

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 (1st 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

PGBOSK-R
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Faculty of
Life Sciences
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M.Sc. Zoology (2 nd 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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Life Sciences
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M.Sc. Zoology (3rd 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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M.Sc. Zoology (4 th 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) – 1st 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) – 1st 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⁺⁺ 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 8th 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) – 1st 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⁺ K⁺, and H⁺; 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⁺⁺ in regulation of muscle contraction. Contraction of smooth & cardiac muscles, role of phosphorylation, Ca⁺⁺ 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) – 1st 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) – 1st 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 Phytoparastic 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, 7th edition. Cambridge Univ. Press.



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M. Sc. (Zoology) – 1st 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



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M. Sc. (Zoology) – 1st 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) – 1st 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. Bennett, 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).



Dir

M. Sc. (Zoology) – 2nd 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) – 2nd 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. Haldane, 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) – 2nd 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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Signature

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) – 2nd 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 2nd ed. (2006), Boca Raton, FL : Taylor & Francis



M. Sc. (Zoology) – 2nd 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 6th Edition, Primrose S.B., Twyman, R. & Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles & Applications of recombinant DNA 2nd 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) – 2nd 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) – 2nd 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) – 2nd 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_m 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 4th 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 2nd 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) – 2nd 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_m 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, 10th 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.
16. Introduction to Biostatistics by Robert R. Sakal and F. James Rohlf: Dover Publications, Inc. Mineola, New York.
17. Introductory Biostatistics by Chap T. Le: A John Wiley & Sons Publication.
18. Genetics and the origin of species by T. Dobzhansky, Columbia University Press.
19. Principles of Systematic Zoology by E. Mayr, Tata McGraw Hill Publishing, New Delhi.
20. Taxonomy by R.E. Blackwelder, John Wiley & Sons, New York
21. Organic Evolution by Lull, MacMillan Co., New York.
22. Time, life and Man by R.A. Stirton, John Wiley and Sons, New York.

3rd, 4th Sem

M. Sc. (Zoology) – 3rd Semester
ZOO – 301 – Molecular 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

Nucleic acid –structure: DNA and RNA as genetic material, Chemical structure and base composition of nucleic acids, Double helical structures, Supercoiled DNA, Forces stabilizing nucleic acid structure, properties of DNA, Renaturation and denaturation of DNA, T_m and Cot curves, Structure of RNA.

DNA Replication: General features of DNA replication, Enzymes and proteins of DNA replication, of replication, Prokaryotic and eukaryotic replication mechanism, Replication in phages, Replication in retroviruses.

Unit –II

Transcription: Mechanism of transcription in prokaryotes and eukaryotes, RNA polymerases and promoters, Post-transcriptional processing of tRNA, rRNA and mRNA (5' capping, 3' polyadenylation and splicing).

Antisense and ribozyme technology: Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, biochemistry of ribozyme, hammerhead, hairpin and other ribozymes, strategies for designing ribozymes, applications for antisense and ribozyme.

Unit –III

Translation: Genetic code, General features, Deciphering of genetic code, Code in mitochondria, Translational mechanism in prokaryotes and eukaryotes, Post translational modification and transport, Protein targeting (in brief), Non ribosomal polypeptide synthesis, Antibiotic inhibitors and translation.

Unit –IV

Regulation of Gene Expression in Prokaryotes and Eukaryotes: Operon concept, Positive and negative control, lac, trp and arb operon, Catabolite repression, attenuation, regulation of gene expression in eukaryotes (a brief account).

Homologous recombination: Holiday junction, FLP/FRT and Cre/Lox combination, RecA and other recombinases

Text/Reference Books:

1. Adams et al. (1992) Biochemistry of Nucleic Acids, 11th ed., Chapman and Hall, NY
2. Lewin B. (2010) Gene X, Pearson Prentice and Hall, New Delhi.
3. Karp G. (2010) Cell and Molecular Biology –Concept and Experiments, 5th Edition, John Wiley, NY.
4. Lodish et al. (2013) Molecular Cell Biology, 7th Edition, W.H. Freeman Publisher
5. Gardener et al. (2001) Principles of Genetics, 8th ed., John Wiley, New York
6. Klug and Cummings (2012) Concept of Genetics, 10th ed., Pearson Education
7. Cooper G.M. and Hausman R.E (2013) The Cell: A molecular approach, Sinauer Associates Inc, Publisher, USA, 6th edition
8. Alberts B, and Johnson A (2016) Molecular Biology of Cell, Garland Science Publisher

Amiya 18/9/18
Vineeta Shukla 18/9/18

M. Sc. (Zoology) – 3rd Semester
ZOO – 302 – Developmental 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, chemistry, dynamics and regulation of sperm activity, capacitation and egg-surface targeting. Molecular biology, cytology and biochemistry of oogenesis: Synthesis and storage of maternal transcripts, proteins and cell organelles. rDNA amplification in amphibian transcription on lampbrush chromosomes, ovulation and its hormonal control in mammals.

Unit -II

Molecular and cellular biology of fertilization: acrosome reaction and signal transduction monospermy and species-specificity. Egg activation, early cleavages and blastocyst formation in mammals and biochemical and cellular changes during the passage down the oviduct to the uterus.

Unit -III

Implantation and formation of the placenta in mammals. Gastrulation in mammals-formation of primitive streak, morphogenetic movements and neural induction. Organogenesis and foetal development. Pattern forming genes and expression in Drosophila and mammalian embryos. Growth Factors and Signal Cascades BMP, Nodal, Wnt, Notch and Retenoid signaling during gastrulation.

Unit -IV

Introduction to stem cells: Molecular basis of embryonic and adult stem cells. Pluripotency and its application. Cell cycles regulators in stem cells. Epigenetic mechanism of cellular memory, Germ line stem cells and its cloning. Programmed morphogenetic histogenetic cell death (apoptosis). Erythropoiesis, myelopoiesis. Ageing.

List of Recommended books:

1. Developmental Biology (2003) - Gilbert S. F. Sinauer Asso.
2. Principles of Development (2002) - Wolpert L et al., Oxford University Press
3. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
4. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
5. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.
6. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells. Two Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, 2012, Academic Press
7. R. Lanza, J. Gearhart et al (Ed), Essential of Stem Cell Biology, Elsevier Academic press

Mishra
18/9/18

Manish Shukla
18/9/18

M. Sc. (Zoology) – 3rd Semester
ZOO – 303 Environmental 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

Environmental policies at global and national level. Remote sensing and geographic information system: Basic concepts, procedure and Applications. Concept of sustainable development: utility and significance

Unit-II

Environment impact assessment: environmental monitoring different phases and significance. Solid waste management: Primary waste products-Solid waste, toxic biological and hospital landfills, incineration, source reduction and recycling.

Unit –III

Bioremediation, its role and significance. Toxicological risk assessment and management. Principles and significance of systematic toxicology. Genotoxicology. Applications of toxicology anthropogenic activities and environment. Human toxicology and medicinal ethics.

Unit-IV

Environmental Toxicology: Food additives, air, water and soil pollutants. Effect of pollutant on ecosystem with case study of important Organo-phosphorous and Organo-chlorine pesticides, Nitrates, Polychlorinated biphenyls. Clenbutarol. Biodegradation

List of Recommended books:

1. Concepts of Ecology by Edward J. Kormondy; Prentice Hall of India (Pvt) Ltd
2. Fundamentals of Ecology by W.B. Odum, E.P. Saunders. Toppan Co. Ltd., Tokyo, Japan.
3. Ecology by Paul Colin Vaux; John Wiley & Sons, Inc.
4. Environmental Pollution by H.M Dix., John Wiley Publications, New York.
5. Handbook of Solid Waste Management by Wilson, Van Nostrand, Reinhold.
6. Environmental Studies by D.B. Botkin, & E.A. Keller, Martill Publishing Co., Columbus, Toronto, London.
7. Ecology of Natural Resources, Francoid remade, John Wiley & Sons, New York, Singapore.
8. Ecology by Paul Colinvaux; John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore.
9. Applied Ecology and Environmental Management by Edward I. Newman
10. Principle of Environmental Science by W.P. Cunningham & M.A. Cunningham.
11. Environmental Impact Assessment Methodologies by Y. Anjaneyulu.
12. Bioremediation Technology by Fulekar, M.H.
13. Biotransformation: Bioremediation Technology for Health & Environmental Protection by R. D. Stapleton Jr. and V.P. Singh (Ed), Elsevier.
14. Casarett & Doull's Toxicology: The Basic Science of Poisons by Curtis Klaassen

Mishra
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Anneela Shukla
18/9/18

M. Sc. (Zoology) – 3rd Semester
ZOO –304A – Aquaculture (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

Freshwater habitat: Types of Freshwater habitats – Lotic and Lentic Waters. Zonation in Lentic habitat. Hydrobiological characteristics – Temperature, penetration of light, turbidity, dissolved gases, pH, biogenic salts etc. Water problems in aquatic and amphibious situations
Ecological classifications of freshwater organisms other than fishes : On the basis of trophic status, On the basis of mode of life – Benthos, Periphyton, Plankton, Nekton and Neuston. On the basis of zonation in lentic and lotic habitats.

Unit-II

Classification of lakes: Trophic classification of lakes – Oligotrophic, eutrophic and dystrophic lakes. Thermal classification of lakes – Forel's and Yoshimura's classifications of lakes. Hutchinson's classification of lakes – Amictic, cold monomictic, dimictic, warm monomictic, oligomictic and polymictic lakes.

Productivity: Concepts of productivity – Biomass, biotic potential, standing crop, carrying capacity, yield, productivity, primary and secondary productivity. Estimation of Primary production – Harvest method, oxygen production method, carbon dioxide assimilation method, radioisotope method, chlorophyll method, disappearance of raw materials and pH method.

Unit-III

Eutrophication: Definitions and types - natural and cultural eutrophication. Causes and impact of eutrophication. Control of eutrophication – Mechanical, Chemical and Biological control.

Bioassay – Terminology, methodology, calculation of LC 50 and EC 50 values and threshold concentrations.

Methods in Field Biology: Methods of estimating population density of animals

Unit-IV

Estuarine Habitat: Characteristics of estuarine habitat. Classification of estuaries. Estuarine fauna – Temporary and permanent. Adaptations of estuarine fauna.

Special Aquatic Habitats: Polar and alpine lakes. Salt lakes. Special stream environment

Ecological succession:

Definitions and types of ecological succession. Succession of animal communities through Hydrarch

List of Recommended books:

1. Jhingran, V.G., *Fish and Fisheries of India*, Hindustan Publishing House (India), New Delhi (1991).
2. *Aquaculture Production*, FAO, Fisheries Circular No.815, No.4, Rev.FAO Rome (1998).
3. Mohan Joseph, M, *Aquaculture in Asia*, Asian Fisheries Society, Mangalore (1990)

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4. Talwar, P.K., & Jhingran, A.G., Inland Fishes of India. Vols.I & II. P.K. Talwar & Jhingran, A.G., Oxford & IBH, New Delhi (1991).
5. Lagler Karl F., *Freshwater Fishery Biology*. Wm.C.Brown Company Publ., Dubuque, Iowa (1969).
6. Bangenal, T., *Methods for Assessment of Fish Production in Freshwaters* 3rd Ed., IBH Handbook No.3 Blackwell Scientific Publication, Oxford (1970).
7. Johal, M.S., and Tandon, K.K., *Monograph on the Fishes of reorganized Punjab*: Parts I & II. Punjab Fisheries Bulletin (1979, 1980).
8. Odum, E.P., *Fundamentals of ecology*, W.B. Saunders Co. Philadelphia (1971).
9. Welch, P.S., *Limnology*. McGraw Hill Book Co. New York (1952)
10. Wetzel, R.G., *Limnology*. W.B.Saunders Co. Philadelphia (1983).
11. Hynes, H.B.N., *The Biology of Polluted Waters*, Liverpool Univ. Press, Liverpool (1978).
12. Ruttner, F., *Fundamentals of Limnology*. Univ. Press, Toronto (1975).
13. Tandon, K.K. & Johal, M.S., *Age and growth in Indian Freshwater Fishes*. Narendra Publishing House, Delhi (1995).
14. Johal, M.S., Aggarwal, S.C., *Fishery Development*. Narendra Publishing House, Delhi (1997).
15. Peter B. Moyle & Joseph J. Cedh, *Fishes :An Introduction to Ichthyology*, Prentice - Hall, Inc. Jersey, U.S.A. (1986).

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M. Sc. (Zoology) – 3rd Semester
ZOO –304B – Entomology (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

Salient features with suitable examples of the insect orders - Thysanura, Odonata, Isoptera, Orthoptera, Hemiptera, Coleoptera, Lepidoptera, Hymenoptera and Diptera. Structure and function of the following systems in insects: Digestive System, Respiratory System, Nervous System and Reproductive System.

Unit-II

Post embryonic development and types of metamorphosis in insects. Structural modifications in the larvae & pupae. Parthenogenesis in insects. Effect of temperature and photoperiod on the lives of insects, details of onset, termination and significance of diapause.

Unit-III

Systematic position, habits, nature of damage and outlines of the life cycles of following pests of crops, vegetables & fruits. Plant host-insect interaction. Insect-pest management of useful insects : Silkworm, honeybee, Lac insect.

A. CROPS

Cotton :

- (i) *Pectinophora gossypiella* (Pink boll worm)
- (ii) *Bemisia tabaci* (Cotton white fly)
- (iii) *Dysdercus cingulatus* (Red cotton bug)

Sugarcane

- (i) *Pyrrilla perpusilla* (Sugarcane leaf hopper)
- (ii) *Scirpophaga nivella* (Sugarcane top borer)

Paddy

- (i) *Hieroglyphus banian* (Rice grass hopper)
- (ii) *Leptocorisa varicornis* (Ciundhi bug)

Wheat

- (i) *Tanymecus indicus* (Ghujhia weevil)
- (ii) *Sesamia inferens* (Wheat stem borer)

B. VEGETABLES

- (i) *Dacus cucurbitae* (Pumpkin fruit fly)
- (ii) *Raphidopalpa foveicollis* (Red pumpkin beetle)

C. FRUITS

- (i) *Dasycha mangifera* (Mango mealy bug)
- (ii) *Diaphorina citri* (Citrus psylla)

3. Pests of stored food products with particular reference to their systematic position, habits, nature of damage caused by them along with the outlines of their life cycles :

- (i) *Callosobruchus maculatus* (Pulse beetle)
- (ii) *Sitophilus oryzae* (Rice weevil)
- (iii) *Tribolium castaneum* (Rust red floor beetle)
- (iv) *Sitotroga cerealella* (Angoumois grain moth)

Mishra
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Anand Kumar
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Unit-IV

Insect control: Chemical control: Categories of pesticides, important examples, their application and mode of action; Insect repellents and attractants. Biological Control: Principles. History, use of parasites, predators and pathogens. Integrated Pest Management (IPM). Principle and practices of Apiculture.

List of Books recommended:

1. General Entomology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Calcutta, Bombay by M.S. Mani, 1990.
2. The Insects, Structure & Function, English Language Book Society Hodder and Sloughton, G. Britain by R.F. Chapman, 1978.
3. Imms Text Book of Entomology Methuen & Co. Ltd. New York: EP. Dutton & Co INC. by Richards & Davies, 10th edition (1997).
4. Honey bees and their management in India. ICAR Publications by R.C. Mishra, 1995.
5. Agricultural Pests of India and South East Asia by A.S. Attwal, Kalyani Publishers, New Delhi, 1991.
6. Insects and Mites of Crops in India by MRGK. Nair, ICAR, N.Delhi, 1975.
7. Economic and Applied Entomology by Kumar and Nigam. Emkay Publications, Delhi, 2000.
8. Destructive and Useful Insects by Metcalf and Metcalf. McGraw Hill Publications, New York, 1951.
9. Integrated Pest Management by David Dent, Chapman & Hall, London, New York, Madras, 1995.
10. Insect Pheromones and their use in Pest Management by House Sevens and Jones. Chapman Hall, London, New York, Madras, 1998.
11. Beekeepy for Profile and Pleasure. Addison Webb. Agrobios, 2004.
12. Textbook of Applied Entomology: P. Srivastava. Vol.1. Kalyani Publishers, 2005

Mishra
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Unnesh Bhowmik
18/9/18

M. Sc. (Zoology) – 3rd Semester
Laboratory – V
ZOO – 305 – Pertaining to Theory Papers ZOO-301, 302 (Core Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. Isolation of Genomic DNA.
2. Isolation of RNA.
3. Quantitative analysis of DNA.
4. Restriction digestion of DNA.
5. Ligation of DNA fragments.
6. Molecular weight analysis using agarose gel electrophoresis.
7. Isolation of plasmid DNA.
8. Western blotting.
9. Southern blotting.
10. Preparation of competent cell.
11. To study the different stages of development in frog and chick through permanent slides.
12. To study the spermatogenesis of rat and grasshopper through slides.
13. To prepare the permanent stained slides of developing stages from fertilized egg of hen
14. To study different larvae in invertebrates from permanent slides.
15. To study the larvae of invertebrates (Redia, Cercaria, Arthropod larvae, Glochidium larva) through permanent slides.
16. Study of salivary gland chromosomes of larvae of chironomus/Drosophila from permanent slides.
17. Study of metaphase karyotypes from photographs/permanent slides of Drosophila, grasshopper and man/rat.
18. Study of sex-chromatin Bars body from human buccal mucosa.

***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. Sambrook J, EF Fritsch and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
2. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
3. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
4. Lodish et al., Molecular Cell Biology Freeman and Company 2016.
5. Smith and Wood, Cell Biology, Chapman and Halls 1996
6. Watson et al, Molecular Biology of the gene, Pearson Prentice Hall, USA 2003
7. Sambrook J, EF Fritsch and T. Maniatis (2000) Molecular Cloning: A laboratory Manual, cold spring Harbor laboratory Press, New York.
8. Glover DM and BD Hames (2006), DNA cloning: A practical Approach, IRL Press, Oxford.
9. Priyanks Siwach and Namita Singh (2007) Molecular Biology, Theory and Practices, Laxmi Publication.
10. Lodish et al., Molecular Cell Biology Freeman and Company 2016.

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11. Smith and Wood. Cell Biology. Chapman and Halls 1996
12. Watson et al. Molecular Biology of the gene. Pearson Prentice Hall. USA 2003
13. Developmental Biology (2003) - Gilbert S. F. SinauerAsso.
14. Principles of Development (2002) - Wolpert L et al., Oxford University Press
15. The Art of the Genes (1999) - How Organisms Make Themselves Coen E. Oxford University Press
16. Genetic Analysis of Animal Development (1993) 2nd ed. - Wilkins A. S., Wiley-Liss
17. Biological Physics of the Developing Embryo (2005) - Forgacs G. & Newman S. A., Cambridge University Press.
18. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells. Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells. 2012, Academic Press.
19. R. Lanza, J. Gearhart et al (Ed), Essential of Stem Cell Biology. Elsevier Academic press.

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M. Sc. (Zoology) – 3rd Semester
Laboratory – VI
ZOO – 306 A – Pertaining to Theory Papers ZOO-303 (Core Elective Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. Introduction to various instruments and their working principles used in environment biology laboratory.
2. Detection of coliform for determination of purity of potable water.
3. Determination of total dissolved solids of water.
4. Determination of dissolved oxygen concentration of water sample.
5. Determination of biological oxygen demand (BOD) of sewage sample/Pond/Lake.
6. Determination of chemical oxygen demand (COD) of sewage sample/Pond/Lake.
7. Isolation of Xenobiont degrading bacteria by selective enrichment technique
8. Determination of pH/ TDS (Total dissolved solids). TSS (Total suspended solids) of water sample.
9. Determination of organic carbon/Nitrogen/Phosphorous in soil.
10. Test for the degradation of aromatic hydrocarbon by bacteria.
11. Effect of sulphur dioxide on crop plants.
12. Estimation of nitrate in drinking water.

***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. Environmental Microbiology –A laboratory manual, L.L. Gerba, C.P. and Brendeeke, J.W. (1995) Academic Press, New York.
2. Experiments in Microbiology, Plant Pathology and Biotechnology 4th edition Anuja K.R. (2010) New Age International Publisher –New Delhi.
3. Microbiology –A laboratory manual 4th edition, Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
4. Microbiology-a laboratory manual 4th edition, Cappuccino J. and Sheeman N (2000) Addison Wesley, California
5. Environmental Microbiology – A laboratory manual. Pepper, L.L.; Gerba, C P and Brendeeke, J.W. (1995) Academic Press, New York

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M. Sc. (Zoology) – 3rd Semester
Laboratory – VI
ZOO – 306B – Pertaining to Theory Papers ZOO-304 (Core Elective Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. Qualitative study of biotic components of aquatic ecosystem.
2. Quantitative study of biotic components of aquatic ecosystem.
3. Study of different types of Phytoplankton (Bacillariophyceae Chlorophyceae, Euglenophyceae & Cyanophyceae).
4. Study of different types of Zooplankton (Protozoa, Rotifera, Cladocera, Copepoda).
5. Study of Benthic fauna.
6. Study of Neuston.
7. Study of Nekton.
8. Study of Macrophytes.
9. Estimation of Nitrates in water.
10. Estimation of Phosphates in water.
11. Estimation of dissolved oxygen by modified winklen method in water.
12. Determination of Primary productivity in an aquatic habitat.
13. Study of impact of Heavy metals on productivity.
14. Identification of the following fishes up to species level of Punjab, Haryana and Himachal Pradesh using already prepared field keys. Noting down their important characters, making sketches, and economic importance of each fish species along with ecological notes: *Notopterus notopterus*, *N. chitala*, *Schiozothorax richardsonii*, *plagiostomus*, *Hypophthalmichthys molitrix*, *Cyprinus carpio*, *Ctenopharyngodon idella*, *Puntius*, *Labeo rohita*, *Catla catla*, *Cirrhinus mrigala*, *Tor putitora*, *Garra gotyla gotyla*, *Noemechilus botia*, *Botia berdi*, *Mystus seenghala*, *Aorichthys* spp., *Wallago attu*, *Heteropneustes fossilis*, *Channa*, *Mastacembelus armatus*.
15. Study of important deep-sea and hills stream fishes with special reference to various adaptations.
16. Study of hard parts e.g., scales, vertebrae, otoliths and opercular bones for age determination, Calculations of back-calculated lengths using Fraser-Lee, equation. On the basis of available growth data calculation of various growth parameters e.g., annual increment, specific rate of linear growth, growth characteristic, growth constant, calculation of harvestable size and maximum size to be attained by the fish.
17. Study of various exotic fishes introduced in India and their characteristic features
18. Study of different bivalves involved in Pearl Culture.
19. Collection and their identification upto family level of atleast three different species from the pterygote orders prescribed in theory.
20. Identification marks and taxonomic status of insect pests of crops vegetables, fruits and stored products.
21. Dissection of suitable insects for the study of following systems:
 - a. Digestive System
 - b. Nervous System
 - c. Reproductive System
22. Systematic position up to family and ecology of the following medical and veterinary pests
 - a. *Anopheles* b. *Culex* c. *Aedes* D. Blow fly e. Bot fly f Horse fly g. Flesh fly.
23. Introduction to apiculture practices and handling of Beehives

Amjhar
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Arushi Shukla
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24. Permanent stained preparation of male and female external genitalia.
25. Study of different types of larvae and pupae with the help of preserved material.

***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. Jhingran, V.G., *Fish and Fisheries of India*, Hindustan Publishing House (India), New Delhi (1991).
2. *Aquaculture Production*. FAO. Fisheries Circular No.815, No.4. Rev.FAO Rome (1998).
3. Mohan Joseph, M. *Aquaculture in Asia*, Asian Fisheries Society, Manglore (1990).
4. Talwar, P.K., & Jhingran, A.G., *Inland Fishes of India*, Vols.I & II. P.K. Talwar & Jhingran, A.G., Oxford & IBH, New Delhi (1991).
5. Lagler Karl F., *Freshwater Fishery Biology*, Wm.C.Brown Company Publ., Dubuque, Iowa (1969).
6. Bangenal, T., *Methods for Assessment of Fish Production in Freshwaters* 3rd Ed., IBH Handbook No.3 Blackwell Scientific Publication, Oxford (1970).
7. Johal, M.S., and Tandon, K.K., *Monograph on the Fishes of reorganized Punjab*, Parts I & II. Punjab Fisheries Bulletin (1979, 1980).
8. Odum, E.P., *Fundamentals of ecology*, W.B. Saunders Co. Philadelphia (1971).
9. Welch, P.S., *Limnology*, Mcgraw Hill Book Co. New York (1952)
10. Wetzel, R.G., *Limnology*, W.B.Saunders Co. Philadelphia (1983).
11. Hynes, H.B.N., *The Biology of Polluted Waters*, Liverpool Univ. Press, Liverpool (1978).
12. Ruttner, F., *Fundamentals of Limnology*, Univ. Press, Toronto (1975).
13. Tandon, K.K. & Johal, M.S., *Age and growth in Indian Freshwater Fishes*, Narendra Publishing House, Delhi (1995).
14. *General Entomology*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Calcutta, Bombay by M.S. Mani, 1990.
15. *The Insects, Structure & Function*, English Language Book Society Hodder and Sloughton, G. Britain by R.F. Chapman, 1978.
16. *Imms Text Book of Entomology* Methuen & Co. Ltd. New York: E.P. Dutton & Co. INC. by Richards & Davies, 10th edition (1997).
17. *Honey bees and their management in India*, ICAR Publications by R.C. Mishra, 1995.
18. *Agricultural Pests of India and South East Asia* by A.S. Attwal, Kalyani Publishers, New Delhi, 1991.
19. *Insects and Mites of Crops in India* by MRGK. Nair, ICAR, N Delhi, 1975
20. *Economic and Applied Entomology* by Kumar and Nigam, Emkay Publications, Delhi, 2000.
21. *Destructive and Useful Insects* by Metcalf and Metcalf, McGraw Hill Publications, New York, 1951.
22. *Integrated Pest Management* by David Dent, Chapman & Hall, London, New York, Madras, 1995.
23. *Insect Pheromones and their use in Pest Management* by House Sevens and Jones, Chapman Hall, London, New York, Madras, 1998.
24. *Beekeeping for Profile and Pleasure*, Addison Webb, Agrobios, 2004
25. *Textbook of Applied Entomology*, P. Srivastava, Vol.I, Kalyani Publishers, 2005

Mishra
18.9.18

Anand Shukla
18/9/18

M. Sc. (Zoology) – 4th Semester
ZOO – 401 – Immunology (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: Phylogeny of immune System, innate & acquired Immunity, clonal nature of immune system, primary & secondary lymphoid organs

Cells of Immune System: Haematopoiesis & differentiation, B-lymphocytes, T-lymphocytes, Macrophages, Dendritic Cells, Natural Killer & lymphokine activated Killer Cells, Eosinophils, Neutrophils & Mast Cells, lymphocyte trafficking, humoral & cell mediated immune response.

Unit-II

Immune System: Nature & Biology of antigens & superantigens, Immunoglobulins-structure & functions of different classes, Antigenic determinants (Isotype, Allotype & Idiotype), Antigen-antibody interactions, Antibody engineering, MHC, Antigen processing & presentation, structure of MHC I & II, Genomic organization and MHC polymorphism.

Unit-III

Regulation of Immune Response: Genomic organization and generation of diversity of B-Cell and T-Cell receptors, B-Cell and T-cell Regulation, Antibody dependent cell mediated cytotoxicity & macrophage mediated cytotoxicity, cytokines & their role in immune regulation, Complement system

Unit-IV

Immunological Techniques: Immunoprecipitation reactions, Agglutination reactions, Complement tests, ELISA, RIA, Immunofluorescences.

Immune System in Health & Diseases: Hypersensitive Reactions, Auto immunity, AIDS and other immunodeficiencies.

Text/references books:

1. Immunology, 8th Edition., Goldsby, R.A., Kindt T.J., Osborne B.A. (2012) W H Freedom & Comp, NY.
2. Essential of Immunology, 10th Ed. Riott, Ivon, Delves, Peter (2001) Blackwell Scientific Publications, Oxford.
3. Fundamentals of Immunology; Paul W.E. (Eds.) Raven Press, New York.
4. Immunology – A short course – Eli Benjamini, R Coico, G Sunshine (Wiley-Liss).
5. Immunology – An introduction 5th Edition (2013) Tizard I.R. Philadelphia Saunders College Press.
6. Basic Immunology, Sharon J (1998) Williams and Wilkins, Battimore.
7. Janeway et al., Immunobiology, 8th Edition, Current Biology publications, 2012

M. S. K. S.
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W. S. S.
18/09/18

M. Sc. (Zoology) – 4th Semester
ZOO – 402 – Molecular Endocrinology (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

Basic concept of endocrinology, its scope and role in molecular biology. Chemical nature of hormones: Amino-acid derived hormones. Peptide hormones. Glyco-protein hormones. Steroid hormones and Prostaglandin. Biosynthesis of peptide hormones, transcriptional and post-transcriptional modifications. Network of extra-cellular and intracellular signals. Role of cell structure in intracellular communication. Prostaglandin structure, type, synthesis and biological activities.

Unit-II

Mechanism of action of peptide hormones; Cell Signaling; concept of second messengers. cAMP, cGMP, Ca⁺⁺, Calmoduline, IP₃, DAG, NO. signal transduction mechanisms. Mechanism of action of steroid hormones; Nuclear receptors, orphan genes and receptors and their role in metabolism and development. Cross talk concept, Heat shock proteins (hsp).

Unit-III

Hormonal regulation of Metabolism: Role of Insulin & Glucagon in regulation of Carbohydrate metabolism. Metabolic regulatory hormones in Lipid & Protein metabolism. Role of Parathyroid Hormone in Ca⁺⁺ & PO₄ regulation. Gastrointestinal hormones and their role in regulation of metabolic activity. Regulatory substances – Erythropoietin, growth factors, Thymus gland & Kinins. Diabetes & Obesity management vis-à-vis life style & Endocrine factors.

Unit-IV

Genetic basis of hormonal disorders. Sequence-specific DNA binding proteins, DNA binding receptor proteins and their role in gene transcription, cell differentiation and cell proliferation. Role of hypothalamus in hormonal control. Anterior pituitary hormones, posterior pituitary hormones; thyroid gland and thyroid hormones, pancreas (insulin and glucagon). Endocrine control of food and fluid intake/obesity calcium regulation, adrenal gland. Reproductive organs and their hormonal control in male and females; estrogen and androgen. Reproductive cycle, parturition and pathologies.

List of Recommended books:

1. Benjamin Lewin, Genes VII, Oxford University Press
2. Lodish et al. Molecular Cell Biology
3. Ethan Bier, The Coiled Spring, Cold Spring Harbor Press

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4. L.P. Freedman. *Molecular Biology of Steroid and Nuclear Hormone Receptors*. Birkhauser.
5. G. Litwack. *Biochemical Actions of Hormones*. Academic Press.
6. *General Endocrinology* by Turner. C.D. and Bagnars, W.B. Saunders Company: 1976.
7. *Comparative Endocrinology of Invertebrates* by Highnam, K.C. and Hill, I. Enwaral Arnold Ltd., London; 1981.
8. *Endocrinology* by Golds -Worthy, G.J. Robinson, J. and Mordue, W. John Wiley and Sons, New York; 1981.
9. *An Introduction to Invertebrates Endocrinology* by Tombes, A.S. Academic Press, New York; 1970.
10. *Comparative Vertebrate Endocrinology* by Bentley, P.J. Cambridge Univ. Press: 1998.
11. *Endocrinology* (4th ed) by. Hadley, M. E. Prentice Hall: 1996.

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M. Sc. (Zoology) – 4th Semester
ZOO – 403 – Biosafety, Bioethics and IPR (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

Biosafety and risk assessment issues, regulatory framework, National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, cross border movement of germplasm, risk management issues-containment

Unit – II

General principles for the laboratory and environmental biosafety, health aspects, toxicology, allergenicity, antibiotic resistance etc. Impact on environment, gene flow in natural and artificial ecologies, source of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

Unit – III

Ecological aspects of GMOs and impact on biodiversity, monitoring strategies and methods for detecting transgenics, radiation safety and non-radio isotonic procedure, benefits of transgenics to human health, society and the environment.

Unit – IV

The WTO and other international agreements, intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications etc. protection of plant variety and farmers right act, Indian patent act and amendments, patent filing, convention on biological diversity, implications of intellectual property rights on the commercialization of biotechnology products.

List of Recommended books -

1. Singh BD, 2007. *Biotechnology: Expanding Horizon*. Kalyani publishers.
2. <http://patentoffice.nic.in>
3. www.wipo.org
4. www.dbtindia.nic.in
5. www.dbtbiosafety.nic.in

M. J. Kumar
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Anneela Shukla
18/9/18

M. Sc. (Zoology) – 4th Semester
ZOO –404A – Biodiversity and Wild Life (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

Biodiversity: concept; Types of biodiversity; national & global status; endemism, speciation and extinction; levels of biodiversity; hotspots and hottest hotspots; Major Diversity regions of India with special reference to Himalaya, Western Ghats, Central India and Indo-Gangetic Plains. Significance of biodiversity and its socio-economic importance, causes of biodiversity depletion, rarity of species, threat value, categories of existence, blue/red data categories.

Unit-II

Zoogeography: Zoogeographical regions and their fauna.
Principles of conservation, objectives, implications, action plans and conservation status in India. Conservation for sustainable use-a holistic approach, major approaches to management.

Unit-III

Strategies for conservation: *In-situ* conservation: International efforts and Indian initiatives; potential areas in India – sanctuaries, national park, biosphere reserves, wetlands and Ramsar convention, *Ex-situ* conservation: Principles and practices. *In vitro* repositories, cryobanks in biodiversity conservation.

Unit-IV

Wildlife of India: Different types with references to animals, causes of depletion, significance and conservation of wildlife.

Wildlife Tourism (Red Data Book, IUCN Categories of wildlife species)

Wildlife Projects: Tiger Project, Crocodile Breeding Project, Hangul project, Gir lion Sanctuary project

List of Recommended books:

1. Techniques for wildlife Census in India by W.A. Rogers (A field manual); Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majumuria; Teepress Services, L.P., 487/12-SOI, Wattenslip, Pratunam Bangkok, 10400, Thailand.
3. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay.
4. Wildlife in India by V.B. Saharia, Natraj Publishers, Dehradun.
5. E.P. Gee, The Wildlife of India.
6. Wildlife in India by Saharia, V.B. Natraj Publ. Dehradun (U.P.).

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7. Wildlife Biology by Raymond F Dasmann, Wiley Eastern Ltd., New Delhi, 1982.
8. Rao, R.R. 1994. Biodiversity in India (Floristic Aspects), Bishen Singh & Mohindra Pal Singh, Dehra Dun.
9. Aggarwal, K.C. 1999. Biodiversity, Agro Botanica, Bikaner.
10. Dhar, U. 1993. Himalayan Biodiversity: Conservation, Strategies, G B. Pant Institute of Himalayan Environment and Development, Kosi, Almorha (Himvikas Publication No. 3).
11. Jeffries, M.J. 1997. Biodiversity and Conservation, Routledge, London & New York
12. Kumar, U. & Asija, M.J. 2000. Biodiversity Principles and Conservation. Agrobios (India)
13. Negi, S.S. 1993. Biodiversity and its conservation in India. Indus Publishing. Co., New Delhi

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Vineela Shukla
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M. Sc. (Zoology) – 4th Semester
ZOO –404B – Parasitology (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 to Parasitology, different types of animal associations: definitions, Parasitism, Mutualism, Hyperparasitism, Hosts: host types, regular hosts, irregular hosts, intermediate hosts. Parasite Host Specificity: Kinds of parasite host specificity, specificity factors related to infection and growth. Host-parasite interaction.

Unit-II

Parasitic (Morphological and physiological) adaptations: Protozoa, Helminths, Nematodes and Arthropods. Immunity to Parasites: Brief account of immunity to malaria, leishmaniasis, trypanosomiasis, schistosomiasis and ascariasis.

Unit-III

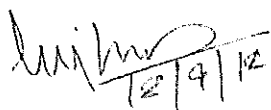
Vectors - Brief account of various insect vectors of human parasitic infections. Parasite Transmission: Introduction, mechanism, circadian rhythm. Zoonosis: viral, rabies, japons encephalitis. Parasitic: Hydatid disease

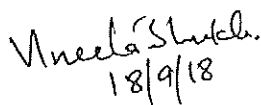
Unit-IV

Ecology of parasites : Ecological niche, host size, and parasite numbus, biological control, evolution of parasitism: Fahrenheit Rule, Szidat Rule, Eichler Rule, origin of parasitism, progressive and retrogressive evolution.

List of Recommended books

1. *Parasitology : The Biology of Animal Parasites*, 5th edition by Noble, E.R. and Noble, G.A., Lea & Febiger, Philadelphia; 1982.
2. *Physiology of Parasites* by Chapell, L.H., Blackie, Glasgow, London; 1979.
3. *Immunology of Infection* by Kaufmann, S., Academic Press; 1999.
4. *An Introduction to Animal Parasitology* by Smyth, J.D., Hodder & Stoughton, London; 1976


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M. Sc. (Zoology) – 4th Semester
ZOO –405A – Biochemistry (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

Biomolecules: An introduction, general structure of biomolecule.

Carbohydrates: Structure, occurrence and biological importance of important monosaccharides, oligosaccharide and polysaccharide. Ring structure and anomeric forms, mutarotation, reactions of monosaccharides, homo and hetero polysaccharides and mucopolysaccharides.

Unit –II

Amino acid and proteins: Structure and properties of amino acids. Essential and nonessential amino acids, peptide bond. Type of proteins and their classification. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins. Structure of hemoglobin and myoglobin.

Unit –III

Lipids: Classification, structure of lipids and their general function. Essential fatty acids. Hydrolysis of fats, saponification value, rancidity of fats iodine number and acid value. Cholesterol-its structure and biological function.

Unit –IV

Nucleic acids: Structure and properties of purine and pyrimidine bases. Nucleosides and nucleotides. Biologically important nucleotides. Double helix model of DNA structure, structural polymorphism of DNA [A, B & Z] and RNA. Biological function of nucleotides.

Vitamins: Structure and biochemical roles of water soluble vitamins and coenzymes.

List of Recommended Books:

1. Lehninger, Principle of Biochemistry, 6th Edition by David L. Nelson and M M Cox [2013] Free and company, New York.
2. Fundamental of Biochemistry, D. Voet and J. G. Voet [2013] John Wiley and Sons New York.
3. Biochemistry 8th Edition by L. Stryer [2015], W.H Freeman and New York
4. Biochemistry 4th edition by G. Zubay [1998] Wm .C Brown Publishers
5. Outline of Biochemistry by Conn E.E, Stumpf P.K, Bruening G and Dav

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M. Sc. (Zoology) – 4th Semester
ZOO –405B – Microbiology (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

History of Microbiology: Discovery of the microbial world. Development of microbiology in the twentieth century. Scope of microbiology.

Microbial Diversity: Prokaryotic and Eukaryotic cells. Morphology and cell structure of major groups of microorganisms e.g. archaea, bacteria, fungi, algae, protozoa and viruses. Classification of viruses, Retroviruses, viroids and prions.

Unit –II

Cultivation and Maintenance of Microorganism: Methods of isolation, purification and preservation of microorganisms. Theory, principles and methods of sterilization.

Concepts of Microbial Nutrition: Culture media, requirement for carbon, nitrogen, phosphorus, sulfur and growth factors. Nutritional categories of microorganisms.

Unit –III

Microbial physiology: Definition of growth. Growth curve and generation time. Mathematical expression of growth. Measurement of microbial growth and factors affecting growth. Synchronous, batch, fed batch and continuous cultures, bacterial endospores.

Bacterial genetics: Transformation, conjugation, transduction, recombination, plasmids and transposons.

Unit –IV

Host-Parasite Relationship: Normal microflora of skin, oral cavity, gastrointestinal tract. Entry of pathogen into the host; colonization and factors predisposing to infections. Types of toxins (exo-, endo- and enterotoxins), their structure and mode of action. Virulence and pathogenesis.

Diseases caused by microbes: Disease reservoirs, Infectious disease transmission. Diseases caused by bacteria and viruses: Tuberculosis, Rabies, Plague, Dengue, Swine flu, Rickettsias, Lyme disease, Malaria, food and water borne human diseases.

List of Recommended Books:

1. Microbiology 9th Revised Ed. Prescott L.M., Harley J.P. (2013) Tata McGraw Hill
2. Microbiology Pelczar Jr., M.J., Chan, E.C.S. (2010) Tata McGraw Hill, New Delhi
3. Brock Biology of Microorganisms 14th Edition, Madigan, M.T., Martinko, J. M. and Parker, J. (2015), Prentice Hall, New Jersey.
4. General Microbiology, Stainer et al. (2003) The MacMillan Press.
5. Tortora, G.J., Funke, B.R., Case, C.L. (2012) Microbiology -An Introduction, 11th Edition, Pearson education Pvt. Ltd. Singapore.

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M. Sc. (Zoology) – 4th Semester
Laboratory – VII
ZOO – 406 – Pertaining to Theory Papers ZOO-401, 402 (Core Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. General Laboratory-safety and Bio-safety measures in immunology laboratory.
2. Introduction to various instruments and their working principles used in immunology laboratory.
3. Blood film preparation and identification of cells
4. Lymphoid organs and their microscopic organization
5. Preparation and administration of antigens.
6. Isolation and purification of Immunoglobulins.
7. Quantification of immunoglobulins.
8. Immunodiagnostics (demonstration using commercial kits)
9. Immunodiffusion techniques:
 - a) Ouchterlony double diffusion
 - b) Radial immunodiffusion.
10. Immuno electrophoresis:
 - a. Counter current Immuno electrophoresis
 - b. Rocket Immuno electrophoresis.
11. Latex agglutination technique.
12. ELISA technique
 - a) Dot ELISA
 - b) Sandwich ELISA
13. To identify the stage of oestrous cycle.
14. To show the endocrine glands in rat through charts/models/video clipping.
15. To study the histology of endocrine glands through permanent stained slides.
16. To study the corrective measures for myopia, hypermetropia, astigmatism, cataract
17. To study the structure of eye, ear and different types of neurons through charts/models

***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. A handbook of Practical Immunology (1983). Edited by G.P. Talwar, Vikas Publishing House Pvt. Ltd. New Delhi-110002.
2. Practical Immunology (1980), Hudson L. and Franks, C.H. Blackwell scientific Publication, Oxford.
3. Fundamental techniques in immunology and serology (2002) Singh A, International Book Distributing Co, Lucknow
4. Current protocols in immunology, (1997). Marjorie, M. John Wiley and sons, Inc USA

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5. Handbook of experimental immunology (1986). Bewesly, P. Blackwell Scientific publications, London.
6. Benjamin Lewin, Genes VII, Oxford University Press.
7. Lodish et al. Molecular Cell Biology.
8. Ethan Bier. The Coiled Spring, Cold Spring Harbor Press.
9. L.P. Freedman. Molecular Biology of Steroid and Nuclear Hormone Receptors. Birkhauser
10. G. Litwack. Biochemical Actions of Hormones, Academic Press.
11. *General Endocrinology* by Turner, C.D. and Bagnars. W.B. Saunders Company; 1976.
12. *Comparative Endocrinology of Invertebrates* by Highnam, K.C. and Hill, L. Enwaral Arnold Ltd., London; 1981.
13. *Endocrinology* by Golds -Worthy, G.J. Robinson, J. and Mordue. W. John Wiley and Sons. New York; 1981.
14. *An Introduction to Invertebrates Endocrinology* by Tombes, A.S. Academic Press. New York; 1970.
15. *Comparative Vertebrate Endocrinology* by Bentley, P.J. Cambridge Univ. Press; 1998.
16. *Endocrinology* (4th ed) by Hadley, M. E. Prentice Hall; 1996.

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M. Sc. (Zoology) – 4th Semester
Laboratory – VIII

ZOO – 407 A – Pertaining to Theory Papers ZOO-404 A, 405 A (Core Elective Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. To study the distribution of animals through zoogeographical maps.
2. A visit to a zoological park to study different wild animals and make a report.
3. To estimate the alkalinity of water.
4. To estimate the chlorides of water.
5. To estimate the nitrates of water.
6. To study the different types of phytoplankton.
7. To study the different types of zooplankton.
8. Introduction to various instruments and their working principles used in biochemistry laboratory.
9. Qualitative estimation of amino acid and protein
10. Qualitative estimation of lipids
11. Qualitative estimation of carbohydrates.
12. Quantitative estimation of protein by Lowry's method.
13. Determination of total soluble sugars by ferricyanide method. (Volumetric procedure)
14. Separation of various components in the different lipid fraction by thin layer chromatography.
15. To measure the activity of enzyme (alpha amylase)/ any other.
16. To study the effect of temperature on enzyme activity.
17. To study the effect of substrate conc. on enzyme activity.

***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. Techniques for wildlife Census in India by W.A. Rogers (A field manual): Wildlife Institute of India, Dehradun.
2. Wildlife Wealth of India by T.C. Majumuria; Teeprass Services, L.P., 487/42-SOI-Wattenslip, Pratunam Bangkok, 10400, Thailand
3. The Book of Indian Animals by S.H. Prater, BNHS-Publication, Bombay
4. Wildlife in India by V.B. Saharia. Natraj Publishers, Dehradun
5. Wildlife in India by Saharia, V.B. Natraj Publ. Deharadun (U.P.)
6. Wildlife Biology by Raymond F Dasmann, Wiley Eastern Ltd., New Delhi, 1982
7. Experiments in Microbiology, Plant Pathology and Biotechnology 3rd Edition Aneja, K.R. (2010) New Age International Publishers, New Delhi.
8. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)- Narosha Publishing House, New Delhi.
9. Principles and techniques of practical biochemistry by K. Wilson and Wolker (1994) Cambridge University Press, Cambridge.
10. An introduction to practical biochemistry by David T. Plummer (1988) Tata McGraw Hill, Book Company, U.K

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M. Sc. (Zoology) – 4th Semester
Laboratory – VIII

ZOO – 407 B – Pertaining to Theory Papers ZOO-404 B, 405 B (Core Elective Course)

Credits: 4

Marks: 100

Duration of exam: (3+3 hour)

1. To study the protozoans and helminth parasites infecting frog, toad and common household insects through slides/charts.
2. To study the helminth parasites infecting gut of the sheep and goat obtained from slaughter house.
3. To study the parasites from stained blood smears - *Leishmania*, *Plasmodium* and *Trypanosoma*.
4. To study the vectors of different parasitic infections (Mosquito, ticks, sand-fly etc).
5. Introduction to various instruments and their working principles used in microbiology laboratory.
6. Microscopy: Care, handling and use of microscopes
7. Micrometry: Calibration, microscopic measurement of microorganisms.
8. Staining methods
9. Preparation of liquid and solid culture media for growth of microorganisms.
10. Pure Culture Techniques: Streak plate, pour plate, spread plate. Preparation of slants and stab cultures. Storage of microorganisms
11. Isolation and enumeration of microorganisms from soil and water.
12. Measurement of microbial growth and study of effect of various factors on growth of microorganisms: temperature, pH, U.V. and carbon and nitrogen sources on growth
13. Biochemical characterization of selected microbes.
14. Milk Microbiology-SPC, testing the quality of milk using MBRT 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. Parasitology : The Biology of Animal Parasites. 5th edition by Noble, E.R. and Noble, G.A., Lea & Febiger, Philadelphia; 1982.
2. Physiology of Parasites by Chapell, L.H., Blackie, Gloggow, London; 1979.
3. Immunology of Infection by Kaufmann, S., Academic Press; 1999.
4. An Introduction to Animal Parasitology by Smyth, J.D., Hodder & Stoughton, London; 1976.
5. Experiments in Microbiology, Plant Pathology and Biotechnology 4th Edition Aneja, K.R. (2010) New Age International Publishers, New Delhi.
6. Microbiology-a laboratory manual 4th edition, Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
7. Environmental Microbiology A laboratory manual, Pepper, I.L., Gerba, C.P. and Brendecke, J.W. (2015) Academic Press, New York.
8. Introductory practical biochemistry by S. K. Sawhney and Randhir Singh (2000)- Narosha Publishing House, New Delhi.

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