

# FACULTY OF LIFE SCIENCES

## Syllabus

For

### M. Sc. ZOOLOGY (FOR COLLEGES)

(SEMESTER: I - IV)

Examinations: 2019–20



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**Guru Nanak Dev University**  
**Amritsar**

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**Semester-I**

Course No.	Title	Marks		Total
		Theory	Practical	
ZooC- 501	Functional Organization of Animals – I	100	-	100
ZooC- 502	Animal Ecology	100	-	100
ZooC- 503	Cell Biology	100	-	100
ZooC- 504	Computer Programming & Data Processing	50	-	50
ZooC-551	Practical- I (F.O.A. -I)	--	50	50
ZooC-552	Practical- II ( Ecology &Cell Biology)	--	50	50
<b>Total</b>		<b>350</b>	<b>100</b>	<b>450</b>

**Semester-II**

Course No.	Title	Marks		Total
		<i>Theory</i>	<i>Practical</i>	
ZooC-601	Functional Organization of Animals- II	100	-	100
ZooC-602	Applied Zoology I (Invertebrates)	75	-	75
ZooC-603	Evolution	50	-	50
ZooC-604	Seminar	50	-	50
ZooC-605	Biostatistics	50		50
ZooC-651	Practical- III ( F.O.A.-II)	--	50	50
ZooC-652	Practical-IV (Evolution & Applied Zoology-I)	--	50	50
<b>Total</b>		<b>325</b>	<b>100</b>	<b>425</b>

**Semester-III**

Course No.	Title	Marks		Total
		<i>Theory</i>	<i>Practical</i>	
ZooC- 701	Research Techniques	100	-	100
ZooC- 702	Developmental Biology	100	-	100
ZooC- 703	General Biochemistry	100	-	100
ZooC- 704	Applied Zoology-II (Vertebrates)	75	-	75
ZooC- 751	Practical -V ( Research Techniques & Applied Zoology-II)	--	50	50
ZooC- 752	Practical VI (Developmental Biology & Biochemistry)	--	50	50
<b>Total</b>		<b>375</b>	<b>100</b>	<b>475</b>

**Semester-IV**

Course No.	Title	Marks		Total
		<i>Theory</i>	<i>Practical</i>	
ZooC- 801	Animal Behaviour and Wildlife Conservation	100	-	100
ZooC- 802	Animal Genetics & Biotechnology	100	-	100
ZooC- 803	Concepts of Immunology	100	-	100
ZooC- 804	Biosystematics	50	-	50
ZooC- 851	Practical -VII (Behaviour and Wildlife)	--	50	50
ZooC-852	Practical VIII (Genetics & Biosystematics)	--	50	50
<b>Total</b>		<b>350</b>	<b>100</b>	<b>450</b>

**ZooC– 501: FUNCTIONAL ORGANIZATION OF ANIMALS– I****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Nutrition & Digestion**

Ingestion of soluble food and particulate food in relation to habitat and habits.

Symbiotic nutrition.

Mechanism of digestion and regulation of secretion in non-chordates and chordates.

**Section-B****Transport and circulatory mechanisms**

Intracellular transport in Protozoa.

Circulation of external medium of transport within the body of sponges and cnidarians.

Open and closed types of circulatory system.

Chambered, tubular and ampullary hearts, neurogenic and myogenic hearts

Evolution of Heart and Cardiovascular system

**Section-C****Respiratory System:**

Respiratory organs in aquatic animals and aquatic respiration.

Respiratory organs and aerial mode of respiration.

Distribution and brief chemistry of respiratory pigments and their function in nonchordates and chordates.

**Reproduction**

Pattern of reproduction in non-chordates and larval forms.

Evolution of the urino-genital system in chordates with special reference to the separation of the two systems

**Section-D****Osmoregulation and Excretion**

Osmoconformers and osmoregulators, hyperosmotic, hyposmotic and isosmotic mediums,

Excretion and metabolic waste products – an introduction.

Excretory structures and waste disposal in non-chordates, coelom, coelomic ducts, nephridia, antennal / green glands, malpighian tubules.

Osmoregulation in non-chordates, adaptation to different environments / habitats.

Development and adult structural organization of chordate kidney: nephron, the functional unit.

**Suggested Reading Material:**

1. Barrington, E. U. W. (1967), *Invertebrates Structure and Functions*. Houghton Mifflin Co. Boston.
2. Barth, R. H. and Broshears, R. E (1982), *The Invertebrate world*. Holt Saunder, Japan.
3. Brusca, R. C. and Brusca, G. J. (2003), *Invertebrates second edition*. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
4. Cooper, G. M. (2004), *The Cell: A Molecular Approach IIIrd edition*, ASM Press, Washington, D.C.
5. Engemann, J. G. and Hegner, R. W. (1981), *Invertebrate Zoology (3rd ed.)* Macmillan, New York.
6. Gardiner, M. S. (1972), *The Biology of Invertebrates*, McGraw Hill, New York.
7. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), *Animal physiology*. Sinauer Associate, INC. Pub. Saunderland, Massachusettes, USA.
8. Hoar, W. S. (1984), *General and Comparative Physiology*. Prentice Hall of India Pvt. Limited, New Delhi, India.
9. Karp, G.(2005), *Cell and Molecular Biology; concepts and experiments (4<sup>th</sup> ed.)*,Hoboken, John Willy and Sons, New York.
10. Meglitsch, P. A. and Schran, F. R. (1991), *Invertebrate Zoology 3<sup>rd</sup> Ed*. Oxford University Press, New York.
11. Pechenik, A. Jan. (2000), *Biology of the invertebrates, Fourth Edition*, McGraw Hill Book Co. Singapore.
12. Prosser, C.L. (1984), *Comparative Animal Physiology*. Satish Book Enterprise Books seller & Publishers, Agra.
13. Purves, W. K., Oriane, G. H., Space, H. C. and Salava, D. (2001), *Life – The Science of Biology 6<sup>th</sup> ed.*, Sinauer Assoc. Inc., USA.
14. Randall, D., Burggren, K.L. and French, K. (2002), *Eckert Animal Physiology: Mechanisms and Adaptations*. W.H. Freeman and Company, New York.
15. Ruppert, E. E. and Barnes, R. D. (2004), *Invertebrate Zoology 7<sup>th</sup> ed*. Saunders Publ., Philadelphia.
16. Willmer, P. Stone, G. and Johnston, I ( 2000 ). *Environmental Physiology of Animals*, Blackwell Science.
17. Withers, P.C. (1992), *Comparative Animal Physiology Saunder College Publishing*, New York.

**ZooC – 502 ANIMAL ECOLOGY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Introduction and History of Ecology**

Structure and Functions of some special types of ecosystems (Grasslands, forests, deserts and aquatic ecosystems).

**Weather**

Temperature, Moisture, Light, fire, Malentite, pollution

**Section-B****Analysis of Environment**

Resource

Food, its distribution, relative and absolute shortages

Place in which to live

**Community Structure**

Ecological Niche, Food chains, Food webs, biomagnifications, succession / temporal changes.

**Interactions and Coactions**

Between animals of same kind

Between animals of different kind

Predation, Parasitism, Commensalism, Mutualism etc.

**Section-C****Adaptations**

Cave, deep sea, arboreal, aerial, and subterrestrial.

Co-adaptations and adaptive resemblances (mimicry, warning colouration, seasonal polymorphism)

**Population Ecology**

Concept of Population

Biotic potential and carrying capacity, dispersal and distribution, population growth and its regulations

Methods of sampling

Life tables and longevity.

Migration and Ecesis.

**Section-D****Applied Ecology**

Anthropogenic interferences

Bio monitoring of environment using animal species

Modeling and Use of remote sensing (GIS ) in ecology (introduction)

Ecological basis of pest regulation (in brief)

**Bio Geography**

Zoo Geographical regions

Island ecology. (endemicity)

**Suggested Reading Material:**

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

**ZooC – 503 CELL BIOLOGY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Introduction**

Cell – a unit of structure and function, cell theory.

**General Properties of the Cell**

Size, shape, number, life span and death.

Cell types: Prokaryotes and eukaryotes

Stem cells.

**Organization of Prokaryote Cell**

Mycoplasma, Bacteria, Cyanobacteria (Blue Green Algae). Structure and importance of their study.

**From Prokaryotes to Eukaryotes**

Events leading to origin of eukaryotic cells. Endo symbiotic theory and recent views.

**Structure of Cell Membrane**

General properties of cell membrane, chemical composition.

The concept of unit membrane.

Various Lipoprotein models including fluid mosaic model.

**Section-B****Golgi Complex**

Structure and Function of : Cisternae, vacuoles and vesicles.

Functions

Role in secretion, cell wall formation, packaging of intracellular products and other functions

GERL concept.

**Mitochondria**

Elaboration of the plasma membrane and multi enzyme complex, outer and inner membranes, cristae, matrix, inner and outer compartments,

Location of enzyme complexes of TCA cycle (and ATP generation)

Electron transport chain, semi autonomous nature (mitochondrial DNA, RNA, ribosomes and protein synthesis)

**Endoplasmic Reticulum**

Extension of cell membrane, cisternae, Site of location

Compartmentalization of enzymes and metabolites and their associated functions.



**Section-C****Ribosomes**

A complex of ribonucleoproteins,

Dynamics of association - disassociation of ribosomes into polysomes, microsomes,

Site of protein synthesis (initiation, elongation, translocation and termination phases of protein synthesis)

Central dogma.

**Lysosomes**

Polymorphic single membrane structure, site of proteolytic activity for intracellular digestion

Phagocytosis, increase in lysosomal activity with age

Lipofuscin pigments, diseases associated with lysosomes.

**Peroxisomes and Glyoxisomes**

Single membrane structure; site of enzyme complexes involved in hydrogen peroxide, metabolism, gluconeogenesis (conversion of non carbohydrate into carbohydrates)

Glyoxylate pathway, microperoxisomes.

**Cytoskeleton**

Actin filament, Myosin, Intermediate filament, microtubules.

**Section-D****Cell Surface Modifications**

Glycocalyx, villi, microvilli, caveolae.

**Cytoplasmic Inclusions**

Inert storage materials, glycogen, starch, lipids, metabolic crystals

**Nucleus**

Nuclear membrane, pores, chromatin, (euchromatin & heterochromatin), nucleolus,

Eukaryote chromosomes structure (DNA, Histone and other proteins, Nucleosome and solenoid concept).

Kinetochore, centromere and gene structure.

**Cell Continuity**

Phases of cell cycles

Mitosis and Meiosis

**Suggested Reading Material:**

1. Alberts, B. Bracy, P. Lewis, J. Raff, M. Roberts K and Watson, J. (eds) (1994). Molecular Biology of the Cell, Garland Publishing, New York.
2. Avers, C. J. (1976). Cell Biology, Van Nostrand Reinhold, New York.
3. Cooper, G. M. (2004). The cell, A Molecular Approach ASM press, Washington, D. C.
4. Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.

5. Darnell, J. Lodish, H. and Baltimore, D. (2004). *Molecular Cell Biology*, 2<sup>nd</sup> edition, Freeman, New York.
6. Derobertis, E. D. P. and Derobertis, E.M.F. (1987). *Essentials of Cell and Molecular Biology*. Hold Saunders – Philadelphia.
7. Dewitt., W. (1977). *Biology of the Cell – An evolutionary approach*, Saunders – Philadelphia.
8. Holtzman, E. and Novikoff, A. B. (1984). *Cells and Organelles*. Saunder – Philadelphia.
9. Hopkins, C. L. (1978). *Structure and Functions of Cells* . Saunders – Philadelphia.
10. Karp, G. (1984). *Cell Biology* 4<sup>th</sup> Edition, McGraw Hill, New York.
11. Karp G. (1999). *Cell and Molecular Biology. Concepts and Experiments*, 2<sup>nd</sup> Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
12. Loewy, A. G. , Siekevitz, P, Menningee, J. R. , and Allant, J. A. N. (1991). *Cell Structure and Functions. An integrated Approach* 3<sup>rd</sup> edition . Saunders College Publishing, Philadelphia, London.
13. Pollard. T.D. and Earnshaw, W.C. (2002) *Cell Biology*. Saunders, Philadelphia London. New York, St. Luis Sydney, Toronto.
14. Powar, C. B. (1990). *Cell Biology*. Himalaya Publishing House, Bombay.
15. Sadava, D. E. (1993). *Cell Biology – Organelle, Structure and Fucntions*. H. Jones and Bartlett- Boston.
16. Sheeler, P. and Binachi, D. E. (1983). *Cell Biology*, John Wiley, New York.
17. Smith & Wood (1992). *Cell Biology*, Chapman & Hall, London, New York.
18. Wolfe, S. L. (1983). *Introduction of Cell Biology*, Woodworth Belmont.

**ZooC-504: COMPUTER PROGRAMMING & DATA PROCESSING****Time: 3 hrs.****Max. Marks: 50****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

1. Introduction to computer capability, history and classification of computers.
2. Computer architecture, organization, its components, hardware and software concepts, operating systems, peripherals, I/O devices.
3. Introduction to programming Languages.

**Section-B**

4. Problem solving through computers, flow chart systems and software development.
5. Personal Computers, characteristics, capabilities, application packages.
6. Word Processing and desktop publishing.
7. Limitations of computers.

**Section-C**

8. Introduction to Basic syntax notation overview.
9. Program structure, elements, basic character set, constants, variables operators and expressions.
10. Basic Statements I/O statements. Edit statements, fill statements, declarative statements, remark statements, arrays.
11. Assignments and controls statements: ON GO TO, IF THEN, ELSE FOR NEXT, WHILE WEND, UNTIL NEXT.

**Section-D**

12. Subroutine functions.
13. Files, basic files organizations, file related statements and key-words.

**ZooC-551: PRACTICAL –I (FUNCTIONAL ORGANIZATION OF ANIMALS-I)****Time: 4 hrs.****Max. Marks: 50**

1. Study of permanent slides:-
  - Mouth parts : honey bee, housefly, cockroach, butterfly, mosquito, and bug.
  - Salivary glands.
  - Blood of animals.
  - Radula of Pila and jaws of Leech
2. Using slides/charts/models/videos study of following:-
  - Anatomy of gut in relation to food and feeding habits of detritivores, carnivores, herbivores, omnivores and sanguivores.
  - Different kinds of Heart and blood vascular system in animals.
  - Respiratory structures: Gills (Crustaceans, Bivalves, Cephalopods, and Fish); Book Lungs (Scorpion); Trachea and spiracles (Cockroach).
  - Nephridia in annelids (earthworm), green glands in crustaceans, Malpighian tubules in Cockroach.
  - Excretory system of frog, lizard, bird and rat.
  - Histology of ovary, oviduct, uterus, testis and placenta in different groups of invertebrates & vertebrates.
  - Reproductive organs in Hydra, Flatworm, Earthworm, Cockroach, Pila, Fish, Frog, Lizard, Bird and Rat.

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

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

**ZooC -552: PRACTICAL –II (ECOLOGY AND CELL BIOLOGY)****Time: 3 hrs.****Max. Marks: 50**

-Population estimations: Using Mark and Release method and to study the effect of migration on them (Using Moong and Mash beans).

Estimation of population:

Protozoans

Nematodes

Soil arthropods

Combined population studies using quadrates.

Intrapopulation distribution and poisson distribution, construction of life table and survivorship curves from given data.

-Microscopy:

Principles of compound, phase contrast, electron microscopy.

Use and care of Light compound microscope.

Lens aberrations

-Study of Cells: using permanent slides

Prokaryote cells: *Lactobacillus*, *E. coli*. Blue green algae.

Eukaryote cells, Testicular material (for studies of spermatogenesis).

-Microtomy: Introduction of the instrument – its use, care.

-Preparation of permanent slides: Principles and procedures – Section cutting of tissues and staining of tissues with Haematoxylin/Eosin method.

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

-Cytochemical techniques: Study carbohydrates, nucleic acids, proteins, lipids and enzymes.

-Study of electron micrographs of various cell organelles :- plasma membrane, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum (smooth and granular), Cilia, Centrioles, inclusions like glycogen, lipids etc.

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

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

**[www.ugc.ac.in](http://www.ugc.ac.in)**

**ZooC -601: FUNCTIONAL ORGANIZATION OF ANIMALS –II****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Integumentary System**

Embryonic origin

General features of the Integument

Specializations of integument

Evolution of Skin

**Muscular System**

Classification of Muscles, Structure of Skeletal Muscles and cardiac muscle, Tendons

Muscle mechanics

Muscle Function Basis of Muscles contraction,

Muscle Fiber, Muscle organs and fibers

Bone-muscle lever systems

**Section-B****Skeletal System**

Exo and Endo Skeleton in Invertebrates

Appendicular skeleton in vertebrates, Basic Components

Phylogeny of fishes and tetrapods

Evolution of the Appendicular system

Form and Function

Swimming

Terrestrial locomotion

**Section-C****Integratory Systems**

Chemical coordination of body functions through neuro-secretion in non-chordates.

Physiology of nerve net and giant fibre system.

Evolution of functional anatomy of brain.

**Endocrine System**

Endocrine organs

Chemical coordination of body functions through hormones and neuro secretions

**Section-D****Sensory System**

General sensory organs

Free sensory receptors

Encapsulated sensory receptors

Associated sensory receptors

Mechanisms of perceiving stimuli

Special sensory organs (Mechano, Radiation, Chemo. and Electoreceptors)

Additional special sensory organ

**Suggested Reading Material.**

1. Barrington, E. U. W. (1967), *Invertebrates Structure and Functions*. Houghton Mifflin Co. Boston.
2. Barth, R. H. and Broshears, R. E (1982), *The Invertebrate World*. Holt Saunder, Japan.
3. Brusca, R. C. and Brusca, G. J. (2003), *Invertebrates Second Edition*. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
4. Cooper, G. M. (2004), *The Cell: A Molecular Approach*, IIIrd edition, ASM Press, Washington, D.C.
5. Engemann, J. G. and Hegner, R. W. (1981), *Invertebrate Zoology (3rd ed.)* Macmillan, New York.
6. Gardiner, M. S. (1972), *The Biology of Invertebrates*, McGraw Hill, New York.
7. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), *Animal Physiology*. Sinauer Associate, INC. Pub. Saunderland, Massachusettes, USA.
8. Hoar, W. S. (1984), *General and Comparative Physiology*. Prentice Hall of India Pvt. Limited, New Delhi, India.
9. Karp, G.(2005), *Cell and Molecular Biology; Concepts and Experiments (4<sup>th</sup> ed.)*, Hoboken, John Willy and Sons, New York.
10. Meglitsch, P. A. and Schran, F. R. (1991), *Invertebrate Zoology 3<sup>rd</sup> Ed*. Oxford University Press, New York.
11. Pechenik, A. Jan. (2000), *Biology of the Invertebrates, Fourth Edition*, McGraw HillBook Co. Singapore.
12. Prosser, C.L. (1984), *Comparative Animal Physiology*. Satish Book Enterprise Books Seller & Publishers, Agra.
13. Purves, W. K., Oriane, G. H., Space, H. C. and Salava, D. (2001), *Life – The Science of Biology 6<sup>th</sup> ed.*, Sinauer Assoc. Inc., USA.
14. Randall, D., Burggren, K.L. and French, K. (2002), *Eckert Animal Physiology: Mechanisms and Adaptations*. W.H. Freeman and Company, New York.
15. Ruppert, E. E. and Barnes, R. D. (2004), *Invertebrate Zoology 7<sup>th</sup> ed*. Saunders Publ., Philadelphia.
16. Willmer, P. . Stone, G. and Johnston, I ( 2000 ). *Environmental Physiology of Animals*, Blackwell Science.
17. Withers, P.C. (1992), *Comparative Animal Physiology Saunder College Publishing*, New York.

**ZooC -602: APPLIED ZOOLOGY- I (INVERTEBRATES)****Time: 3 hrs.****Max. Marks: 75****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Arthropods (Important Species and their Economic Importance)**

- Diplopods and chilopods
- Arachnids (other than plant pests)
- Insects (other than insect pests of crops, parasites of man and domestic animals)
  - As pollinators
  - In Biological pest management
  - As source of food
  - Venomous insects

**Apiculture**

- History and Introduction
- Honey bee and kinds
- Social organization of colony and nests
- Life Cycle
- Relation between honeybees and plants
- Flora for Apiculture
- Honey composition, quality and importance
- Bee keeping, selection, methods, precautions
- Products of bee keeping
- Bee enemies and diseases

**Section-B****Lac culture**

- Introduction
- Lac insect:- species, Life cycle and Host plants
- Lac composition, properties & importance
- Cultivation and harvesting of Lac
- Enemies of Lac insect and host plants
- Lac industry in India

**Sericulture**

- Indian sericulture industry (distribution and prospects)
- Silk moth species and their Life Cycle
- Silk composition, kinds and uses
- Mulberry cultivation
- Rearing of silkworm
- Treatment and disposal of cocoons
- Silk reeling, twisting and weaving
- Diseases & pests of silkworm



**Section-C****Crustaceans (Important species and their Economic Importance)**

Crab, lobsters, copepods.

**Prawn Culture**

Introduction to prawns

Prawn: species

Fresh water prawn farming and Marine Prawn farming

Methods of Prawn farming

Spoilage and its prevention

Processing and preservation of prawns

Future of prawn culture

**Molluscs (Economically important species)**

Eulamellibranchs

Gastropods

Cephalopods

**Pearl Culture**

Pearl culture, Historical background

Pearl oyster –species

Pearl formation, composition, quality and commercial value

Artificial Culturing of Pearls, synthetic pearls types and their manufacturing.

Methods of harvesting

Problems of pearl industry

**Section-D****Economic Importance of :-****Protozoans**

Important Parasitic species, diseases caused, prevention and cure.

**Annelids**

Leeches

Vermiculture; species of worms, conditions for efficient vermiculture (domestic and commercial level), Economics of Vermiculture

**Helminthes**

Liver flukes

Cestodes/ tapeworms

Roundworms (Animal and plant parasitic Nematodes)

**Echnioderms**

Sea cucumbers

Star Fish

**Suggested Reading Material**

1. Bhamrah, H. S. & Juneja, K. (2001), An Introduction to Mollusca. Anmol Publications Pvt., Ltd. New Delhi.
2. Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm ; Vermiculture and Vermicomposting , Kalyani Publishers India.
3. Carter, G. A. (2004) Beekeeping , Biotech Books, New Delhi.
4. Fenemore, P. G. and Prakash, A. (1992), Applied Entomology, Wiley Eastern Ltd. New Delhi.

5. Ghorai, N. (1995), Lac Culture in India. International Books and Periodicals, New Delhi.
6. Jhingran , V. G. (1991) Fish and Fisheries of India, Hindustan Publishing Company India.
7. Kumar, A. and Nigam, P. M. (1989), Economic and Applied Entomology EMKAY Publishing Co. New Delhi.
8. Mishra, R. C. (1995), Honey Bees & their Management in India. ICAR, New Delhi.
9. Mustafa, S. (1990) Applied and Industrial Zoology. Associated Publishing Company, New Delhi.
10. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
11. Sathe, T. V. and Jadhav, A. D. (2001) Sericulture and Pest Management, Daya Publishing House, New Delhi.
12. Shimizu, M. (1972) Handbook of Silkworm Rearing (Agricultural Techniques Manual-1) Fuji Publishing Co. Ltd , Tokyo, Japan.
13. Singh, S. (1962), Bee Keeping in India, I. C. A. R. Publications, New Delhi.
14. Sobti, R. C. (1992), Medical Zoology, Nagin Chand & Co. Jalandhar.
15. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
16. Ullal, S.R. and Narsimhanna, M. N. (1981), A Handbook of Practical Sericulture, Central Silk Board, Bombay.
17. Venkatanarasaiah, P. (1992), Sericulture in India, Ashish Publishing House, New Delhi.

**ZooC -603: EVOLUTION****Time: 3 hrs.****Max. Marks: 50****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Origin of Life**

- Origin of Micro molecules
- Origin of Macro molecules
- Origin of Viruses
- Origin of Prokaryotes
- Origin of Unicellular eukaryotes and multicellularity

**Organic Evolution**

- Theories
- Evidences
- Separation of kingdoms

**Section-B****Variations**

- Types of variations
- Causes of variations
- Mutation rates and directions

**Natural Selection:**

- Types of selection
- Selection forces
- Experimental demonstration of Natural selection
- Industrial melanism and polymorphism
- Sexual selection
- Selection and non adaptive characters

**Section-C****Speciation**

- Isolation and its types
- Gradual and abrupt
- Origin of higher categories

**Distribution of Species**

- Island, Ocean and Continental distribution
- Theories of continental drift

**Extinction**

- Kinds of extinction
- Causes of extinction
- Great extinctions

**Section-D****Quantative and Molecular Aspects of Evolution**

Hardy- Weinberg law

Selection pressure

Mutation pressure

Genetic drift

Migration

Meiotic drive

Brief account of:

Evolution of genome in viruses, prokaryotes and eukaryotes

Evolution of sexual reproduction,

Molecular clocks

Future Course of Evolution

**Suggested Reading Material**

1. Avers, C. J.(1989). Evolution Process and Pattern in Evolution Oxford University, Press, New York, Oxfor.
2. Ayala, F. J. and Valentine J. W. (1979). Evolving the theory and Process of Organic Evolution, Benjamin Cumming.
3. Brookfield, A. P. (1986). Modern aspects of Evolution. Hutchinson London, Melbourne.
4. Gallow, P. (1983). Evolutionary principles. Chapman and Hall.
5. Freeman, S. and Herron, Jon C. (2007). Evolutionary analysis Pearson Prentice Hall, New Jersey.
6. Futuyma, D. J. (1998), Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
7. Meglitsch, P. A. (1991), Invertebrate Zoology (3<sup>rd</sup> edition), Oxford University Press.
8. Minkoff, E. C. (1983), Evolutionary Biology, Addison Wesley Pub. Co., London.
9. Wen-Hsiung Li (1997), Molecular Evolution, Sinauer associates Inc.Pub. USA.

**ZooC-604: Seminar****Max. Marks: 50****Instructions for the Paper Setters:**

The students are required to present a seminar on a topic of relevance and importance from the subject Zoology. The seminar carries 50 marks (10 for material, 15 for presentation, 5 for discussion and 20 for the seminar based paper at the end of the semester).

**ZooC-605: BIOSTATISTICS****Time: 3 hrs.****Max. Marks: 50****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**SECTION-A**

Elementary Statistics: Representation of data- discrete data, continuous data, histogram, polygons, frequency curves. The mean Variability of data, Standard deviation. Median, Quantiles, Percentile, Skewness, Box and whisker diagrams (box plots), Introduction to statistical sampling from a population, Random Sampling.

**SECTION-B**

Probability: Experimental Probability, Probability when outcomes are equally likely, Subjective Probabilities, Probability laws Probability rules for Combined events, Conditional Probability and Independent Events, Probability trees, Bayes theorem. Probability Distribution Bernoulli Distribution, Binomial Distribution Poisson Distribution Uniform Distribution Normal Distribution, Normal approximation to binomial distribution, Central limit theorem.

**SECTION-C**

Multivariate Analysis: Regression and correlation:, Correlation & Regression, Scatter diagram, Regression function, Linear correlation and regression lines, Product moment correlation coefficient. Cluster analysis: Basics (Tree clustering), Distance Measures, Hierarchical tree, linkage rules (single and complete linkage, UPGMA), Two-way joining, k-means clustering and interpretation of results, expectation maximization. Principal Component Analysis (PCA): Principles and Applications to real life data.

**SECTION-D**

Random Variables Discrete and continuous Random variables Cumulative distribution function, Probability Mass function, Probability Density Function Expectation of random variables- experimental approach and theoretical approach. Expectation of  $X$  and variance of  $X$ , Expectation of function  $E[g(X)]$  . Hypothesis Testing: Fischer test, Chi Square test, Student t-test, ANOVA in reference to experimental design.

**Text Reference Books: -**

1. Brian S., Ripley D. and Venables W. N. (2002). Modern Applied Statistics. Springer Verlag
2. J. Crawshaw and J Chamber (2002) Advanced level Statistics, 4th Edition, Melson Thornes.
3. Kapoor V.K. and Gupta S.C. (2000) Fundamentals of Mathematical Statistics. Sultan Chand and Company, New Delhi
4. Gupta S.P. (2000). Statistical methods. Sultan Chand and Company, New Delhi.
5. Mendenhall W. and Sincich T. (1995). Statistics for engineering and sciences (IVth edition). Prentice Hall.
6. Elhance D.N. (1984). Fundamentals of Statistics. Kitab Mahal, Allahabad.

**Suggested Reading Material:**

1. Hussain I. et. al. Mathematics, A textbook for class XI, NCERT.
2. Joshi, D.D. et. al. Mathematics, A textbook for class XII, NCERT.
3. Batschelet, Mathematics for Life Sciences.
4. S. Sokal, R. and James F. Introduction to Biostatistics.

**ZooC-651: PRACTICAL –III (FUNCTIONAL ORGANIZATIONS OF ANIMALS-II)****Time: 4hrs****Max. Marks: 50**

1. Study of permanent slides:
  - Skin of fish, frog, lizard, bird and mammal.
  - Setae of earthworm
  - Spicules of Sponges and Herdmania.
  - Internal ear of fish
  - Tentorium of grasshopper
  - Muscle fibers, cartilage and bone.
  - Endocrine glands of vertebrates.
2. Appendicular skeleton.
3. Study the following with the help of charts/models/videos/permanent slides.
  - Appendages of Prawn
  - Wing venation, coupling and types of wings of insects.
  - Comparative anatomy of nervous system in Earthworm, Cockroach, Pila, Sepia, Fishes, Bird and Mammal.
  - Eye muscles of fish/mammal
  - Modification of antenna in arthropods

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

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



**ZooC-652: PRACTICAL IV (EVOLUTION AND APPLIED ZOOLOGY-I)****Time: 4 hrs****Max. Marks: 50**

- Calculations for regression, correlation and variance of gene frequency and genetic equilibrium (taking pea pods).
- Examination of the principle of natural selection as a process related to evolution in a population (using coloured marbles / beads).
- Comparison of skeletons for listing evolutionary trends.
- Comparison of molluscan shells to depict polyphyletic origin.
- Comparison of homologous and analogous structures (e.g. insect antenna, legs, limbs of vertebrate etc.).
- Demonstration of kinds of mimicry in various groups of animals.
- Mapping of geographic distribution of some birds, insects, fish etc.
- Study of various evolutionary phenomenon using slides / photographs.
- Study of fossils.
- Preparation of Phylogenetic tree using some Priority weight characters with the help of 8 – 10 animals from various categories.
- Visit to apiary/vermicomposting unit/ sericulture unit/ Prawn Farm and preparation of report.

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

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

**ZooC-701: RESEARCH TECHNIQUES****Time: 3hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

**Centrifugation:** Basic principles, theory and applications of preparative and analytical centrifugation, rotor types, sedimentation co-efficient and care of rotors.

**Chromatography:** Theory, principle and application of column, paper, thin layer, ion-exchange, affinity chromatography, GLC, HPLC and FPLC.

**Section-B**

**Spectroscopy:** Lambert Beer's law, theory & principles of single and double beam UV/Visible spectroscopy, principle of NMR, ESR, Mass spectroscopy and their application in biology for qualitative and quantitative determination of biomolecules. Introduction to fluorescence spectroscopy and IR spectroscopy.

**Section-C**

**Electrophoresis:** Theory and application SDS-PAGE and Agarose Gel electrophoresis. Introduction to IEF, (Iso-electric focusing) 2-D gel and capillary electrophoresis and their application in biology for isolation of biomolecules based on charge and molecular weight.

**Introduction to gene amplification techniques**

**Section-D**

**Radioisotopic Techniques:** Basic concepts of radioisotopy, theory and applications of Geiger-Muller tube, solid and liquid scintillation counters, primary and secondary fluors. Safety rules for radioisotopic studies. Biological applications

**Books:**

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

**ZooC-702: DEVELOPMENTAL BIOLOGY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Gametogenesis and Fertilization**

Spermatogenesis, oogenesis, vitellogenesis  
 Egg and sperm interaction, fertilization  
 Natural and artificial parthenogenesis  
 In vitro fertilization and embryo transplantation

**Section-B****Cleavage, Gastrulation & Differentiation**

Cleavage and its patterns  
 Biochemical changes during cleavage  
 Influence of male and female pronuclei during early development  
 Gastrulation and morphogenetic movements  
 Morphogenesis of germ layers  
 Morphogenetic field  
 Differentiation  
 Determination, transdetermination

**Section-C****Induction and Maturation**

Induction, organization, competence and inductive response, hierarchies of induction, principles of reciprocal action  
 Control and morphophysiology of metamorphosis in insects and frog  
 Regeneration in Platyhelminthes and Coelenterates  
 Histomorphological changes in regeneration of tail in Amphibians and Reptiles, limb in amphibians and Vertebrate lens  
 Concept of growth at cellular, subcellular and organ level

**Section-D****Genetic Control of Development**

Nuclear determination of developmental events  
 Molecular basis of early embryonic development  
 How is genetic control exercised during development  
 Influence of extrinsic factors on genetic control  
 Nucleus and cytoplasmic interactions during development

**Suggested Readings:-**

1. Balinsky, B.I. (1981). An Introduction to Embryology, Saunders, Philadelphia.
2. Bellairs, R. (1971). Development Processes in Higher Vertebrates, University of Miami Press, Miami.
3. Berrill, N.J. (1971): Developmental Biology. McGraw Hill, New Delhi.
4. Dawnpart, Developmental Biology.
5. Ebert, J.D. & Sussex, IM. (1970): Interacting Systems in Development, Holt, Rinehart and Winston, New York.
6. Gilbert, F. (1985, 95 & 2000): Developmental Biology, Sinaur.
7. Goel, S.C. (1984): Principles and Animal Developmental Biology, Himalaya, Bombay.
8. Grant, P. (1978): Biology of Developing System.
9. Karp. G. & Berrill, M.J. (1981): Development. McGraw Hill, New Delhi.
10. Oppenheimer, J.M. and Willer, B.H. (1964): Foundation of Experimental Embryology, Prentice-Hall, New Delhi.
11. Pritchard, D.J. (1986): Foundation of Development Genetics, Taylor and Francis, London.
12. Saunders, J.W. (1982): Developmental Biology, Patterns, Principles, Problems, MacMillan, New York.
13. Spratt, N.T. Jn. (1971): Developmental Biology, Wordsworth, Belmont, Co.
14. Waddigton CH. (1966): Principles of Development and Differentiation. MacMillan, New York.
15. Loomis, W.F. (1986) Developmental Biology Macmillan, New York.
16. Miller, W.A. (1997). Developmental Biology Springer Verlag, New York.
17. Browder, L ( ) . Developmental Biology, a Comprehensive Synthesis Plenum, New York.

**ZooC-703: GENERAL BIOCHEMISTRY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Biomolecules**

Biological fitness of organic compounds. Dimension and shape of biomolecules, supramolecular structures and cell organelles.

**Water**

Physical properties and structure of water, hydrogen bonding, solvent properties of water, ionization of water, fitness of aqueous environment for living organism, pH and buffers.

**Proteins**

Amino acids as building blocks of proteins, essential amino acids, non-protein amino acids, structure of peptide bond, organizational levels of protein structure. Relationship between primary and higher order structures, supramolecular assemblies of proteins, solubility denaturation, functional diversity and species specificity of proteins, protein classification, chemical synthesis and sequencing of polypeptides.

**Section-B****Enzymes**

As catalyst specificity, enzyme substrate complex, active sites. Michaelis – Menton kinetics,  $V_{max}$  and  $K_m$  and their significance, Reversible and Irreversible inhibition, Regulatory enzymes.

**Carbohydrates**

Definition, families of monosaccharides, structure of carbohydrates, stereoisomerism, trisaccharides and polysaccharides (starch, glycogen, cellulose, dextrans), sugars of bacterial cell wall

**Section-C****Lipids**

Definition and Classification of lipids, fatty acids and essential fatty acids, General structure and functions of major lipid subclasses, acylglycerols, phosphoglycerides, Sphingolipids, terpenes, steroids and prostaglandins.

**Biological membranes**

Common features, structural components, phospholipids, glycolipids and cholesterol

Lipid bilayer and membrane proteins, Fluid mosaic model and membrane asymmetry, Transport across membranes

**Section-D**

Generation and storage of metabolic energy

**Bioenergetics, Metabolic Pathways**

Glycolysis, pentose phosphate pathways, glyoxalate, Citric acid cycle, Oxidative phosphorylation. Gluconeogenesis,  $\beta$  oxidation of fatty acids, biosynthesis of saturated fatty acids, general reactions and metabolism of amino acids

**Nucleic Acid Structure:**

Watson and Crick model of double DNA helix, synthesis of Nucleotides, Chemical Synthesis of Nucleic acid.

**Suggested Reading Material:-**

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

**ZooC-704: APPLIED ZOOLOGY-II (VERTEBRATES)****Time: 3hrs****Max. Marks: 75****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Pisciculture**

Economically important fresh water and marine fishes  
 Aims and evolution of Fish culture  
 Fish Farming Technologies  
 Factors affecting fish culture  
 Problems of seed collection from natural resources (in brief)  
 Induced breeding methods  
 Products and by products from pisciculture.

**Poultry**

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

**Section-B****Fur Industry**

Fur producing animals  
 Fur farming, dressing, processing and dyeing  
 Fur industry in India

**Leather Industry**

Animals of leather industry  
 Processing of skin: flaying, Curing, salting and tanning during  
 Enemies of skin industry

**Section-C****Dairy Farming**

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

**Wool Industry**

Animals of wool industry

Types, structure and physicochemical properties of wool

Processing of wool: shearing, clearing, drying, bleaching, dyeing, spinning and twisting

**Section-D****Piggery**

Characteristics of swine and important breeds

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)

Use of animals in vaccine production

**Suggested Reading Material:**

1. Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
2. Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, New Delhi.
3. Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
4. Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co. India.
5. Khanna, S. S. (1986), An Introduction to Fishes, Central Book Depot, Allahabad.
6. 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.



**ZooC-751: PRACTICAL -V (RESEARCH TECHNIQUES & APPLIED ZOOLOGY-II)****Time : 4 hrs****Max. Marks: 50****Chromatography Techniques:** (for separation of macromolecules)

- Paper chromatography
- Thin layer chromatography
- Gel permeation chromatography

**Spectrophotometric Techniques:**

- Preparation of standard curve of BSA, DNA, RNA
- Measurement of transmission of light through different solutions or substances at different wavelengths of light.
- Estimation of DNA/RNA

**Electrophoresis Techniques:**

- Preparation of native polyacrylamide gel.
- Gel separation of proteins by native PAGE.
- Preparation of SDS-polyacrylamide gels
- Separation of proteins by SDS-PAGE.
- Direct and Indirect ELISA

**Centrifugation:**

- Sedimentation using Swing out Rotor and Angle Rotor
- Differential centrifugation

Vist to a fish farm/poultry form/pig farm/sheepor goat farm/meat processing industry/leather industry/wool industry and preparation of report.

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

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**ZooC-752: PRACTICAL VI (DEVELOPMENTAL BIOLOGY AND BIOCHEMISTRY)****Time: 4hrs.****Max. Marks: 50**

-Study of different larval forms across the animal Kingdom using charts/models/videos.

-Developmental stages of chick and frog through slides/charts.

-Metamorphosis through charts/audio video means in frog and insect.

-Study of Gametes through permanent slides:-

a) Spermatogenesis in rat/frog/grasshopper

b) Study of testis (rat/frog/grasshopper)

c) Study of Ovary (rat/frog/grasshopper)

d) Oogenesis in rat / frog/fish

-Quantitative analysis of proteins by Lowry/ Bradford method.

-Estimation of Lipids

-Estimation of Carbohydrates

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

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

**ZooC-801: ANIMAL BEHAVIOUR AND WILDLIFE CONSERVATION****Time: 3hrs****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Introduction**

Ethology as a branch of biology

Animal Psychology – classification of behavioural patterns, analysis of behaviour (ethogram)

**Neural and Hormonal Control of Behaviour**

Genetic and environmental components in the development of behaviour

**Communication:**

Chemical, Visual tactile and Audio communication

Functions of communication

Song specificity in birds

Evolution of language (primates)

Host-parasite relations

**Section-B****Social Behaviour**

Aggregations-schooling in fishes, flocking in birds, herding in mammals, Advantages and disadvantages of living in groups

Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness

Social organization in insects and primates

**Reproductive Behaviour**

Evolution of sex.

Mating and Courtship behaviour

Sperm competition

Sexual selection and Parental care

**Learning and Memory**

Conditioning, Habituation, Associative learning, Reasoning and Cognitive skills

**Section-C****Wild life in India**

Wild life as a resource and its value  
 Causes of depletion of wildlife  
 Wild life ecology, ecological sub regions, distribution of wildlife in India  
 Methods of studying wildlife and census of wildlife  
 National and state animals of India  
 Red data book, endangered, vulnerable, rare, threatened and intermediate species  
 Names, Organization and management of Wildlife sanctuaries, National parks and Biosphere reserves

**Wildlife Conservation**

Role of Zoos, parks and sanctuaries for conservation of some wild animals  
 Laws, legislation and statutory bodies for protecting wildlife  
 Measures for wildlife conservation  
 Problems of wildlife management

**Section-D****Status of Wildlife in Punjab**

Wildlife conservation and Human conflict

**Special projects for Endangered Species and concerns**

Project Tiger  
 Project Hangul  
 Project Rhino  
 Project Elephant  
 Gir Lion Sanctuary Project  
 Project Great Indian Bustard  
 Crocodile breeding Project  
 Ecology & Conservation of the Himalayan Musk deer and the Manipur Brow antlered deer

**Suggested Reading Material:**

1. Aggarwal,. (2000), Biodiversity.
2. Aggarwal,. ( 2000 ), Wildlife of India.
3. Alcock, J. (1998), Animal behaviour, An evolutionary approach Sinauer Assoc., Sunderland, Mass, USA.
4. Ali, S. (1971), The Books of Indian Birds, Bombay Natural History Society, Bombay.
5. Burton, L. D. (2003), Fish and Wildlife: Principles of Zoology and Ecology. Delmar Thompson Learning Pb.
6. Dasmann, R. F., ( 1982 ), Wildlife Biology, Wiley Eastern, New Delhi.
7. Drickamer, L. C. and Vessey, S. H. (1986), Animal Behaviour - Concepts, Processes and Methods. (2<sup>nd</sup> ed.), Wordsworth Publ. Co., California.
8. Fulbright, Timothy, E. and Hewitt, D. G. (2008). Wildlife Science: Linking Ecological Theory and Management Applications. CRC Press, Taylor and Francis : BocaRaton, F L.
9. Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
10. Gopal, R. ( 1992), Fundamental of Wildlife management Justice Home Allahabad.

11. Goodenough, J., McGurie and Wallace, R. A. (2001), Perspective on animal behaviour. John Wiley & Sons, Inc. New York.
12. Hosetti, B. B. ( 1997 ), Concepts in Wildlife Management, Chawla Press, Delhi.
13. Huntingford F. ( 1984 ), The study of animal Behaviour, Chapman and Hall, London.
14. Manning, A. and Dawkins, M. S. ( 1992 & 1998 ), An Introduction to Animal Behaviour , 4<sup>th</sup> ed. ( Cambridge low price editions ). Cambridge University Press, Cambridge.
15. Manning, A. (1979), An Introduction to Animal Behaviour, 3<sup>rd</sup> Edition . The English Language Book Society and Edward Arnold Publishers Ltd.
16. McFarland, D. (1985 & 1999), Animal Behaviour. Pitman Publishing Ltd. London.
17. Majupuria T. C. (1990), Wildlife Wealth of India (Resources and Management), ISBN, Tecpress Services, Thailand.
18. Moulton, M. P. and Sanderson, J. (1997), Wildlife issues in a changing world. St. Luice Press Florida.
19. Negi, S. S. ( 1995 ), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
20. Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay.
21. Saharia, V. P. (1982), Wildlife in India, Natraj Publisher, Dehradun.
22. Samways, M. J. (1994), Insect Conservation Biology, Chapman and Hall, New York.
23. Sharma, B. D. (1994), High Altitude Wildlife of India, Oxford IBH, New Delhi.
24. Sharma, B.D. ( 1999 ), Indian Wild Life Resources Ecology and Development . Daya Publishing House, Delhi.
25. Sharma, B.D. (2002 ), Man environment and wildlife animal. IBH Publishing Co., Pvt . Ltd. New Delhi.
26. Teague, R. D. ( 1987), A manual of Wildlife Conservation, Natraj Publishers, Dehradun.
27. Tikadar, B. K. ( 1988 ), Threatened Animals of India, Publications of Zoological Survey of India, Calcutta.
28. Tirvedi, P.R. and Singh, U. K. ( 1996 ), Environmental Laws of Wildlife.

**ZooC-802: ANIMAL GENETICS & BIOTECHNOLOGY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A**

DNA- The genetic material:

DNA: Structure, Properties, Replication and packaging into chromosomes

Prokaryote nucleoid structure

Chemical composition of eukaryote chromosomes

Euchromatin, Heterochromatin and banding pattern

Repetitive DNA and sequence organization

Protein synthesis

Linkage, Crossing over and Chromosome Mapping

Cytological basis of crossing over

Two factor crosses, Three factor crosses and interference

Somatic Cell hybridization.

**Section-B****Mutations**

Introduction and classification of mutation

Molecular basis of mutation

Radiation and chemical induced mutation

Correlation between mutagenicity and carcinogenicity

Mutation Frequency

Practical applications of Mutations

**Gene Concepts**

Classical versus molecular concepts of Gene

Complementation test for functional allelism

Regulation of gene expression in prokaryotes and Eukaryotes

**Section-C****Bacterial Genetics**

Transformation, transduction and conjugation.

F mediated sex-duction.

Mechanism of recombination in bacteria.

Plasmid, Episome, IS elements and Transposons.

**Genetics of Viruses**

Organisation and expression of bacteriophage genomes

Structure and infection cycles of Viruses of eukaryotes

Animal viruses and cancer

**Section-D****Recombinant DNA technology**

Gene cloning and Sequencing.

Restriction endonuclease.

Vectors.

cDNA cloning.

Identification of Specific clone with a specific probe.

Techniques: Southern, Northern, Western Blotting, PAGE, PCR, DNA finger printing, DNA foot printing.

In situ hybridization, RFLP.

Practical applications of gene cloning.

**Extranuclear inheritanc**

Criteria for extranuclear inheritance

DNA and drug resistance.

Mitochondrial DNA and genetic diseases.

Mechanism of Sex determination, Sex differentiation, Sex linked inheritance.

**Books Recommended:**

1. Ayala, F.J. & Kiger, Jr. J.A. (1980) Modern Genetics. The Benjamin Cummings Publishing Co. Inc.
2. Brown T.A. (1992). Genetics- A Molecular Approach, 2<sup>nd</sup> ed. Van Nostrand Rainhold (international).
3. De-Robertis, F.D.P. and De-Robertis Jr., E.M.E. (1987). Essentials of Cell and Molecular Biology, Saunders, Philadelphia.
4. De-Robertis, F.D.P. and De-Robertis Jr., E.M.E. (1987). Cell and Molecular Biology, Saunders, Philadelphia.
5. Freifelder, D. & Malacinski. G.M. (1993) : Essentials of Molecular Biology, Jones & Bartlett Publishers, Boston.
6. Gardener, E.J., Simmons, M.T.J. & Sunstad, D.P. (1999) : Principles of Genetics, 8th ed. John Wiley & Sons, New York.
7. Miglani, G.S. (2000). Basic Genetics Narosa Publishing House, New Delhi.
8. Sambrook, J., Fritisch, E.F. and Maniatis, J. (1989). Molecular Cloning. A lab manual.
9. Winter, P.C., Hickey, G.I. and Fletcher, H.L. (1999) Instant notes in Genetics. New Delhi
10. Satson, J.D. et. al. (1987) : Molecular Biology of Gene, 4th ed. Vol. I & II. The Benjamin / Cummings Publishing Co., Inc.
11. Weaver, R.F. and Hedrick, P.W. (1992). Genetics Wm. C. Brown Publishers Dubuque.
12. Zubay. U.G. (1987), Genetics. The Cummings Publishing Co., Inc.

**ZooC-803: CONCEPTS OF IMMUNOLOGY****Time: 3 hrs.****Max. Marks: 100****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Introduction**

Types of immunity-innate and adaptive. Features of immune response-memory, specificity and recognition of self and non-self. Terminology and approaches to the study of immune system. Immunity to viruses bacteria, fungi and tumours.

**Cells and Organs of the immune system**

Lymphoid cells, heterogeneity of lymphoid cells, T-cells, B-cells, Null cells, Monocytes, polymorphs; primary and secondary lymphoid organs-thymus, Bursa of fabricius spleen, lymph nodes, lymphatic system, Mucosa Associated Lymphoid Tissue (MALT), Lymphocytes traffic.

**Section-B****Humoral Immunity:**

Antigen-antibody interactions, affinity and avidity, high and low affinity anti-bodies. Immunoglobulins, classes and structure. Molecular mechanism of generation of antibody diversity. Complement fixing antibodies and complement cascade.

**Cell Mediated Immunity**

T-cell subset and surface markers. T-dependent and T-independent antigens, recognition of antigens by T-cells and role of MHC, structure of T – cell antigen receptors.

**Section-C****Immunological Disorders**

Types of Hypersensitivity reactions, autoimmune disorders, their underlying molecular mechanism, aetiology, diagnostic, prognostic and prophylactic aspects, Immunodeficiency disorders, Aids

**Immuno biotechnology:****Hybridoma Technology**

Immunization of animals, isolation of stimulated spleen cells, Myeloma cell lines used as fusion partners. Fusion methods, Detection and applications of monoclonal antibodies, Vaccines: conventional vaccines, Viral vaccines, Bacterial vaccines, peptide vaccines, genetically engineered vaccines, Production and application of lymphokines.



**Section-D****Immunodiagnostic Procedures**

Various types of Immunodiffusion and immunoelectrophoretic procedures, Immunoblot, ELISA, RIA, Agglutination of pathogenic bacteria, haemagglutination and inhibition.

**Books Recommended:**

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

**ZooC -804: BIOSYSTEMATICS****Time: 3hrs.****Max. Marks: 50****Instructions for the Paper Setters:**

Eight questions of equal marks (Specified in the syllabus) are to be set, two from each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

**Section-A****Introduction**

- Terms / Definitions
- History/ Development of theories / kinds of classification
- Importance of Biosystematics

**Material basis of Biosystematics**

- Different attributes or evidences
- Character kinds
- Character weighing
- New aspects of Biosystematics:
  - Cytotaxonomy
  - Chemotaxonomy
  - Molecular taxonomy

**Section-B****Taxonomic Procedures**

- Taxonomic collections
- Preservation
- Identification
- Taxonomic keys ( Different kind, salient features, merits and demerits)
- International Code of Zoology/ Cal Nomenclature
- Nomenclature Principles, important rules, their interpretation and application in scientific nomenclature.

**Section-C****Taxonomic Publications**

- The Scientific publications
- Systematic publications
- Contents of publications

**Taxonomic Hierarchy**

- Species category and various concepts of species
- Hierarchy of categories
- Lower and higher categories
- Subspecies and other sub specific categories
- Decision at species and sub species level

**Section-D****History of kingdom systems (resume of whittakar's system and other recent systems of classification)**

- An outline of classification of kingdom Animalia
- Salient features of minor phyla.

**Suggested Reading Material:**

1. Gote, H.E. (1982), Animal Taxonomy, Edward Arnold.
2. Jaffery, C. (1973), Biological Nomenclature, Edward Arnold.
3. Kapoor, V.C. (1987), Theory and Practice of Animal Taxonomy, IPH Pb. New Delhi.
4. Mayer, E. (1969), Principle of Systematic Zoology, McGraw Hill Book Co. London.
5. Mayer, E. & Aschhok (1991), Principles of Systematics, McGraw Hill Book Co. London.
6. Minell, A. (1993), Biological Systematics, The State of Art. Chapman & Hall, London.
7. Quicke, D.L.J, (1996), Principles & Techniques of Contemporary Taxonomy, Blacky Academic & Professional, London, New York, Madras.
8. Kitching, I.J., Forey, P.L. Humpheries, C.J. & William, D. 1998. Cladistics: Theory and Practice of Parsimony Analysis, Oxford University Press.
9. Sebu, Randall T. 2000, Biological Systematics: Principles & Applications Cornell University Press 256 pp.
10. Winston, J. 1999. Describing Species Practical Taxonomic Procedure of Biologists. Columbia University Press, Lincoln, R.J. Dictionary of Ecology, Evolution and Systematics.

**ZooC -851: PRACTICAL VII (BEHAVIOUR AND WILD LIFE)****Time: 4 hrs****Max. Marks: 50**

To study the influence of temperature on development and population built up of *Tribolium/Rhizopertha/Callosobruchus*.

To study the food preference in different animals.

- a) *Tribolium/Rhizopertha*
- b) *Pieris brassicae*.

To investigate the locomotive, explorative, withdrawal and habituation behaviours in Earthworm and Slug

To study the latent and operant learning in rat.

To study the thigmotaxis response in *Callosobruchus/ Tribolium/ Rhizopertha*

**To study the Geotaxis Responses in**

- a) *Tribolium*
- b) Ant
- c) *Pieris brassicae* Larvae
- d) Slug

**To study the Humidity Preference in**

- a) *Drosophila / Zaprionus*
- b) *Tribolium*
- c) *Callosobruchus*
- d) *Pieris brassicae* Larvae

**To study the Phototaxis to Point Source and Different Colours of Light.**

- a) Earthworm
- b) *Zaprionus*.
- c) *Tribolium*
- d) *Callosobruchus*
- e) *Pieris brassicae* Larvae

**Use of videos to Study the**

- a) Grooming and righting behaviour in cockroach.
- b) Tarsal response in butterfly/housefly.
- c) Equilibrium study on housefly.
- d) Effect of temperature on opercular movement in fish

**To Investigate the Chemosensory Responses in *Zaprionus* / *Bactrocera***

- Study of body rhythms in human beings
- Animal behaviour patterns using photostat sheets.
- Assignment on Wildlife project.

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

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

**ZooC -852: PRACTICAL VIII (GENETICS AND BIOSYSTEMATICS)****Time: 4 hrs****Max. Marks: 50**

- To prepare and study the karyotype of human cell from meta phase pictures.
- To study the pedigree analysis of a family.
- To study blood groups in human beings.
- Demonstration of Barr body in the oral epithelium of human beings.
- To study different stages of mitosis in root tips of *Allium cepa*.
- To study permanent slides of:-
  - Mitosis in bone marrow cells of rat.
  - Stages of meiosis in testis of rat/grasshopper/*Allium cepa*.
  - Polytene chromosomes in third instar larvae of *Zaprionus paravittiger*.
- To study dermatoglyphics with palms of hands and fingertips.
- To study inheritance of morphogenetic human characters.
- Isolation of DNA from plant tissues.
- Numericals on Mendelian laws of inheritance and linkage.
- Serum extraction from blood.
- ELISA & RIA, Rocket Immuno- electrophoresis.
- Demonstration of various kinds of equipment required for collection and preservation of animals.
- Videos of Methods of collection and preservation.
- Kinds of keys and their use at higher and lower category levels.

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

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