

**4 Years Bachelor of Science (B.Sc.) Programme  
Micro-syllabus of B.Sc. first year Zoology**

**Course Title : Non-chordata and Protochordata**

**Course No. : B.Sc. Zool. 101**

**Nature of Course : Theory**

**Course Objectives:**

At the end of course students will be able to:

- Classify the non-chordates up to Orders with their examples.
- Know the functional anatomy of typical representative/s of each Phylum.
- Understand polymorphism, parasitism, social life etc. of some non-chordates.
- Know the economic importance of non-chordate animals.
- Know the structures, affinities and development of Protochordates.

**Full Marks : 100**

**Pass Marks : 35**

**Year : I**

**Teaching materials** required to fulfill the objectives are boards, charts, flex prints, overhead projector (OHP), power-point projector and other basic teaching materials prepared by teachers and as provided by the campuses.

**Group A: Lower Non-chordata**

Unit	Sub-unit	Description of content of the sub-unit (depth)	*I.P.	Text/Ref. for the topics (for detail see the list of text & references)
<b>Taxonomy 10 pds.</b>	Concept, trends and significance of taxonomy	Concept: definition, a brief history about animal classification, biological species concept, zoological nomenclature, standard endings in higher taxa (such as superfamily, family, subfamily and tribe). Trends: External morphology, anatomy, developmental biology, karyological, numerical, ecological, ethological, molecular and cyber-taxonomy or eTaxonomy. Significance: As a major discipline, biodiversity	3	Mayr & Ashlock;  Narendran

		conservation, agriculture and pest management, quarantine, medical and veterinary science.		
	Concept of Protozoa and Metazoa & the origin of Metazoa	Concept of Protozoa and Metazoa. The origin of Metazoa.	1	Parker & Haswell
	Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes and Annelida	General characters and classification up to orders with important characters and examples.	6	Jordan & Verma
<b>Protozoa 14 pds.</b>	<i>Vorticella</i>	Systematic position, habit, habitat, structure and reproduction.	2	Jordan & Verma
	<i>Leishmania donovani</i>	Systematic position, historical background, distribution, habit, habitat, structure, life cycle, pathogenecity, diagnosis and control measures.	2	Chatterjee; Kotpal
	<i>Giardia lamblia</i>	Systematic position, historical background, distribution, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee; Kotpal
	<i>Entamoeba histolytica</i>	Systematic position, historical background, distribution, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Jordan & Verma; Chatterjee
	<i>Trichomonas vaginalis</i>	Systematic position, historical background, distribution, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Jordan & Verma; Chatterjee
	<i>Eimeria tenella</i>	Systematic position, historical background, distribution,	2	Jordan & Verma;

		habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.		Chatterjee
	<i>Babesia bigemina</i>	Systematic position, historical background, distribution, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee
<b>Porifera 7 pds.</b>	<i>Scypha</i>	Systematic position, habit, habitat, distribution, structure, reproduction and embryogeny.	2	Jordan & Verma
	Freshwater sponges	General structure, habit and habitat, association with other animals and plants with some examples.	1	Annandale
	Canal system	Definition and types (asconoid, syconoid, leuconoid and rhagon). Functions of canal system.	2	Jordan & Verma; Kotpal; Parker & Haswell
	Skeletal system	Definition, classification, types and development. Taxonomic importance of spicules.	1	Jordan & Verma
	Economic importance of Porifera	Beneficial and harmful sponges to mankind.	1	Jordan & Verma; Kotpal; Parker & Haswell
<b>Coelenterata 12 pds.</b>	<i>Obelia</i>	Systematic position, habit, habitat, structure: colony, polyp, gonangium and medusa, reproduction, development and metagenesis.	4	Jordan & Verma
	Polymorphism	Definition, patterns, origin and significance.	3	Kotpal
	Corals	Introduction, distribution, types and formation of corals and coral reefs. Coral and dinoflagellate symbiosis and coral bleaching. Human intrusion in coral reefs.	4	Jordan & Verma; Kotpal
	Economic importance of	Economic importance of Coelenterates.	1	Kotpal

	Coelenterates			
<b>Platyhelminthes</b> 12 pds.	<i>Fasciola hepatica</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	3	Jordan & Verma; Kotpal
	<i>Schistosoma haematobium</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	3	Chatterjee
	<i>Taenia solium</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Jordan & Verma; Kotpal
	<i>Echinococcus granulosus</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Kotpal
	Morphological and physiological adaptations of helminth parasites	Parasitism, kinds of parasitism and parasitic adaptations.	2	Kotpal
<b>Aschelminthes</b> 10 pds.	<i>Ascaris lumbricoides</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee
	<i>Ancylostoma duodenale</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee
	<i>Enterobius vermicularis</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee
	<i>Wuchereria bancrofti</i>	Systematic position, habit, habitat, structure, life cycle, pathogenicity, diagnosis and control measures.	2	Chatterjee
	<i>Meloidogyne incognita</i> (phyto-nematode)	Systematic position, habit, habitat, structure, life cycle, pathogenicity and control measures.	1	Jenkins & Taylor
	Economic importance of Aschelminthes	Ashelminthes and diseases (human, plants and animals).	1	Kotpal
<b>Annelida</b> 10 pds.	Coelom	Structure, coelom in Polycheata, Oligochaeta, Hirudinea and Archiannelida.	2	Jordan & Verma; Kotpal

	Nephridia	Definition, functions and types.	2	Jordan & Verma; Kotpal
	<i>Hirudinaria granulosa</i>	Systematic position, habit, habitat, structure, organ systems, life cycle and parasitic adaptations.	4	Jordan & Verma; Kotpal
	Introduction of vermicomposting	Definition, significance and common earthworm species involved.	1	Sultan
	Economic importance of annelids	Beneficial and harmful annelids.	1	Kotpal

### **Group B: Higher Non-chordata and Protochordata**

Unit	Sub-unit	Description of content of the subunit (depth)	*I.P.	Text/Ref. for the topics
<b>Taxonomy 6 pds.</b>	Classification of Arthropoda, Mollusca, Echinodermata and Protochordata	General characters and classification up to orders with important features and examples.	6	Jordan & Verma
<b>Arthropoda 25 pds.</b>	General morphology and economic importance of spiders, mites and ticks	General morphology and differentiating characters of spiders, mites and ticks. Economic importance of spiders, mites and ticks.	3	Parker & Haswell
	Organ systems of freshwater prawn ( <i>Palaeomon</i> )	General introduction to prawn on distribution, habit and habitat. External features and appendages. Digestive system, circulatory system, respiratory system,	7	Jordan & Verma; Kotpal

		nervous system, sense organs and reproductive organs.		
	<i>Periplaneta Americana</i>	General introduction to cockroach on distribution, habit and habitat. External features, life cycle and economic importance.	3	Kotpal
	<i>Phlebotomus argentipus</i>	External features, life cycle, control measures and economic importance.	1	Chandler & Read
	<i>Culex quinquefasciatus</i>	External features, life cycle, control measures and economic importance.	2	Jordan & Verma
	<i>Aedes aegypti</i>	External features, life cycle, control measures and economic importance.	1	Chandler & Read
	<i>Sitophilus oryzae</i>	External features, life cycle, control measures and economic importance.	1	Hill
	Mouthparts of insects	Types of mouth parts in insects.	2	Jordan & Verma; Kotpal
	Metamorphism in insects	Definition and kinds of metamorphosis in brief.	2	Jordan & Verma; Kotpal
	Social behavior of termites	Social behavior, cast system and economic importance.	2	Jordan & Verma; Kotpal
	Economic importance of Arthropods	Beneficial and harmful arthropods.	1	Jordan & Verma; Kotpal
<b>Mollusca 22 pds.</b>	Shells in Mollusca	Comparative study of shells in different classes.	2	Jordan & Verma; Kotpal
	Structure and organ systems of Apple Snail ( <i>Pila globosa</i> )	Habit and habitats. Shell, body parts (head, foot and visceral mass and mantle). Digestive system (alimentary canal, digestive glands and digestion), respiratory system (organs and mode of respiration). nervous system and sense organs, reproductive system (male and female reproductive organs, copulation and fertilization).	7	Jordan & Verma; Kotpal

	Structure and organ systems of fresh water mussel: <i>Lamellidens (=Unio)</i>	Habit and habitat. Shell, body (mantle, head, foot). Digestive system (alimentary canal, digestive glands and digestion), respiratory system (structure of gills or ctenidia), nervous system and sense organs (statocyst, sensory cells), reproductive system and development.	5	Jordan & Verma; Kotpal
	Pearl and its formation	Economic importance and formation of pearls.	2	Jordan & Verma; Kotpal
	Dispersal, damage and control measures of African Giant Land Snail ( <i>Lissachatina fulica</i> )	General introduction of African Giant Land Snail about its shape, size, origin, invasive and pestiferous nature. Dispersal of this snail in different countries including Nepal. Control measures: mechanical, biological and chemical.	3	Mead; Raut & Barker; Budha & Naggs
	Torsion and detorsion in Gastropoda	Process of torsion, shell coiling and detorsion. Effect and significance of torsion.	2	Jordan & Verma; Kotpal
	Economic importance of molluscs	Beneficial and harmful molluscs.	1	Jordan & Verma; Kotpal
<b>Echinodermata</b> <b>8 pds.</b>	Structure, organ systems and development of <i>Asterias</i>	Systematic position, habit, habitat, external features, endoskeleton, digestive system, water vascular system, nervous system, sense organs, reproductive system and development.	6	Jordan & Verma
	Larval forms in Echinodermata	Types of larval forms.	2	Jordan & Verma
<b>Protochordata</b>	Structure, organ systems and	Systematic position, habit, habitat, external morphology, coelom, endoskeleton, digestive system and nervous system.	4	Kotpal; Dhami & Dhami;

<b>14 pds.</b>	affinities of <i>Balanoglossus</i>	Affinities with non-chordata (Echinodermata and Annelida) and Chordata.		Jordan & Verma
	Structure, organ systems and affinities of <i>Herdmania</i>	Systematic position, habit, habitat, external morphology, coelom, digestive system, nervous system and reproductive system. Affinities with Non-Chordata, Chordata, Hemichordata and Cephalochordata.	4	Kotpal; Dhami & Dhami; Jordan & Verma
	Development of <i>Herdmania</i>	Fertilization, pre-larval development, larval development and retrogressive metamorphosis.	2	Kotpal; Jordan & Verma
	Structure, organ systems and affinities of <i>Branchiostoma</i>	Systematic position, habit, habitat, external morphology, coelom, digestive system, nervous system and reproductive system. Affinities with Non-Chordata, Chordata, Urochordata, and Hemichordata.	4	Kotpal; Dhami & Dhami; Jordan & Verma

\*I.P.: Instruction Periods

### Practical course Zoo. 102

Units	Sub-units	Detail description of the sub-units	No. of Prac.	Remarks
<b>Techniques</b>	Collection and preservation of Non-chordates	Collection and preservation techniques of invertebrates: 1. ecto-parasites and endo-parasites 2. Annelids 3. Arthropods 4. Molluscs Collection of above mentioned common invertebrates by students.	3	Throughout the session
<b>Taxonomy</b>	Identification of non-chordates	Study of museum specimens of non-chordate phyla including identification of collected specimens by students.  On the basis of classification studied in theory class, allow students to write the systemic positions of their collection and museum specimens with diagnostic characters.  Teacher should help to identify students' collection and teach them how to label, store them properly.	17	
<b>Culture</b>	Protozoan culture	Paramecium culture using hay. Study of the cultured protozoans	3	
<b>Permanent histological slides</b>	Sections of <i>Fasciola</i> , <i>Ascaris</i> , <i>Hirudinaria</i> ,	Make available the histological slides: T.S of male and female <i>Ascaris</i> , whole mount of <i>Fasciola</i> , T.S of <i>Hirudinaria</i> , <i>Balanoglossus</i> and <i>Branchiostoma</i> . T.S and L.S of Sycon.	2	

	<i>Balanoglossus</i> and <i>Amphioxus</i>	And other available slides.		
<b>Slide preparation</b>	Temporary slide preparation	<i>Paramecium</i> , Statocyst of prawn Jaw of snail/ slug Jaw of <i>Hirudinaria</i> Mosquito larva Nematode parasites of chicken or other animals	7	
	Permanent slide preparation	Mosquito larva Mouthparts of mosquito, cockroach, honeybee, housefly and butterfly Daphnia/ Cyclops/cypris Preparation of permanent slides of ecto and endo parasites Radula of snail	7	
<b>Dissection</b>	Leech	Dissection of leech to expose - General anatomy - excretory organs - reproductive organs	2	
	Prawn	Morphology of appendages Dissection of prawn to expose - Nervous system - Digestive organs	3	
	Cockroach	Dissection of cockroach to expose - General anatomy - Digestive organs - Reproductive organs	4	
	<i>Pila/Lissachatina</i>	Dissection of <i>Pila/Lissachatina</i> to expose	2	

		- General anatomy - Nervous system		
<b>Case study and report writing</b>	Medical problems	Team work or individual. Student/s will visit primary health centre, health posts or hospitals and collect secondary data related to any diseases and prepare the report.		Throughout the session
	Veterinary problems	Team work or individual. Student/s will visit veterinary hospitals and collect secondary data related to any diseases and prepare the report.		Throughout the session
	Agriculture pests	Student/s will visit agricultural field such as vegetable crops, paddy, wheat, horticulture etc to study pests of respective fields and prepare the report.		Throughout the session
	Faunal survey/ Field trip	Students can prepare an individual or group report on any group of non chordate such as butterfly, grasshoppers, cockroaches, leeches, earthworms, snails and slugs etc.		Throughout the session
<b>Practical record</b>		Each student should prepare a practical record on studied museum specimens, identified invertebrates, studied and prepared slides, dissected animal systems.		Throughout the session

### **Text books**

- Dhami, P.S. and Dhami, J.K. Invertebrate Zoology, latest ed., R. Chand & Co. Pub., New Delhi, India.
- Dhami, P.S. and Dhami, J.K. Vertebrate Zoology, latest ed., R. Chand & Co. Pub., New Delhi, India.
- Jordan, E.L. & Verma, P.S. Invertebrate Zoology, latest ed., S. Chand & Co. Pub., 1127 pp.
- Jordan, E.L. & Verma, P.S. Chordate Zoology, latest ed., S. Chand, New Delhi.
- Kotpal, R.L. Modern textbook of Zoology: Invertebrates, latest ed., Rastogi Pub., Meerut, India.
- Kotpal, R.L. Modern textbook of Zoology: Vertebrates, latest ed., Rastogi Pub., Meerut India.
- Parker, T.J. & Haswell, W. A. A text book of Zoology, Vol. 1. The McMillan Press Ltd. London, U.K.
- Parker, T.J. & Haswell, W. A. A text book of Zoology, Vol. 2. The McMillan Press Ltd. London, U.K.

### **References**

- Annandale, N. 1911. Freshwater sponges, hydroids and polyzoa. The fauna of British India including Ceylon and Burma. Taylor and Francis, London.
- Barnes, R.D. Invertebrate Zoology, Latest Ed. Saunders College Pub., 1089 pages
- Budha, P.B. and Naggs, F. 2008. The Giant African Land Snail *Lissachatina fulica* (Bowdich) in Nepal. The Malacologist, No.50:19.
- Chatterjee, K.D. Parasitology (Protozoology & Helminthology). Latest Ed., Medical Publishers, Calcutta, India..
- Chandler A.C. and Read C.P. (1961). Introduction to Parasitology. John, Wiley and Sons, Inc., New York.
- Dhami, P.S. and Dhami, J.K. Invertebrate Zoology, Latest Ed. R. Chand & Co. Pub., New Delhi, India.
- Hill, D.S. 1993. Agricultural insect pests of the tropics and their control. Second edition. Special edition for sale in Asia only. Cambridge University Press, Cambridge.
- Jenkins, W.R. & Taylor, D.P. 1967. Plant Nematology. Reinhold Publishing Corporation, New York, 270 pp
- Mayr, E. and Ashlock, P.D. 1991. Principles of systematic zoology 2nd edition. McGraw-Hill, Inc., New York. 474 pp.
- Mead, A. R. 1961. The African Giant Snail: A Problem in economic malacology. The University of Chicago Press.
- Narendran, T.C. 2006. An introduction to Taxonomy. Zoological Survey of India, 80 pp.
- Prasad, S.N. Life of Invertebrates, Latest Ed. Vikas Publishing House Pvt. Ltd., New Delhi, India.
- Prasad, S.N. Life of Vertebrates, Latest Ed. Vikas Publishing House Pvt. Ltd., New Delhi, India.
- Raut, S.K. and Barker, G.M. 2002. *Achatina fulica* Bowdich and other Achatinidae as pest in tropical agriculture. In: Mollusca as crop pest. CAB International, pp. 55-114.
- Sobti, R.C. Medical Zoology, 1995. Shoban Lal Nagin Chand & Co., Delhi, India.
- Sultan A. I. 1997. Vermicology: The Biology of Earthworms. Orient Longman Ltd., Hyderabad, India
- <http://www.archive.org>
- <http://www.biodiversitylibrary.org>