FURKATING COLLEGE (AUTONOMOUS) SYLLABUS
FYUGP2020

B.Sc IN ZOOLOGY (NEP)

FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN ZOOLOGY, DIBRUGARH UNIVERSITY

1. The Preamble:

Present day animal science is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, animal science (Zoology) has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field biologists have contributed significantly in assessing and exploring newer dimensions for animal diversity. New insights have been gained in for zoological research and conservation. Challenging areas of teaching and research have emerged in animal ecology and reproductive biology. Concern for ever increasing pollution and climate change is at its highest than ever before. Keeping the above mentioned advancements and animal resources in North East India in view, a revised curriculum is offered by Furkating College at the undergraduate level as per the National Education Policy-2020 so that the undergraduate Zoology students of Furkating College shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of animal science, namely animal diversity, physiology, biochemistry, molecular biology, reproduction, genetics, anatomy, ecology, economic zoology, wildlife biology and the impact of environment on the living organism. All these aspects have been given due weightage over the eight semesters. It is essential for the undergraduate students to acquaint themselves with various updated tools and techniques. Keeping view of employment entrepreneurship, applied courses such as apiculture, sericulture, vermicomposting, fish rearing etc. have also been introduced. These courses shall provide the students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Zoology with the new curriculum will be able to explore the rich biodiversity of North East India.

2. Introduction:

Furkating College UG syllabus of Zoology is designed as per the guidelines of National Education Policy-2020. This Four Year Under Graduate Programmed (FYUGP) in Zoology consists of Major (Core) disciplines, Minor disciplines, Multi-Disciplinary Generic Elective Courses (GE), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Engagement like NCC/NSS, Digital and Technological solutions, Internship, Field Studies, Research Ethics, Research Projects and Discipline Specific electives (DSE) to acquaint the students with balanced knowledge on the plant resources, environment, contemporary issues and entrepreneurship.

The Bachelor of Science in Zoology of Furkating College under NEP-2020 is a programed with multiple exit options. UG certificate, UG Diploma, UG Degree and UG Degree (Honours with Research) in Zoology will be awarded to students after successful completion of one, two, three and four years respectively. It is expected that, on successful completion of this four year programme students will be skilled in multidisciplinary aspects for exploration and sustainable utilization of natural resources of NE region of India.

3. Aims of Four Year Under-Graduate Programme (FYUGP) in Zoology:

1. To introduce the students to the diverse animal kingdom.

2. To enable the students to explore the biodiversity and help in conservation.

3. To develop capabilities of students for critical evaluation of contemporary issues related to environment and sustainable development.

4. To generate skilled human resource for biological entrepreneurship.

4. Graduate Attributes of the FYUGP in Zoology:

Disciplinary Knowledge

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of animal science and allied areas of study in a multidisciplinary context.

Students should have the ability to connect relevant disciplines, and recent trends in biological and contemporary issues.

Communication Skills

The graduates in Zoology should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals.

Moral and Ethical Awareness/Reasoning

Ability to recognize ethical issues that are pertinent to one's work and pledge not to engage in unethical behavior such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one’s research with honesty and integrity in all aspects.

Multicultural Competence

Ability to correlate and compare recent developments in various branches of plant science worldwide; ability to collaborate research in various fields of biology with other researchers from allied organizations ; acquisition of knowledge on traditional practices of different ethnic communities.

Information/Digital Literacy

The graduates of Zoology should have the ability to utilize Information and Communications Technology (ICT) tools, biological databases and computer and softwares in solving biological problems.

Reflective Thinking and Problem Solving:

After completion of graduation in Zoology the students will be able to understand the value of animal resources, need for conservation, bio-prospecting and sustainable utilization of resources for human welfare.

Critical Thinking

The graduates of Zoology should be competent for critical analysis of problems related to biology, sustainable uses of biological resources and their conservation strategies.

5. Programme Learning Outcome

P.O. 1: Knowledge on diversity of animals, their importance and strategies for conservation.

P.O. 2. Scientific approach to address problems in biology and sustainable use of resources for human welfare.

P.O. 3. Application of knowledge and skills in entrepreneurship.

P.O. 4. Develop new techniques/methods for solving the problems of the allied disciplines.

6. Teaching Learning Process

The programme allows using varied pedagogical methods and techniques both within classroom and beyond.

- Lecture
- Tutorial
- Power point presentation
- Documentary film on related topic
- Project Work/Dissertation
- Group Discussion and debate
- Seminars/workshops/conferences
- Field visits and Report/Excursions
- Mentor/Mentee

7. Teaching Leaning Tools

- Projector
- LCD Monitor
- WLAN
- White/Green/Black Board

8. Assessment

- Home assignment
- Project Report
- Class Presentation: Oral/Poster/Power point
- Group Discussions
- In semester examinations
- End Semester examinations

FYUGP Structure as per UGC Credit Framework of December, 2022

Year	Semester	Course	Title of the Course	Total Credit
Year 01	1st Semester	C - 1	Animal Diversity I	4
		Minor 1	Animal Diversity I	4
		GEC - 1	Natural resource management	3
		AEC 1	Modern Indian Language	4
		VAC 1	Understanding India	2
		VAC 2	Health and Wellness	2
		SEC 1	a) Freshwater Aquaculture/ b) Apiculture	3
				22
	2nd Semester	C - 2	Animal Diversity II	4
		Minor 2	Animal Diversity II	4
		GEC 2	Wildlife Conservation and Management	3
		AEC 2	English Language and Communication Skills	4
		VAC 3	Environmental Science	2
		VAC 4	Yoga Education	2
		SEC 2	a) Sericulture/ b) Aquarium Fish Keeping	3
				22
The students on exit shall be awarded Undergraduate Certificate (in the Field of Study/Discipline) after securing the requisite 44 Credits in Semester 1 and 2 provided they secure 4 credits in work based vocational courses offered during summer term or internship / Apprenticeship in addition to 6 credits from skill based courses earned during 1st and 2nd Semester				
Year 02	3rd Semester	C - 3	Cell Biology	4
		C - 4	Comparative Anatomy of Vertebrates	4
		Minor 3	Human Physiology	4
		GEC – 3	Insect vectors and Diseases	3
		VAC 3	Digital and Technological Solutions / Digital Fluency	2
		AEC – 3	Communicative English / Mathematical Ability	2
		SEC – 3	a) Vermicomposting/ b) Medical Diagnostics	3
				22

Structure of Question Paper shell be as follows:

80 marks paper:

1	**1mark questions**	**X 10 nos.(no alternative)**	**= 10**
2	**2 marks very short answer type questions**	**X 5 nos.(no alternative)**	**=10**
3	**5 mark short answer type question**	**X 4nos.out of 6 question**	**=20**
4	**10 marks long answer type question**	**X 4 nos. (a/b, c/d ,e/f, g/h)**	**=40**
		Total	**80**

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course : Animal Diversity I
Course Code : ZOOL-MA-1014
Nature of the Course : Core
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce the concept of various forms of chordates and non-chordates
- To explain their classification
- To analyze their structural anatomy.

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	**Section A: Non-Chordates –I** **Protista, Parazoa and Metazoa** General characteristics and Classification up to Classes Structural organization & nutrition of *Euglena*, *Amoeba* and *Paramecium*. Locomotion and Reproduction in Protozoa	6	1	-	7
2 (12 marks)	**Porifera, Cnidaria& Ctenophora** General characteristics and Classification up to classes. Canal system in porifera. General characteristics and Classification up to classes. Polymorphism in Cnidaria. Corals and coral reefs. General characteristics and Evolutionary significance of Ctenophora	7	1	-	8
3 (12 marks)	**Platyhelminthes & Nemathelminthes** General characteristics and Classification up to classes Life cycle of *Taenia solium and A. lumbricoides* General characteristics and Classification up to classes. Life cycle of *Ascaris lumbricoides* Parasitic adaptations in helminthes	6	1	-	7
4 (12 marks)	**Section B: Chordates I** Introduction to Chordates &Protochordata General characteristics and classification upto classes. Affinities of protochordata. Larval forms in protochordata, retrogressive metamorphism in unochordata. Origin of Chordata and Agnatha The Echinoderm theory of origin of chordates Advanced features of vertebratesover Protochordata. General characteristics and classification of cyclostomes up to class.	12	2	-	14
5 (12 marks)	Zoogeographical regions of the world, Theories pertaining to distribution of animals, Plate tectonic and Continentaldrift theory, distribution of vertebrates in different zoogeographical regions.	**7**	**1**	**-**	**8**

6 (20 marks)	**Identification:** **Porifera** Study of museum specimen: *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*and One specimen/slide of anyctenophore Study of *Sycon*(T.S. and L.S.), *Hyalonema, Euplectella,Spongilla* **Museum Specimen** **Protochordata:** *Balanoglossus, Herdmania, Branchiostoma,* Colonial UrochordataSections of *Balanoglossus*through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania*spicules **Agnatha** *Petromyzon, Myxine* Study of whole mount of *Euglena, Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium* Examination of pond water collected from different places for diversity in Animal protista (Protozoa) Study of adult *Fasciola hepatica, Taenia solium* and their life cycles (Slides/micro- photographs) Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs) To submit a Project Report on any related topic based on theory syllabus.	**-**	**-**	**30**	**30**
	TOTAL	**39**	**6**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Submission of Project report on larval forms
  - Presentation on the larval forms

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the different groups of animals under chordates and non-chordates and their importance.
- Understand the zoogeographical distribution of animals
- Analyze and examine the structural differences between different groups of animals.

SUGGESTED READINGS:

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders InternationalEdition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, BlackwellScience
3. Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson
4. Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
5. Pough H. *Vertebrate life*, VIII Edition, PearsonInternational.

Title of the Course	**:**	**Animal Diversity II**
Course Code	**:**	**ZOOL-MA-2024**
Nature of the Course	**:**	**Core**
Total Credits	**:**	**04**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

- To introduce the concept of various forms of chordates and non-chordates
- To explain their classification
- To analyze their structural anatomy.

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	**Non-Chordates II** **Introduction to Coelomates, Annelida and Arthropods** INTRODUCTION TO COELOMATES: Evolution of coelom and metamerism Annelida: General characteristics and Classification up to classesExcretion in Annelida Arthropoda: General characteristics and Classification up to classesSocial life in bees and termites	8	1	-	9
2 (12 marks)	**Onychophora& Mollusca and Echinodermata** General characteristics and Evolutionary significance of onychophora Classification up to classes of mollusca Torsion and detorsion in Gastropoda Water-vascular system in Asteroidea *General charecteristics of classification upto classes of Echinodermata* *Affinities with Chordates*	12	2	-	14
3 (12 marks)	**Chordates II** Pisces: General characteristics of Chondrichthyes and Osteichthyes,classification upto order Migration, Osmoregulation and Parental care in fishes	5	1	-	6
4 (12 marks)	Amphibia &Reptilia: Origin of *Tetrapoda*(Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians General characteristics and classification up to order of reptilia.Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes	**7**	**1**	**-**	**8**
5 (12 marks)	Aves and Mammals: General characteristics and classification of Aves up to order *Archaeopteryx*—flight mechanism, in birds, air sacs. Migration in birds.	**7**	**1**	**-**	**8**

	General characters and classification of mammals up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages. Dentition in mammals.				
(20 marks)	Practical: Study of the following specimens: Annelids - *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta,* termites and honey bees Onychophora - *Peripatus* **Molluscs** - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* **Echinodermata:** Asterias, ophiura, Clypeaster, Echinus,Cucumaria and Antedon. **Fishes** *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon,Anabas,* Flat fish **Amphibia** *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra* **Reptilia** *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus* Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta** Study of six common birds from different orders. Types of beaks and claws. Dissection of weberian ossicles of *Mystus,* pecten from Fowl head Identification: *Sorex,* Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*	**-**	**-**	**30**	**30**
	TOTAL	**39**	**6**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- -To submit a Project Report on any related topic to larval forms
- - To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes.

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the different groups of animals under chordates and coelomates and their importance.
- Analyze and examine the structural differences between different groups of animals.

SUGGESTED READINGS:

- □ Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- □ Pough H. *Vertebrate life,* VIII Edition, PearsonInternational.
- □ Darlington P.J. *The Geographical Distribution of Animals,* R.E. Krieger PubCo.
- □ Hall B.K. and Hallgrimsson B. (2008). *Strickberger's*

Evolution. IV Edition. Jones and Bartlett PublishersInc.

Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology,* VII Edition. Holt Saunders InternationalEdition

- Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I.(2002). *TheInvertebrates: A New Synthesis,* III Edition, Blackwell Science
- Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

Title of the Course : Cell BiologyCourse
Code : ZOOL-MA-3014
Nature of the Course : Core
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce the concept of cell as functional unit of life
- To study the structure of cell
- To understand the functions of cellular components

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	Overview of cell: Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions Plasma Membrane: Structure and functions. Models of plasma membrane structure Transport across membranes: Active and Passive transport, Celljunctions: Tight junctions and Gap junctions, Desmosome	10	1	-	11
2 (12 marks)	Endomembrane System Structure and Functions of Endoplasmic Reticulum, Golgi Apparatus,Lysosomes Cytoskeleton: Structure and Functions of Microtubules, Microfilaments and Intermediate filaments	9	2	-	11
3 (12 marks)	Mitochondria and Peroxisomes Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis, Peroxisomes	7	1	-	8
4 (12 marks)	Nucleus: Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)	**7**	**-**	**-**	**8**
5 (12 marks)	**Cell Division and Cell Signalling** Mitosis, Meiosis, Cell cycle and its regulation GPCR and Role of second messenger (cAMP)	**7**	**1**	**-**	**8**
6 (20 marks)	**PRACTICALS:** Preparation of permanent slide todemonstrate: i DNA by Feulgenreaction ii DNA and RNA byMGP iii Mucopolysaccharides by PASreaction iv Proteins by Mercurobromophenol blue/FastGreen Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheekcells. Preparation of temporary stained squash of onion root tip to study various stages ofmitosis Study of various stages of meiosis.	**-**	**-**	**30**	**30**
	TOTAL	**40**	**5**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**

- Others (Any one) - **10 Marks**
- Group Discussion
- Seminar Presentation

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the cell constituents, their structure and functional significance.

SUGGESTED READINGS:

- Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons.Inc.
- De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins,Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates,MA.
- Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). *Molecular Biology of the Cell*, V Edition, Garland publishing Inc., New York and London.

Title of the Course : Comparative Anatomy of Vertebrates
Course Code : ZOOL-MA-3024
Nature of the Course : Core
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce and explain the anatomy of different systems in Vertebrates
- To analyze the structural modifications in anatomy of different groups

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	**Integumentary System:** Structure, functions and derivatives of integument	6	1	-	7
2 (12 marks)	**Skeletal System:** Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	6	1	-	7
3 (12 marks)	**Digestive System and Urinogenital System** Alimentary canal and associated glands, dentitionSuccession of kidney, Evolution of urinogenital ducts,Types of mammalian urinogenital system	13	2	-	15
4 (12 marks)	**Respiratory System:** Skin, gills, lungs and air sacs; Accessory respiratory organs General plan of circulation, evolution of heart and aortic arches	8	1	-	9
5 (12 marks)	**Nervous System and Sense Organ** Comparative study of brain Autonomic nervous system, Spinal cord and Cranial nerves in mammals Classification of receptors Visual and auditory receptors in man	**7**	**1**	**-**	**8**
6 (20 marks)	**Practicals:** Dissection of fish (carp) to study efferent andafferent branchial system(subject to permission) Study of placoid, cycloid and ctenoid scales through permanent slides /photographs Study of Disarticulated skeleton of Frog, *Varanus,* Fowl,Rabbit Study of Mammalian skulls: One herbivorousand one carnivorous animal Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)	**-**	**-**	**30**	**30**
	TOTAL	**39**	**6**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- Seminar Presentation
- Group Discussion
- Assignment

- **-LEARNING OUTCOMES:**

After the completion of this course, the learner will be able to:
Analyze the modifications and anatomical relationship among the vertebrates.

SUGGESTED READINGS:

- Comparative Anatomy of Vertebrates by RK Saxena
- Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

Title of the Course : Animal Diversity I
Course Code : ZOOL-MI-1014
Nature of the Course : Minor
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce the concept of various forms of chordates and non-chordates
- To explain their classification and their structural anatomy.

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	**Section A: Non-Chordates –I** **Protista, Parazoa and Metazoa** General characteristics and Classification up to Classes Structural organization & nutrition of *Euglena*, *Amoeba* and *Paramecium.* Locomotion and Reproduction in Protozoa	6	1	-	7
2 (12 marks)	**Porifera, Cnidaria& Ctenophora** General characteristics and Classification up to classes. Canal system in Porifera. General characteristics and Classification up to classes. Polymorphism in Cnidaria. Corals and coral reefs. General characteristics andEvolutionary significance of Ctenophora.	7	1	-	8
3 (12 marks)	**Platyhelminthes & Nemathelminthes** General characteristics and Classification up to classesLife cycle of *Taenia solium* and *Ascaris Lumbricoides* Parasitic adaptations in helminthes	6	1	-	7
4 (12 marks)	**Section B: Chordates I** Introduction to Chordates &Protochordata General characteristics and outline classification General characteristics of Hemichordata, Urochordataand Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata Origin of Chordata and Agnatha Echinoderm theory of origin of chordates Advanced features of vertebratesover Protochordata. General characteristics and classification of cyclostomes up to class	12	2	-	14
5 (12 marks)	Zoogeographical region of the world, Theories pertaining to distribution of animals, Plate tectonic and Continentaldrift theory, distribution of vertebrates in different zoogeographical region	**7**	**1**	**-**	**8**

6 (20 marks)	Identification: Protochordata: Balanoglossus, Herdmania, Branchiostoma, Colonial UrochordataSections of Balanoglossusthrough proboscis and branchiogenital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmaniaspicules Agnatha Petromyzon, Myxine Study of Sycon(T.S. and L.S.), Hyalonema, Euplectella,Spongilla Identification of museum specimen: Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madreporaand One specimen/slide of anyctenophore Study of whole mount of Euglena, Amoeba and Paramecium, Binary fission and Conjugation in Paramecium Examination of pond water collected from different places for diversity in Animal protista (Protozoa) Study of adult Fasciola hepatica, Taenia solium and their life cycles (Slides/micro- photographs) Study of adult Ascaris lumbricoides and its life stages(Slides/micro-photographs) To submit a Project Report on any related topic based on theory syllabus.	-	-	**30**	**30**
	TOTAL	**39**	**6**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Submission of Project report on larval forms
  - Presentation on the larval forms

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the different groups of animals under chordates and non-chordates and their zoogeographical distribution.
- Analyze and examine the structural differences between different groups of animals.

SUGGESTED READINGS:

Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders InternationalEdition.

Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, BlackwellScience

Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.

Pough H. *Vertebrate life*, VIII Edition, PearsonInternational.

Title of the Course : Animal Diversity II
Course Code : ZOOL-MI-2014
Nature of the Course : Minor
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce the concept of various forms of chordates and non-chordates
- To explain their classification and structural anatomy.

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	**Non-Chordates II** **Introduction to Coelomates, Annelida and Arthropods** Evolution of coelom and metamerism General characteristics and Classification up to classes Excretion in Annelida General characteristics and Classification up to classes Social life in bees and termites	8	1	-	9
2 (12 marks)	**Onychophora& Mollusca and Echinodermata** General characteristics and Evolutionary significance Classification up to classes Torsion and detorsion in Gastropoda Water-vascular system in Asteroidea Affinities with Chordates Study of the following specimens: Echinodermates - *Pentaceros*/*Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*	12	2	-	14
4 (12 marks)	**Chordates II** Pisces: General characteristics of Chondrichthyes and Osteichthyes,classification upto order Migration, Osmoregulation and Parental care in fishes	5	1	-	6
5 (12 marks)	Amphibia &Reptilia: Origin of *Tetrapoda*(Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians General characteristics and classification up to order; Affinities of*Sphenodon*; Poison apparatus and Biting mechanism in snakes	**7**	**1**	**-**	**8**
6 (12 marks)	**Aves and Mammals:** General characteristics and classification up to order *Archaeopteryx*-- a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages	**7**	**1**	**-**	**8**
(20 marks)	Practical: Study of the following specimens: Annelids - *Aphrodite, Nereis, Heteronereis, Sabella,*	**-**	**-**	**30**	**30**

	Serpula, Chaetopterus, Pheretima, Hirudinaria Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta,* termites and honey bees Onychophora - *Peripatus* **Molluscs** - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* **Fishes** *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon,Anabas,* Flat fish **Amphibia** *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra* **Reptilia** *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus* Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta** Study of six common birds from different orders. Types of beaks and claws. Dissection of weberian ossicles of *Mystus,* pecten from Fowl head Identification: *Sorex,* Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous*				
	TOTAL	**39**	**6**	**30**	**75**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- -To submit a Project Report on any related topic to larval forms
- - To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes.

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the different groups of animals under chordates and coelomates, their adaptation and importance.
- Analyze and examine the structural differences between different groups of animals.

SUGGESTED READINGS:

- □ Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- □ Pough H. *Vertebrate life,* VIII Edition, PearsonInternational.
- □ Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- □ Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett PublishersInc.
- □ Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders InternationalEdition
- □ Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I.(2002). *TheInvertebrates: A New Synthesis,* III Edition, Blackwell Science

□ Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*. II Edition, E.L.B.S. and Nelson

Title of the Course : Human Physiology
Course Code : ZOOL-MI-3014
Nature of the Course : Minor
Total Credits : 04
Distribution of Marks : 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES:

- To introduce the concept of human physiology
- To examine the function of different physiological systems in humans

UNITS	CONTENTS	L	T	P	Total Hours
1 (12 marks)	Digestive System: Structure and function of digestive glands; Digestion and absorption of carbohydrates, fats and proteins	7	-	-	6
2 (12 marks)	Structure, location, classification and function of epithelial tissue, connective tissue, muscular tissue, nervous tissue. Types of bones in human body. Nerve and Muscle: Structure of neuron, Propagation of nerve impulse (myelinated and non-myelinated nerve fibre); Structure of skeletal muscle, Mechanism of muscle contraction (Sliding filament theory.	12	-	-	15
3 (12 marks)	Respiratory and Cardiovascular Physiology: Pulmonary Ventilation, External and internal Respiration, Transport of oxygen and carbon dioxide in blood, Factors affecting transport of gases. Structure and anatomy of heart, Coordination of heartbeat, Cardiac cycle, ECG	10	-	16	24
4 (12 marks)	Renal and Reproductive Physiology: Structural anatomy of kidney, Mechanism and regulation of urine formation, Brief account of spermatogenesis and oogenesis, Menstrual cycle	**8**	**-**	**-**	**8**
5 (12 marks)	Endocrine System: Overview of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones; Mode of hormone action, Placental hormones	**8**	**-**	**8**	**8**
6 (20 marks)	Practicals: Study of histological slides of lung, kidney, thyroid, pancreas, adrenal, testis,ovary Preparation of temporary mount of Bloodfilm. Preparation of haemin and haemochromogencrystals. Estimation of haemoglobin using Sahli'shaemoglobinometer. Study of permanent histological sections of	**-**	**-**	**30**	**30**

	mammalian oesophagus, stomach, duodenum, rectum				
	TOTAL	**45**	**-**	**30**	**75**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Seminar
  - Group Discussion

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Have a better understanding of various physiological systems in body and their significance.

SUGGESTED READINGS:

- Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008). Vander's Human Physiology, XI Edition, McGraw Hill.
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
- Marieb, E. (1998). Human Anatomy and Physiology, IV Edition, Addison-Wesley.
- Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers.
- Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd.

Title of the Course : Natural resource management
Course Code : ZOOL-GEC-1013
Nature of the Course : Generic Elective Course-I
Total Credits 03
Distribution of Marks: 80 (End Sem) + 20 (In-Sem)

COURSE OBJECTIVES: *The objective of this course is to provide knowledge to the students on importance, sustainable utilization, conservation and management of natural resources.*

UNITS	CONTENTS	L	T	P	Total Hours
I 15 MARKS	**Natural resources:** Definition and types. Natural resources of NE India. Renewable and non-renewable sources of energy.	8	01	-	09
II 25 MARKS	**Sustainable utilization of land and water resources**: Soil degradation and management; water resources (Freshwater, marine, estuarine) wetlands; Threats and management strategies and their management.	10	01	-	13
III 15 MARKS	**Biodiversity:** Definition, types, significance, threats, management strategies, CBD, Bioprospecting	10	02	-	10
IV 25 MARKS	**Contemporary practices in resource management**: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. National and international efforts in resource management and conservation	11	02	-	13
	Total	**39**	**06**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
  - Sessional Examinations
  - Assignment

LEARNING OUTCOMES:

1. Know about the natural resources, its types, sustainable utilization and management practices.

SUGGESTED READINGS:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
3. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

Title of the Course **:WILD LIFE CONSERVATION AND MANAGEMENT**
Course Code **:ZOOLGEC-2013**
Nature of the Course **:GE**
Total Credits **:03**
Distribution of Marks **:80 (End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

- To introduce the concept wildlife and its management
- To explain the importance of wildlife and its conservation
- To understand conservation tools and methods

UNITS	CONTENTS	L	T	P	Total Hours
1 (14marks)	**Introduction to WildLife** Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies.	5	1	-	6
2 (13 marks)	**Evaluation and management of wildlife** Habitat analysis, Physical parameters: Topography, Geology, Soil and water; Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.	9	1	-	10
3 (13 marks)	**Management of habitats** Setting back succession; Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats	7	1	-	8
4 (13)	**Population estimation** Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, Hair identification, Pug marks and census method.	7	1	-	8
5 (13 marks)	**Management planning of wild life in protected areas** Estimation of carrying capacity; Eco tourism / wild life tourism in forests; Ecology of perturbence. Care of injured and diseased animal; Quarantine	**5**	**1**	**-**	**6**
6 (14 marks)	**Protected areas** National parks & sanctuaries, Community reserve; Important features of protected areas in India with special reference to NE India.	**7**	**-**	**-**	**7**

	TOTAL	**39**	**6**	**-**	**45**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- Presentation
- Project assignment

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:
Have a clear understanding of wildlife, habitats, threats and conservation measures.

SUGGESTED READINGS:

- Wildlife Ecology, Conservation and Management by John M. Frysell
- Wildlife Conservation and Management By Reena Mathur
- Textbook of Wildlife Management by SK Singh

Title of the Course	**:**	**Freshwater Aquaculture**
Course Code	**:**	**ZOOL-SEC-1013**
Nature of the Course	**:**	**SEC**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

- To introduce the concept of freshwater aquaculture.
- To understand the technique of fish rearing, transportation and the technique of induced breeding.
- To explain the maintenance of fish health.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 marks)	Introduction to Aquaculture, Basic concept of extensive, intensive and superintensive aquaculture, monoculture, polyculture and integrated farming.	7	-	-	7
2 (15 marks)	Rearing of Larval and brood fishes, Traditional and Chinese hatcheries, feed preparation for carps and catfishes, Live food culture, Transportation of fish seeds and brooders.	7	-	-	7
3 (15 marks)	Concept of induced breeding, ornamental fish, Captive breeding of carp, catfishes, Diagnostic characters of brood fishes and ornamental fishes, Breeding of carps and catfishes in simulated environments, Standardisation of hormonal doses.	8	-	-	8
4 (15 marks)	Maintenance of fish health and prophylactic measures, Diagnostic of common fungal, bacterial, protozoan and ectoparasites, Control measures for common fish diseases, Role of immunostimulants in aquaculture.	8	-	-	8
5 (20 marks)	**Practicals:** 1) Study of fishing gears 2) Basic symptoms of fish diseases 3) Demonstration of Induced Breeding	**-**	**-**	**30**	**30**
	TOTAL	**30**	**-**	**30**	**60**

Where, ***L: Lectures*** ***T: Tutorials*** ***P: Practicals***

MODES OF IN-SEMESTER ASSESSMENT: **(20 Marks)**

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- Project report submission
- Presentation

- **LEARNING OUTCOMES:**

After the completion of this course, the learner will be able to:

- Rear fishes under different environmental conditions
- Prepare fish feeds.

- Diagnosis of fish health and take prophylactic measures.

SUGGESTED READINGS

- D. Kapoor, R. Dayal and A.G. Ponniah: Fish Biodiversity of India, NBFGR Publication, Lucknow.
- R.H. McConnell: Ecological Studies in Tropical Fish Communities, Cambridge University Press.
- Matty: Fish Endocrinology.
- T.K. Govindan: Fish Processing Technology, Oxford & IBH, New Delhi
- Fish and Fisheries - S.S. Khanng
- Fresh Water Aquaculture – Rath
- Hand Book of fish and Fisheries -

Title of the Course	**:**	**AQUARIUM FISH KEEPING**
Course Code	**:**	**ZOOL-SEC-2013**
Nature of the Course	**:**	**SEC**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**80 (End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

- To introduce the concept of aquarium fish keeping.
- To study ornamental fishes and their importance.
- To learn the technique of fish feed preparation.
- To learn acclimatization of fish.

UNITS	CONTENTS	L	T	P	Total Hours
1 (15 marks)	Introduction:The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	6	-	-	6
2 (15 marks)	Biology: Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Botia, Gourami, *Channa bleheri, Channa barca*	10	-	-	10
3 (15 marks)	Food and feeding : Use of live fish feed organisms. Preparation and composition of formulated fish feeds Live fish transport - Fish handling, packing and forwarding techniques	7	-	-	7
4 (15 marks)	Transportation and maintenance: General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry, Scope of aquarium fish industry in NE India	7	-	-	7
5 (20 marks)	Practicals 1) Management of aquarium environment 2) Collection of ornamental fishes 3) Acclimatization of fish 4) Preparation of feed and Feeding of aquarium fish	-	-	30	30
	TOTAL	30	-	30	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- Collection of Ornamental Fish

- Project Report Submission
- Presentation
- **LEARNING OUTCOMES:**

After the completion of this course, the learner will be able to:

- Rear fish in aquariums for entrepreneurship.

SUGGESTED READINGS

1. G. Helfman, Bruce B. Collette, D.E. Facey, B. W. Bowen: The Diversity of Fishes: Biology, Evolution, and Ecology, John Wiley & Sons
2. R. J. Wootton: Fish Ecology, Springer
3. W. Vishwanath, W.S. Lakra and U.K. Sarkar: Fishes of North East India, NBFGR Publication, Lucknow
4. Handbook of Fisheries and Aquaculture – ICAR

4. Ornamental Fish culture and Aquarium Maintenance – AO Dholakia

Title of the Course : **MEDICAL DIAGNOSTICS**
Course Code : **ZOOL-SEC-3013**
Nature of the Course : **SEC**
Total Credits : **03**
Distribution of Marks : **80 (End Sem) + 20 (In-Sem)**

COURSE OBJECTIVES:

- To introduce the concept of medical diagnostics
- To study the basic diagnostic tools and techniques..

UNITS	CONTENTS	L	T	P	Total Hours
1 (20 marks)	**Introduction to Medical Diagnostics:** Importance of medical diagnostics.Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.).	12	-	-	12
2 (20 marks)	Urine Analysis: Physical characteristics; Abnormal constituents Tumours: Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, MRI and CT Scan (using photographs).	9		-	9
3 (20 marks)	Non-infectious diseases: Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit Infectious diseases: Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis	9	-	-	9
4 (20 nmarks)	Practicals: 1) Introduction to various tools involved in medical diagnosis 2) Determination of sugar in urine and blood 3) Determination of erythrocyte sedimentation rate 4) Study of ECG (PQRS) 5) Study of heart functioning 6) Whole blood count.	-	-	30	30

	7) Urea estimation in urine.				
	TOTAL:	30	-	30	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (20 Marks)

- One Internal Examination - **10 Marks**
- Others (Any one) - **10 Marks**
- Group Discussion
- Presentation

- **LEARNING OUTCOMES:**

After the completion of this course, the learner will be able to:

- .Have a clear understanding of basic medical diagnostic tests and ability to perform them.

SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B.Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani PublishingHouse
- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for TrainingCourses*
- Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*,Saunders
- Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition,Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co.Ltd.