107B – Pertaining to Theory Papers ZOO-104 (Core Elective Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. Demonstration of working of weighing balances, autoclaves, incubators, laminar flow, water bath.
2. Principle and demonstration of various analytical techniques:
  - a) Simple and Compound Microscope
  - b) Transmission electron microscope/Scanning electron microscope
  - c) Chromatography (HPLC, TLC, Paper Chromatography, Column chromatography, Ion exchange Chromatography)
  - d) Centrifugation
  - e) UV-visible spectrophotometer
  - f) Nanodrop
  - g) ELISA reader
  - h) Sonicator
  - i) Microtome
  - j) PCR / Real Time PCR
  - k) Electrophoresis (AGE and PAGE)
  - l) NMR
  - m) XRD
  - n) Autoradiography
3. Demonstration of Hybridization techniques:
  - a) Colony Hybridization
  - b) Southern Hybridization
  - c) Northern Hybridization
  - d) Western Hybridization
  - e) Dot Blot Hybridization
4. Demonstration of preparation of permanent mount of various tissues.

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**List of Recommended Books:**

1. Hamms GD, Spectroscopy for the Biological Sciences, Wiley Interscience, USA, 2005.
2. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
3. Bophysical Chemistry: Principle and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalya Publication House, Delhi.
4. Nalwa HS. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.
5. Beckatt, A.H. and Stenlake, J.B., Practical Biochemistry, the Athlone Press, London (1988).
6. Bacq, Z.M. and Alexander, P, Fundamentals of Radiography, Pergamon Press, London (1989).



7. Benett, A.H. and Usterbere, H, Phase Microscopy: Principle and applications, John Wiley and Sons, London (1951).
8. Dawes, C.J., Techniques for Transmission and Scanning Electron Microscopy, Ladd Rew. Ind., Inc., Publishers (1981).
9. Freefelder, D, Practical Biochemistry: Application to Biochemistry and Molecular Biology, W.H. Freeman, (1982).
10. Freshney, R.I., Culture of Animal Cells: A manual of basic technique, 5th Ed., Wiley Liss Inc., New York. (2006).
11. Watt, J.M., The Principles and Practice of Electron Microscopy, Watt (1985).
12. Michael G, Flow Cytometry: A Practical Approach, 3rd Edition Edited Michael G. Ormerod Oxford University Press (2000).
13. Kuby, Janis, Immunology, W.H. Freeman and Company (2000).

A handwritten blue checkmark is positioned to the left of a handwritten signature in blue ink. The signature appears to be 'D. J. R.' with a stylized flourish.

**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 201 – Biology of Vertebrates (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Introduction to chordates with their general characters:  
Origin of chordates, Classifications of vertebrate's upto order

**Unit II**

Salient Features and classification up to classes with reference to diversity in animal form and function of Protochordata Urochordata Hemichordata

**Unit III**

Salient Features and classification up to classes with reference to diversity in animal form and function of Pisces, Amphibia

General account: Dipnoi; Migration of fishes; Parental care in fishes and amphibians

**Unit IV**

Salient Features and classification up to classes with reference to diversity in animal form and function, like: Reptilia, Aves, Mammals

General account: Flight adaptation in birds; Migration of birds. Evolution of Horse and man.

**List of Recommended Books:**

1. Boolotian and Stiles: College Zoology (Macmillan)
2. Campbell: Biology (Benjamin)
3. Marshall and Williams: Text Book of Zoology
4. Wolfe: Biology the Foundations (Wadsworth)
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
6. Prescott: Cell (Jones & Bartlett).
7. M.Kato. The Biology of Biodiversity, Springer.
8. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. E.O. Wilson. Biodiversity, Academic Press, Washington.
10. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
11. E. Mayer. Elements of Taxonomy.
12. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 202 – Evolutionary Biology (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit I**

Emergence of evolutionary thoughts and mechanisms:  
Lamarck; Darwin's concepts of variation, Adaptation, struggle, fitness and natural selection;  
Mendelism; spontaneity of mutations; the evolutionary synthesis.

**Unit II**

Origin of cells and unicellular evolution:  
Origin of basic biological molecules; abiotic synthesis of organic monomers and polymers;  
Concept of Oparin and Haldane; experiment of Miller; the first cell;  
Evolution of: unicellular eukaryotes; prokaryotic and eukaryotic cells

**Unit III**

Paleontology and evolutionary history:  
The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multicellular organisms;  
Stages in primate evolution including Homo

**Unit IV**

Molecular Evolution: Concepts of neutral evolution, Molecular divergence and molecular clocks;  
Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; Origin of new genes and proteins.

**List of Recommended Books:**

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutionary Biology, Sinauer Associates, INC Publishers, Sunderland.
4. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinehart and Winston, Inc.
8. Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.

**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 203 – Biosystematics and Biostatistics (Core Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit – I**

Concepts of biosystematics and taxonomy, Historical resume, Importance and applications of systematics in biology.

Trends in biosystematics – concepts of different conventional and newer aspects:

Ecotaxonomy, Behavioural taxonomy, Chemotaxonomy, Biochemical taxonomy, Cyotaxonomy, Numerical taxonomy, Molecular taxonomy.

Taxonomic collections, preservation, curation process and identification. Taxonomic keys-different kinds of taxonomic keys, their merits and demerits.

**Unit – II**

Dimensions of speciation and taxonomic characters:

Species concepts – species category, different species concepts; sub-species and other intra-specific categories, Theories of biological classification, hierarchy of categories, Taxonomic characters – different kinds, weighing of characters

International code of Zoological Nomenclature (ICZN):

Operative principles, Interpretation of the following: Stability, Priority, Concept of availability, formation of names, synonymy, homonymy, the type method, kinds of type specimen, type-designation.

Important Latin words & abbreviations and Linnaean Signs

**Unit – III**

Concepts in statistics, Types of Data, presentation of data, types of graphics, relative frequency, cumulative frequency, Measurement of central tendency: Mean, Median, Mode, Quartile, Percentile. Measures of Dispersion: Range, Variance, Standard deviation, Standard error, coefficient of variation, Moments, Measures of Skewness and Kurtosis.

Computer in Biometrics: Components of computers, Statistical Software in Biology.

**Unit – IV**

Probability distribution: concept, normal, binomial and Poisson's distribution.

Hypothesis testing.

Statistical tests: correlation and regression analyses (linear and non-linear, meanings of intercept, slope and intercept values), student's "t" test (paired and unpaired), F-Test, Chi square test, Mann-Whitney 'U' Test, ANOVA, ANCOVA.

**List of Recommended Books:**

1. M. Kato. The Biology of Biodiversity, Springer.

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2. E.O. Wilson, Biodiversity, Academic Press, Washington.
3. G.G. Simpson, Principle of animal taxonomy, Oxford ISH Publishing Company.
4. E. Mayer, Elements of Taxonomy.
5. E.O. Wilson, The Diversity of Life (The College Edition), W.W. Northerm & Co.
6. S.K. Tikadar, Threatened Animals of India, ZSI Publication, Calcutta.
7. Batschelet, E. Introduction to mathematics for life scientists, Springer-Verlag, Berling.
8. Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.
9. Swartzman, G.L. and S.P.O. Kaluzny. Ecological simulation primer, Macmillan, New York.
10. Lendren, D. Modeling in behavioral ecology. Chapman and Hal, London, UK.
11. Sokal, R.R. and F.J. Rohlf. Biometry. Freeman, San Francisco.
12. Snedecor, G.W. and W.G. Cochran, Statistical methods. Affiliated East-West Pres, New Delhi (Indian ed.).
13. Murray, J.D. Mathematical biology. Springer-Verlag, Berlin.
14. Pielou, E.C. the Interpretation of ecological data:A primer on classification and ordination.

 



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 204A – Medical Biotechnology (Core Elective Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit – I**

Medical Biotechnology: An introduction and scope.

Biopharmaceuticals: Pharmaceutical applications of plant, animal and microbial origin, Relevance of medicinal plant, Therapeutic use of recombinant proteins, Proteins drug manufacturing, Design and engineering of proteins as therapeutic agents, Protein drug delivery.

**Unit – II**

Gene Therapy: Human diseases targeted delivery systems and targets, Gene therapy of genetic and acquired diseases, Biosensors and nano-technology for drug targeting and gene delivery, Future and ethical issues, Genetic counseling.

**Unit – III**

Diagnostics: Use of nucleic acid probes and antibodies in clinical diagnosis, Mapping of human genome, Molecular Markers- types and applications, Molecular diagnosis of genetic diseases.

Diseases: Parkinson's disease, AIDS, Alzheimer's disease, Prion diseases, Molecular basis of cancer, Proto-oncogenes, Oncogenes and human suppressor genes.

**Unit – IV**

Drugs Produced through Biotechnology: Humulin, Activase Humatrope.

Biotechnological Innovations in Vaccines Development: DNA vaccines, Edible Vaccines, Development of malarial vaccine and Tuberculosis vaccine.

Pharmacogenetics: Pharmacogenomics and Personalized medicine – a brief Account.

**List of Recommended Books:**

1. Wu S. Pong and Rojanasakul. Y. (1999) Biopharmaceutical Drug Design and Development, Humana Press, New Jersey.
2. Gary Walsh. (1998) Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, New York
3. Vyas S.P. and Dixit. V.K. (2001) Pharmaceutical Biotechnology, CBS Publisher and Distributor, New Delhi.
4. Gupta P.K. (2004) Molecular Biology and Genetic Engineering, Rastogi Publications Meerut.
5. Pharmaceutical biotechnology, by M J Groves 2<sup>nd</sup> ed. (2006), Boca Raton, FL : Taylor & Francis



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 204B – Animal Biotechnology (Core Elective Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit – I**

Introduction: History, scope & applications of animal biotechnology.

Culture Media: Balanced salt solutions & simple growth media. Brief discussion on chemical, physical and metabolic functions of different constituents of culture medium. Role of serum & supplements, serum & protein free defined media & their applications.

Primary Cell Culture and continuous cell lines: Establishment & evolution of primary cell culture, disaggregation of tissue & primary culture, characteristics of limited life-span cultures, maintenance of cell culture, establishment and properties of continuous cell lines.

**Unit – II**

Measuring parameters of growth, viability and cytotoxicity: Growth phase, cell counting, cell weight, DNA content, protein, rates of synthesis, growth cycle, pulsating efficiency, labeling index, cell cycle time (generation time), measurement of viability and cytotoxicity.

Applications of animal cell Culture: *In vitro* toxicity testing, production of viral vaccines, growth hormones, interferon, cytokines & cell culture based vaccines, embryonic stem cell culture and applications.

**Unit – III**

Gene transfer into Animal Cells: DNA transfer techniques into mammalian cells; Calcium phosphate precipitations, DEAE dextran procedure, microinjection, electroporation.

Viral vectors for gene transfer into mammalian cells: SV40, adenovirus, bovine papilloma virus, baculovirus and retrovirus.

**Unit – IV**

Biotechnology for animal improvement: Super ovulation, Embryo transfer, *in vitro* fertilization & embryo culture.

Animal Cloning: Concepts, principles & techniques of cloning, human cloning- reproductive and therapeutic cloning, applications of animal cloning, ethical & policy issues of animal cloning.

**List of Recommended Books:**

1. Principles of Gene Manipulations 6<sup>th</sup> Edition, Primrose S.B., Twyman, R. & Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles & Applications of recombinant DNA 2<sup>nd</sup> Edition, Glick, B.R. & Pasternak J.J. (1998) ASH Press, Washington D.C.
3. Animal Cell Biotechnology: Spier, R.E. & Griffiths J.B. (1988) Academic Press.
4. Animal Biotechnology: Muray Moo Young (1989) Pergamon Press, Oxford.
5. Animal Cell Culture: Freshney R.T. (1987), IRL Press Oxford, Washington.
6. Culture of Animal Cells: Freshney R.T. (2003), John Wiley & sons, New York.
7. Animal Cell Technology – Principles & Practices: Butlor M. (1987) Oxford Uni. Press.



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**ZOO – 205 – Economic Zoology – II (Open Elective Course)**

**Credits: 4**  
**Time: 3 Hrs.**

**Marks: 100**  
**Theory: 70**  
**IA: 30**

*Note for the paper setter: The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.*

**Unit-I**

**Aquaculture:** Principle, scope, techniques and importance of culturing, economically important aquatic organism, brief account of culturing of Indian major exotics carps and fresh water prawn, induced breeding of major carps and seed fish, pearl – culture (brief note) composite fish culture (polyculture).

**Pisciculture:** Economically important fresh water and marine fishes

**Fish culture:** aims and evolution, Fish Farming Technologies, Factors affecting fish culture.

**Vermiculture** (Brief over view)

**Unit - II**

**Fur Industry:** Fur producing animals, Fur farming, dressing, processing and dyeing, Fur industries in India.

**Leather Industry:** Animals of leather industry, Processing of skin, flaying, Curing, salting and tanning, Enemies of skin industry.

**Unit-III**

**Dairy Farming:** Milching animals, Breeds, Housing and raising and Tools of management, Artificial insemination and IVF for improvement of stock, Milk composition and dairy products.

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

**Unit -IV**

**Piggery:** Characteristics of swine and their products, Breed selection, management and housing and nutritional needs, Products (Pork, Bristles, Lard, Sausages) and by products, Diseases of Pigs

**Other Utilities of Animals:** Pharmaceuticals from animals (in brief), Vaccination, Different types of vaccine, Immunization (Introduction).

**List of Recommended Books:**

1. Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
2. Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, New Delhi.
3. Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
4. Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co., India.
5. Khanna, S. S. (1986), An Introduction to Fishes, Central Book Depot, Allahabad.
6. Mustafa, S. (1990), Applied and Industrial Zoology, Rastogi publications, Meerut.
7. Sarkar, K. T. (1991), Theory and Practice of Leather manufacture. The Author, Madras.
8. Shami, Q. J. and Bhatnagar, S. (2002) Applied Fisheries . Agrobios India.





9. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
10. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
11. Toor, H. S. and Kaur, K. (1996), Fish Culture Manual. PAU, Ludhiana.
12. Yadav, M. (2003) Economic Zoology, Discovery Publication House, New Delhi.



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**Laboratory – III**  
**ZOO – 206 – Pertaining to Theory Papers ZOO-201 (Core Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. Museum specimens and slides :  
Chondrichthyes: Zygaena, Pristis, Narcine, Trygon, Rhinobatus, Chimaera.  
Actinopterygii: Polypterus, Acipenser, Lepidosteus, Muraena, Mystus, Catla.  
Hippocampus, Syngnathus, Exocoetus, Anabas, Diodon, Tetradon, Echeneis and Solea.  
Dipneusti (Dipnoi) : Protopterus (Lung fish)  
Amphibia: Uraeotyphlus, Necturus, Amphiuma, Ambystoma and its Axolotl larva. Triton, Salamandra, Hyla, Rhacophorus.  
Reptilia : Hemidactylus, Calotes, Draco, Varanus, Phrynosoma, Chamaeleon. Typhlops, Python, Eryx, Ptyas, Bungarus, Naja, Hydrus, Vipera, Crocodilus, Gavialis, Chelone and Testudo.  
Aves: Casuarius, Ardea, Anas, Milvus, Pavo, Eudynamis, Tyto and Alcedo.  
Mammalia : Ornithorhynchus, Echidna, Didelphis, Macropus, Loris, Macaca, Manis, Hystrix, Funambulus, Panthera, Canis, Herpestes, Capra, Pteropus.
2. Demonstration of dissection of Labeo through video clipping/models/charts: Digestive and Reproductive systems, Circulatory system: heart, afferent and efferent branchial arteries. Nervous system: cranial nerves and internal ear.
3. Study of the skeleton of Labeo, Rana, Varanus, Gallus & Oryctolagus.
4. Demonstration of dissection of chick and white rat through video clipping/models/charts. Chick: Digestive, arterial, venous and urinogenital systems. White rat: Digestive, arterial, venous and urinogenital systems.
5. Study of the histology of different organs of frog and rat/rabbit through permanent mount.
6. Study of poison apparatus in snakes through charts.

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**Suggested Readings:**

1. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd.
2. Bourne, G.H. The structure and functions of nervous tissue. Academic Press, New York.
3. Carter, G.S. Structure and habit in vertebrate evolution - Sedgwick and Jackson, London.
4. Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates. Central Book Depot,
5. Kent, C.G. Comparative anatomy of vertebrates.
6. Milton H. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
7. Sedgwick, A. A Students Text Book of Zoology, Vol. II.
8. Torrey, T.W. Morphogenesis of vertebrates. John Wiley and Sons Inc., New York
9. Walters, H.E. and Sayles, L.D. Biology of vertebrates. MacMillan & Co., New York.
10. Weichert et al., Elements of chordate anatomy, 4th Edn. McGraw Hill Book Co., New York.
11. Messers, H.M. An introduction of vertebrates anatomy.
12. Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
13. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.



**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**Laboratory – IV**  
**ZOO – 207A – Pertaining to Theory Papers ZOO-202, 204A (Core Elective Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. To prepare the phylogenetic tree
2. To study genetic variability with the help of thumb impression (Dermatography)
3. To determine the T<sub>m</sub> of the DNA sample
4. To test the genetic variability by PTC test
5. To study genetic variability in human population
6. To show reproductive isolation in *Drosophila* species
7. Plasmid isolation
8. Restriction digestion
9. Ligation
10. Genomic DNA extraction
11. Analysis of isozymes/ proteins on SDS page
12. Antimicrobial activity of antibiotics, drugs and probiotics etc.
13. Introduction to animal house
14. Handling of lab animals
15. Various routes of drug administration (lab animals)
16. Immunization of laboratory animals
17. Molecular diagnosis of diseases:
  - a) Southern Hybridization
  - b) Northern Hybridization
  - c) Western Hybridization
  - d) Dot Blot Hybridization
  - e) Biosensor
  - f) PCR Technology
  - g) ImmunoPCR
  - h) DNA Fingerprinting
  - i) ELISA
  - j) RIA
18. Blood film preparation and identification of cells
19. Lymphoid organs and their microscopic organization
20. Preparation and administration of antigens.
21. Isolation and purification of Immunoglobulins.
22. Production of monoclonal antibodies.
23. Immunodiagnosics (demonstration using commercial kits)
24. The Ames test: for detecting potential carcinogens.
25. Staining techniques.
26. Haemagglutination test.
27. Commercial kits-based diagnosis.



28. Diagnostics of TB
29. Diagnostics of Malaria
30. Diagnostics of AIDS
31. Diagnostics of Swine flu
32. Diagnostics of Bird flu
33. Diagnostics of Dengue

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**List of Recommended Books:**

1. Experiments in Microbiology, Plant Pathology and Biotechnology 4<sup>th</sup> Edition. Aneja, K.R. (2010) New Age International Publishers, New Delhi.
2. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)-Narosh Publishing House, New Delhi.
3. Principles and techniques of practical biochemistry by K. Wilson and Wolker (1994) Cambridge University Press, Cambridge.
4. An introduction to practical biochemistry by David T. Plummer (1988) Tata McGraw Hill, Book Company, U.K.
5. J Sambrook and DW Russel, Molecular Cloning: A laboratory Manual Vols1-3. CSHL, 2001.
6. Wu S. Pong and Rojanasakul. Y. (1999) Biopharmaceutical Drug Design and Development, Humana Press, New Jersey.
7. Gary Walsh. (1998) Biopharmaceuticals: Biochemistry and Biotechnology, John Wiley & Sons, New York
8. Vyas S.P. and Dixit. V.K. (2001) Pharmaceutical Biotechnology, CBS Publisher and Distributor, New Delhi.
9. Gupta P.K. (2004) Molecular Biology and Genetic Engineering, Rastogi Publications Meerut.
10. Pharmaceutical biotechnology, by M J Groves 2<sup>nd</sup> ed. (2006), Boca Raton, FL : Taylor & Francis
11. A handbook of Practical Immunology (1983). Edited by G.P. Talwar, Vikas Publishing House Pvt. Ltd. New Delhi-110002.
12. Practical Immunology (1980), Hudson L. and Franks, C.H. Blackwell scientific Publication, Oxford.
13. Fundamental techniques in immunology and serology (2002) Singh A. International Book Distributing Co., Lucknow.
14. Current protocols in immunology, (1997), Marjorie, M. John Wiley and sons, Inc. USA.
15. Handbook of experimental immunology (1986). Bewesly, P. Blackwell Scientific publications, London.

**M. Sc. (Zoology) – 2<sup>nd</sup> Semester**  
**Laboratory – IV**  
**ZOO – 207B – Pertaining to Theory Papers ZOO-203, 204B (Core Elective Course)**

**Credits: 4**

**Marks: 100**

**Duration of exam: (3+3 hour)**

1. General Laboratory-safety and Bio-safety measures in laboratory
2. Routine techniques in handling laboratory animals: feeding, cleaning and general hygienic measures.
3. Demonstration of various kinds of equipments used for animal collection and preservation:
  - a) Taxidermy
  - b) Alizarine preparation
  - c) Raisin Embedding
  - d) Wet Mounting
  - e) Dry Mounting
4. Use of key to identify the fishes of the region, representing different families.
5. Methods of describing common insects representing different orders, with particular reference to the recording of taxonomic characters.
6. Construction of phylogenetic tree using some priory weighed characters.
7. Phylogeny of various animal phyla.
8. Demonstration of Hardy – Weinberg Law and deviations (role of external forces) from the equilibrium in a population.
9. Comparison of skeletons for listing evolutionary trends through pictures/line drawings.
10. Study of ancestry of man, horse, camel and elephant through charts/models.
11. Comparison of homologous and analogous structures (Insect antennae, insect legs, limbs of vertebrates etc.) through pictures/line drawings.
12. Demonstration of kinds of mimicry in various groups of animals through pictures/line drawings.
13. Study of origin of invertebrate and vertebrate groups through charts.
14. Mapping of geographic distribution of birds, insects, fishes etc.
15. Study of various evolutionary phenomena using slides / photographs.
16. Visit to a Fossil park/Geology and Anthropology museums.
17. Descriptive statistics: Systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion, measures of skewness (using calculators).
18. Correlations (product- moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
19. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
20. Statistical distributions: fitting discrete uniform, binomial, Poisson and normal probability distributions to given data.
21. Testing of hypotheses: Tests of significance (mean, standard deviation, correlation coefficient), chi-squared test for goodness of fit, test for independence of attributes, nonparametric tests (run test) using calculators and printed tables and using minitab sampling (drawing random samples using random numbers, tables, chits, computer programmes for random number generation), design of experiments, ANOVA (oneway and two-way)
22. Preparation of tissue culture medium & membrane filtration.



23. Sterilizing test of media and serum
24. Preparation of cell suspension culture.
25. Cell counting using haemocytometer and determination of cell viability
26. Preparation of macrophage from tissue
27. Trypsinization of monolayer & sub culturing
28. Isolation of genomic DNA from blood sample
29. Designing of primer for PCR/ RT-PCR
30. Calculation of T<sub>m</sub> of nucleic acid
31. LAMP/ PCR/ RT-PCR/Multiplex PCR
32. Cell disruption using Sonicator
33. Determination of antimicrobial activity of probiotics.

**\*Some changes in the contents of the practical can be expected depending upon the availability of the material and the required equipment.**

**Text/References Books:**

1. Culture of animal cells (2003). Freshney R.T. John Wiley and sons, New York.
2. Animal Cell Culture (1987). Freshney R.T. IRL Press Oxford, Washington.
3. Animal Cell Culture and Technology: Basics from background to bench. Butler M (2004). Taylor & Francis.
4. Benjamin Lewin. Gene X, 10<sup>th</sup> Edition, Jones and Barlett Publishers 2010.
5. J D Watson et al., Biology of Gene, 6th Edition, Benjamin Cummings, publishers Inc. 2007
6. Alberts et al., Molecular Biology of the Cell, Garland, 2002
7. S B Primrose, R M Twyman, and R W Old. Principles of Gene manipulation. S B University Press, 2001.
8. Brown T A. Genomes, 3rd Edition, Garland Science 2006.
9. J Sambrook and DW Russel, Molecular Cloning: A laboratory Manual Vols1-3. CSHL, 2001.
10. DM Glover and B D Hames, DNA cloning, Oxford 1995.
11. Biostatistics By PN Arora and PK Malhan, Himalaya Publishing House.
12. Experimental Design and Data Analysis for Biologists By Gerry P. Quinn and Michael J. Keough. Publisher: Cambridge University Press.
13. Principles of Biostatistics (with CD-ROM) (Hardcover) By Marcello Pagano and Kimberlee Gauvreau. Publishers: Duxbury Press.
14. Biostatistics: Experimental Design and Statistical Inference (Hardcover) By James F. Zolman. Oxford University Press.
15. Intuitive Biostatistics By Harvey Motulsky. Publisher: Oxford University Press.
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