SYLLABUS FOR FOUR-YEAR UNDERGRADUATE PROGRAMME

IN

ZOOLOGY

AS PER NATIONAL EDUCATION POLICY (NEP) 2020

Recommended by the 1st meeting of the Board of Studies (BoS), Department of Zoology, and approved by the 1st meeting of the Academic Council of Lakhimpur Girls' College, held on 28 June 2026, vide Resolution No. AC/1/2026/05.

LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

NORTH LAKHIMPUR, LAKHIMPUR -787031, ASSAM

Endorsed syllabi of Dibrugarh University as model syllabi for the development of syllabi of the Department of Zoology, Lakhimpur Girls' College (Autonomous) with necessary modification and additions, keeping in view the context and academic requirement.

FYUGP SYLLABI
DEPARTMENT OF ZOOLOGY
LAKHIMPUR GIRLS' COLLEGE (AUTONOMOUS)

1. The Preamble:

The Four-Year Undergraduate Programme (FYUGP) in Zoology is designed in accordance with the National Education Policy (NEP) 2020. Zoology is the scientific study of animals, encompassing their structure, function, evolution, behaviour, genetics, ecology, development, and interactions with the environment. It forms one of the fundamental branches of biological sciences and contributes significantly to medicine, agriculture, biotechnology, environmental management, wildlife conservation, fisheries, and public health.The B.Sc. in Zoology under FYUGP provides comprehensive knowledge of animal biology through a balanced combination of classroom teaching, laboratory experiments, field studies, research projects, internships, and skill-based learning. The curriculum emphasizes experiential learning, critical thinking, digital competency, communication skills, ethical practices, and interdisciplinary approaches.The programme aims to provide a strong foundation in biological sciences while promoting multidisciplinary learning, scientific inquiry, skill development, environmental consciousness, ethical values, and research aptitude.

2. Introduction:

The UG syllabus of Department of Zoology of Lakhimpur Girls' College(Autonomous) is designed to imparting quality education that integrates theoretical knowledge with practical exposure, field-based learning, laboratory skills, and community engagement. The programme prepares students to understand the diversity, evolution, physiology, genetics, ecology, behaviour, and conservation of animals and equips them to address contemporary biological and environmental challenges. It also nurtures lifelong learners who can contribute effectively to higher education, research, entrepreneurship, biodiversity conservation, healthcare, agriculture, and sustainable development.

The programme aims to:

- ✓ Provide comprehensive knowledge of animal diversity, taxonomy, evolution, genetics, physiology, ecology, developmental biology and biotechnology.
- ✓ Develop scientific temperament, analytical thinking and problem-solving abilities.
- ✓ Foster practical laboratory skills, field techniques and research competencies.
- ✓ Promote understanding of biodiversity conservation, environmental sustainability and ecosystem management.
- ✓ Encourage interdisciplinary learning by integrating Zoology with emerging fields such as biotechnology, bioinformatics, environmental science and public health.
- ✓ Develop competence in modern biological techniques, data analysis and digital tools.
- ✓ Prepare students for higher education, research, entrepreneurship and diverse career opportunities.

3. Programme Outcomes (POs):

On successful completion of the B.Sc. Zoology (FYUGP), students will be able to demonstrate comprehensive knowledge of animal diversity, evolution, genetics, physiology, ecology, cell biology, molecular biology, developmental biology and biotechnology. They will be able to apply scientific principles, experimental methods and analytical reasoning to investigate biological phenomena.laboratory experiments, use scientific instruments, maintain laboratory records and interpret experimental observations accurately.

Upon successful completion of the programme, graduates will possess the following attributes:

- ✓ *Disciplinary Knowledge:*Comprehensive understanding of fundamental and advanced concepts in Zoology and allied biological sciences.
- ✓ *Scientific Temperament:* Ability to apply scientific methods, logical reasoning and evidence-based approaches in solving biological problems.
- ✓ *Practical Competence:* Proficiency in laboratory techniques, microscopy, specimen

handling, field surveys, biodiversity assessment and scientific documentation.

- ✓ *Critical Thinking:* Ability to analyse biological information, interpret experimental data and draw scientifically valid conclusions.
- ✓ *Research Competency:* Capability to formulate hypotheses, conduct experiments, analyse results and communicate scientific findings effectively.
- ✓ *Environmental Responsibility:* Awareness of biodiversity conservation, wildlife protection, climate change and sustainable utilization of natural resources.
- ✓ *Communication Skills:* Ability to communicate scientific ideas effectively through oral presentations, reports, seminars and scientific writing.
- ✓ *Digital Literacy:* Competence in using digital technologies, statistical software, bioinformatics resources and scientific databases.
- ✓ *Ethical Values:* Commitment towards professional ethics, scientific integrity, environmental stewardship and responsible conduct in research.
- ✓ *Leadership and Teamwork:* Ability to work collaboratively, demonstrate leadership qualities and contribute effectively to multidisciplinary teams.

COURSE OUTLINE:

Semester	Course Code	Nature of Course	Course Name	Credit
I	ZOO-MAJ-4-101	Major	Animal Diversity I (Major)	4
	ZOO-MIN-4-101	Minor	Animal Diversity I (Minor)	4
	ZOO-MAJ-4-301	Major	Cell Biology (ITEP)*	4*
	ZOO-SEC-3-101	SEC-I	Freshwater Aquaculture	3
	ZOO-GEC-3-101	GEC-I	Natural resource management	3
		TOTALCREDIT		**14**
II	ZOO-MAJ-4-201	Major	Animal Diversity II (Major)	4
	ZOO-MIN-4-201	Minor	Animal Diversity II (Minor)	4
	ZOO-MAJ-4-401	Major	Biochemistry (ITEP)*	4*
	ZOO-SEC-3-201	SEC-II	Aquarium Fish Keeping	3
	ZOO-GEC-3-201	GEC-II	Wildlife Conservation and Management	3
		TOTALCREDIT		**14**
III	ZOO-MAJ-4-301	Major	Cell Biology	4
	ZOO-MAJ-4-302	Major	Comparative Anatomy of Vertebrates (Major)	4
	ZOO-MIN-4-301	Minor	Comparative Anatomy of Vertebrates (Minor)	4
	ZOO-MAJ-4-501	Major	Developmental Biology (ITEP)*	4*
	ZOO-MAJ-4-502	Major	Animal Behaviour and Chronobiology(ITEP)*	4*
	ZOO-SEC-3-301	SEC-III	Fish and Fisheries	3
	ZOO-GEC-3-301	GEC-III	Insect vectors and Diseases	3
		TOTALCREDIT		**18**
IV	ZOO-MAJ-4-401	Major	Biochemistry	4
	ZOO-MAJ-4-402	Major	Animal Physiology (Major)	4
	ZOO-MAJ-4-403	Major	Genetics and Evolutionary Biology	4
	ZOO-MAJ-4-404	Major	Molecular Biology	4
	ZOO-MIN-4-401	Minor	Animal Physiology (Minor)	4
	ZOO-MAJ-4-601	Major	Controlling and Co-ordinating Physiology and Immunology (ITEP)*	4*
		TOTAL CREDIT		**20**

***Only for ITEP**

SEMESTER I

Title of the Course **:Animal Diversity I (Major)**
Course Code **:ZOO-MAJ-4-101**
Nature of the Course **:Major**
Total Credits **: 04**
Distribution of Marks **:100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1) Describe different phyla in animal kingdom
2) Organize theorganismsindifferentcategoriesbasedonmorphologicalcharacteristics
3) Analyze the interrelationship among different species and genera within each group of animals

Learning Outcomes:

- Understand the various phyla in Animal Kingdom
- Compare various organisms based on morphology
- Classify different groups of animals

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2, CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14

CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Practical examination(10marks)
- Group Discussion/Seminar(10marks)
- Assignments(5marks)
- Attendance (5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- Inandendsemesterpracticalexaminationbasedonidentificationofsupplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

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UNIT	CONTENT	L	T	P	Total
1	**Taxonomy**:Principles of taxonomy and systematics, animal classification **Protista,ParazoaandMetazoa** General characteristics and Classification upto Classes Structural organization & nutrition of *Amoeba ,Euglena*,and*Paramecium.* Locomotion and Reproduction in protista (Protozoa),	10	2	-	12
2	**Porifera, Cnidaria& Ctenophora** General characteristics and Classification upto classes with examples. Canal system in sponges and evolutionary significance, Polymorphism in Cnidaria and Coral reef,	7	1	-	8
3	**Platyhelminthes & Nemathelminthes:** General characteristics and Classification upto classes, Life cycle of *Taenia solium, Fasciola hepatica* and *Ascaris lumbricoides* Parasitic adaptation in Helminths.	7	1	-	8
4	**Introduction to Coelomates, Annelida and Arthropods:** Coelom and metamerism,General characteristics and Classification upto classes. Respiration in Arthropoda, Excretion in Annelida., Metamorphosis, Economic importance of insects.	8	1	-	9
5	**Onychophora & Mollusca and Echinodermata:** General characteristics,Classification upto classes.Torsion and detorsion in Gastropoda, Economic importance of Mollusca, Larval forms of Echinodermata, Water-vascular System in Asteroidea,	7	1	-	8

6	**Lab Course** 1) Study of the following specimens: Protista: Amoeba,Euglena, Plasmodium,Paramecium Cindaria:Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora and One specimen/slide of any ctenophore Annelids: Nereis, Aphrodite, Chetopterus,Pheretima, Hirudanaria Arthropods: Limulus, Belastoma, Palamnaeus, Daphnia, Palaemon,Cancer, Brachionus, Bombyx, Periplaneta, Samia ricini. Antherae spp.Termite and honeybee. Helminths:Ascaris,Taenia,Fasciola.Molluscs:Chiton, Dentalium,Pila,Doris,Helix,Unio,Sepia,Octopusand Nautilus. Echinoderms: Pentaceros, Asterias, Ophiura, Echinus,Antedon *2)* Study of *Sycon*(T.S. and L.S.), *Hyalonema, Euplectella, Spongilla* *3)* Study of whole mount of *Euglena*, *Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium.* 4) Study of mouth parts of Periplaneta *5)* Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles(Slides/micro-photographs) 6) Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs). 7) Study of septal nephridia in earthworm,digestive System of Periplaneta(virtual).	-	-	15	15
		39	6	15	60

Where, L:LecturesT:TutorialsP: Practicals

Suggested Readings

- Ruppert and Barnes,R.D.(2006).InvertebrateZoology,VIIIEdition.Holt Saunders International Edition.
- KingsleyJ.TextBook of Vertebrate Zoology Publisher:Nabu Press ISBN: 9781171586524, 1171586523
- Barnes,R.S.K.,Calow,P.,Olive,P.J.W.,Golding,D.W.andSpicer,J.I.(2002). The Invertebrate
- MayrErnst,McGraw-Hill Publisher,PrinciplesofSystematicZoology
- KotpalR.L,Modern text book of Zoology:Invertebrate,Rastogi Publications

SEMESTER I

Title of the Course **:Animal Diversity I (Minor)**
Course Code **:ZOO-MIN-4-101**
Nature of the Course **:Minor**
Total Credits **: 04**
Distribution of Marks **:100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1) Describe different phyla in animal kingdom
2) Organize the organisms in different categories based on morphological characteristics
3) Analyze the inter relationship among different species and genera within each group of animals

Learning Outcomes:

1) Understand the various phyla in Animal Kingdom
2) Compare various organisms based on morphology
3) Classify different groups of animals

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2, CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Practical Examinaation(10marks)
- Group Discussion/Seminar(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- Inandendsemesterpracticalexaminationbasedonidentificationofsupplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNIT	CONTENT	L	T	P	Total
1	**Taxonomy**:Principles of taxonomy and systematics, animal classification **Protista,Parazoa and Metazoa:** General characteristics and Classification upto Classes Structural organization &nutrition of *Amoeba* ,*Euglena*,and *Paramecium.* Locomotion and Reproduction in protista (Protozoa)	10	2	-	12
2	**Porifera, Cnidaria&Ctenophora:** General characteristics and Classification upto classes with examples.Canal system insponges and evolutionary significance,Polymorphism in Cnidaria and Coral reef.	7	1	-	8
3	**Platyhelminthes & Nemathelminthes:** General characteristics and Classification upto classes Life cycle of *Taenia solium, Fasciola hepatica* and *Ascaris lumbricoides* Parasitic adaptation in Helminths.	7	1	-	8
4	**Introduction to Coelomates, Annelida and Arthropods:** Coelom and metamerism,General characteristics and Classification upto classes. Respiration in Arthropoda, Excretion in Annelida. Metamorphosis,Economic importance of insects	8	1	-	9
5	**Onychophora& Mollusca and Echinodermata:** General characteristics Classification upto classes.Torsion and detorsionin Gastropoda.Economic importance of Mollusca,Larval forms of Echinodermata,Water-vascular system in Asteroidea	7	1	-	8

6	**Lab Course** 1.Study of the following specimens: Protista: Amoeba, Euglena,Plasmodium, Paramecium Cindaria: Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora and One specimen/slide of any ctenophore Annelids: Nereis, Aphrodite, Chetopterus,Pheretima, Hirudanaria Arthropods: Limulus, Belastoma, Palamnaeus, Daphnia, Palaemon,Cancer, Brachionus, Bombyx, Periplaneta, Samia ricini. Antherae spp.Termite and honeybee. Helminths:Ascaris,Taenia,Fasciola.Molluscs:Chiton, Dentalium,Pila,Doris,Helix,Unio,Sepia,Octopusand Nautilus. Echinoderms: Pentaceros, Asterias, Ophiura, Echinus,Antedon 2.Study of *Sycon*(T.S. and L.S.), *Hyalonema, Euplectella, Spongilla* 3.Study of whole mount of *Euglena*, *Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium.* 4.Study of mouth parts of Periplaneta 5.Study of adult *Fasciola hepatica*,*Taenia solium* andtheir lifecycles(Slides/micro-photographs) 6.Study of adult *Ascaris lumbricoides* and its life stages(Slides/micro-photographs). 7.Study of septal nephridia in earthworm,digestive System of Periplaneta(virtual).	-	-	15	15
		39	6	15	60

Where, L:LecturesT:TutorialsP: Practicals

Suggested Readings:

- Ruppert and Barnes,R.D.(2006).Invertebrate Zoology,VIII Edition.Holt Saunders International Edition.
- KingsleyJ.TextBook of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523
- Barnes,R.S.K.,Calow,P.,Olive,P.J.W.,Golding,D.W.and Spicer,J.I.(2002). The Invertebrate
- Mayr Ernst,Mc Graw-Hill Publisher, Principles of Systematic Zoology
- Kotpal R.L,Modern text book of Zoology:Invertebrate,Rastogi Publications

SEMESTER I

Title of the Course :Freshwater Aquaculture

Course Code : ZOO-SEC-3-101

Nature of the Course : Skill Enhancement Course (SEC)

Total Credits : 03

Distribution of Marks :100[60End(Theory:45,Practical:15)+40IA]

COs:

1. Analyze concept of freshwater aquaculture.

2. Evaluate the technique of fish rearing, transportation and the technique of induced breeding.

3. Discuss the maintenance of fish health.

Learning Outcomes:

- Understand the freshwater aqua culture concept.
- Analyze fish in gears and induced breeding techniques.
- Identify fish diseases.
- Ornamental fish and Aquarium fish industry

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3		
Procedural					CO2	
Meta cognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

3forhighestcorrelation, 2formoderatecorrelation,and1forlowestcorrelation

Modes of internal assessment:

- Two theory examination (10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file

Viva-voce examination

Course content

UNITS	CONTENTS	L	T	P	Total Hours
1	Introduction to Aquaculture: Basic concept and types: extensive, intensive and semi- intensive; monoculture, polyculture and composite culture; Integrated farming.	5	1	-	6
2	Rearing of Larval and brood fishes, traditional and common chinese hatcheries, feed preparation for economically important carps and cat fishes,Live food culture and its importance in fisheries, Transportation of fish seeds and brooders.	7	1	-	8
3	Concept of induced breeding, Captive breeding of carps & catfishes, Diagnostic characteristics of ornamental &food fishes,Environmental factors in breeding, hormonal doses in breeding.	7	1	-	8
4	Maintenance of fish health and prophylactic measures,Diagnosis of common fungal,bacterial, protozoan and ectoparasites, Control measures & management for common fish diseases, Role of immune stimulants in fish disease management.	6	2	-	8
5	Practicals: 1) Basic symptoms of fish diseases 2) Collection and preservation of indigenous fish species 3) Study of diagnostic characteristics of brood fishes and ornamental fishes. 4) Demonstration of Induced Breeding	-	-	15	15

	TOTAL	25	5	15	45

Where,L:LecturesT:TutorialsP:Practicals SUGGESTED

READINGS

- S.S.Khanna,H.R.Singh:ATextbook of Fish Biologyand Fisheries
- R.K.Rath: Freshwater Aquaculture
- S.H.Ahmad, A.K.Singh :Freshwater Aquaculture
- Dr.Mofidul Islam,Dr.BiplabKr. Das: Freshwater Aquaculture
- Jayashree Datta Munshi,J.S.Datta Munshi:Fundamental of Freshwater Biology

SEMESTER I

Title of the Course: Natural Resource Management
Course Code :ZOO-GEC-3-101
Nature of the Course : Generic Elective Course (GEC)
Total Credit :03
Distribution of Marks :100(60End+ 40IA)

COs:

1. Distinguish between renewable and non-renewable resources
2. Analyse threats to natural and biological resources of NE India
3. Examine management strategies for sustainable utilization of resources

Learning outcomes:

- Differentiate natural and biological resources of NE India
- Identify the threats and issues related to the natural resources
- Execute conservation and management strategies for natural resources

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3forhighestcorrelation,2formoderatecorrelation,and1forlowest correlation

Modes of internal assessment:

- Two theory examination(20marks)
- Group Discussion/Seminar(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy of COs:

Continuous evaluation through in and end semester theory examination

UNIT	CONTENT	L	T	P	Total
1	**Natural resources:** Definition and types. Natural resources of NE India, Renewable and non- renewable sources of energy.	7	-	-	7
2	**Sustainable utilization of land and water resources**: Soil degradation and soil conservation practices, water resources (freshwater and marine) Strategies for sustainable water management. Wetlands; threats and management strategies	15	-	-	15
3	**Biodiversity:** Definition, types, value of significance, threats, conservation strategies with reference to Northeast India, CBD, Bio prospecting.	8	-	-	8
4	**Contemporary Practices in resource management**: EIA, GIS, Participatory Resource Appraisal, Resource Accounting, Solid waste management.National and international efforts in resource management and conservation.	15	-	-	15
		45	-	-	45

Suggested reading:

- Vasudevan,N.(2006).EssentialsofEnvironmentalScience.Narosa Publishing House, New Delhi.
- Singh,J.S.,Singh, S.P.and Gupta, S.(2006).Ecology,Environmentand Resource Conservation. Anamaya Publications, New Delhi.

SEMESTER II

Title of the Course **:Animal DiversityII (Major)**
Course Code **:ZOO-MAJ-4-201**
Nature of the Course **:Major**
Total Credits **: 04**
Distribution of Marks **:100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1) Describe different phyla in animal kingdom
2) Organize the organisms in different categories based on morphological characteristics
3) Analyze the inter relationship among different species and genera within each group of animals

Learning Outcomes:

- Understand the various phyla in Animal Kingdom
- Compare various organisms based on morphology
- Classify different groups of animals

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total
1	**Introduction to Chordates:** General characteristics and outline classification **Protochordata:**General characteristics and classification up to classes with examples of Hemichordata, Urochordata and Cephalochordata; Studyof larval forms in protochordates; Retrogressive metamorphosis in Urochordata **Origin of Chordata:** Theories and Advanced features of vertebrates Over Protochordata	10	1	-	11
2	**Agnatha:** General characteristics and classification of cyclostomes up to classes with example **Pisces**: General characteristics of Chondrichthyes and Osteichthyes,classification upto order,Migration and parental care in fishes .	8	1	-	9
3	**Amphibia:** Amphibia: Origin of *Tetrapoda* (Evolution of terrestrial ectotherms);General characteristics and classification upto order; parental care in Amphibia .**Reptilia**: General characteristics and classification up to order; Affinities of *Sphenodon* , Poisonous and non poisonous snake , Poison apparatus and Biting mechanism in snakes, Snake venom	8	1	-	9
4	**Aves:** General characteristics and classification upto order, *Archaeopteryx*—a connecting link; Principles and aerodynamics of flight, Flight adaptations and Migration in birds**Mammals**: General characters and classification upto order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages, adaptation of Aquatic mammals,Echo location in bats	8	1	-	9
5	**Zoogeography** Zoogeographical realms, theories of animal distribution, Plate tectonic and continental drift, distribution of vertebrates in different realms.	**7**	**-**	**-**	**7**

6	**Lab Course** 1. To study the followings pecimen:**Protochordata**; Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata .Sections of Balanoglossus through proboscis and Branchiogenital regions, **Fishes;** *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes ,Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon,Anabas,* Flat fish, *Channa* spp. *Puntius* spp.*Trichogaster,Heteropneusteus* spp., *Clarias* spp.,*Mystus* spp. **Amphibia;***Ichthyophis/ Ureotyphlus,Necturus,Bufo,Hyla,Alytes,Salamandr* **Reptilia;** *Chelone, Trionyx,Hemidactylus, Varanus,Uromastix,Chamaeleon,Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus* **Aves**; Studyof six common birds from different orders. **Mammalia;** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous. 2. Dissection of weberian ossicles of *Mystus,* , pecten from Fowl head. 3. To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes. 4. Study of animal organ system: Urinogenital System of fish (locally available fish). 5. Sections of Amphioxus through pharyngeal, intestinal and caudal regions.Permanent slide of Herdmania spicules, Placoid and Cycloid Scales in Fishes, Types of beaks and claws. 6. To submit a Project Report on any related topic to larval forms.	**-**	**-**	**15**	**15**
	TOTAL	**41**	**4**	**15**	**60**

Suggested readings:

- Young, J.Z.(2004).*The Life of Vertebrates*.IIIEdition.Oxford university press.
- Pough H.*Vertebrate life,*VIIIEdition,Pearson International.
- Darlington P.J.*The Geographical Distribution of Animals*, R.E.Krieger PubCo.
- Hall B.K.and HallgrimssonB.(2008).*Strickberger'sEvolution*.IVEdition.Jones and Bartlett Publishers Inc.
- Kotpal,R.L,Modern Text Book of Zoology:Vertebrates(5thEdition),Rastogi Publiation .

SEMESTER II

Title of the Course **:Animal DiversityII (Minor)**
Course Code **:ZOO-MIN-4-201**
Nature of the Course **:Minor**
Total Credits **: 04**
Distribution of Marks **:100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1) Describe different phyla in animal kingdom
2) Organize the organisms in different categories based on morphological characteristics
3) Analyze the interrelationship among different species and genera within each group of animals

Learning Outcomes:

- Understand the various phyla in Animal Kingdom
- Compare various organisms based on morphology
- Classify different groups of animals

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1 for lowest correlation

Modes of internal assessment

- Two theory examination(20marks
- Practical Examination(10marks)
- Group Discussion/Seminar(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total
1	**Introduction to Chordates:** General characteristics and outline classification **Protochordata:**General characteristics and classification up to classes with examples of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata **Origin of Chordata:** Theories and advanced features of vertebrates Over Protochordata	10	1	-	11
2	**Agnatha:** General characteristics and classification of cyclostomes up to class with example **Pisces**: General characteristics of Chondrichthyes and Osteichthyes,classification upto order,Migration and parental care in fishes .	8	1	-	9
3	**Amphibia:** Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characteristics and classification up to order; parental care in Amphibia .**Reptilia**: General characteristics and classification up to order; Affinities of *Sphenodon ,* Poisonous and non poisonous snake , Poison apparatus and Biting mechanism in snakes, Snake venom	8	1	-	9
4	**Aves:** General characteristics and classification upto order *Archaeopteryx*—a connecting link; Principles and aerodynamics of flight, Flight adaptations and migration in birds **Mammals**: Generalcharacters and classification up to order;Affinities of Prototheria;Adaptive radiation with reference to locomotory appendages, adaptation of aquatic mammals.Echolocation in bats.	8	1	-	9
5	**Zoogeography** Zoogeographical realms,Theories pertaining to distribution of animals,Plate tectonic and Continental drift theory,distribution of vertebrates in different realms	**7**	**-**	**-**	**7**

6	**LabCourse** **1**.To study the following specimen:**Protochordata**; Balanoglossus, Herdmania, Branchiostoma, ColonialUrochordata.SectionsofBalanoglossus throughproboscisandBranchiogenitalregions, **Fishes;***Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes,Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas,* Flat fish,*Channa*spp. *Puntius* spp.*Trichogaster,Heteropneusteus* spp., *Clarias* spp.,*Mystus* spp. **Amphibia;***Ichthyophis/ Ureotyphlus,Necturus,Bufo,Hyla,Alytes,Salamandr* **Reptilia;** *Chelone, Trionyx,Hemidactylus, Varanus,Uromastix,Chamaeleon,Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus* **Aves**; Studyof sixcommonbirdsfrom different orders. **Mammalia;** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous. **2**. Dissection of weberian ossicles of *Mystus,* , pecten from Fowlhead. **3** To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes. **4** Study of animal organ system: Urinogenital System of fish (locally available fish). **5** Sections of Amphioxus through pharyngeal, intestinal and caudal regions.Permanent slide of Herdmania spicules, Placoid and Cycloid Scales in Fishes, Types of beaks and claws. **6** .To submit a Project Report on anyrelated topic to larval forms.	**-**	**-**	**15**	**15**
	TOTAL	**41**	**4**	**15**	**60**

Suggested reading

- Young,J.Z.(2004).*The Life of Vertebrates*.IIIEdition.Oxford university press.
- Pough H.*Vertebratelife,*VIIIEdition,Pearson International.
- DarlingtonP.J.*The Geographical Distribution of Animals*,R.E.KriegerPubCo.
- HallB.K.andHallgrimssonB.(2008).*Strickberger'sEvolution*.IVEdition.Jones and Bartlett Publishers Inc.
- Kotpal,R.L,Modern Text Book of Zoology:Vertebrates(5thEdition),Rastogi Publiation .

SEMESTER II

Title of the Course **:Aquarium Fish Keeping**

Course Code **: ZOO-SEC-3-201**

Nature of the Course **: Skill Enhancement Course (SEC)**

Total Credits **: 03**

Distribution of Marks **: 100[60End(Theory:45,Practical:15)+40IA]**

COs:

1. Analyze the concept of aquarium fish keeping.

2. Discuss ornamental fishes and their importance.

3. Evaluate the technique of fish feed preparation.

Learning Outcomes:

- Explain the concept of fish keeping in aquariums
- Discuss about ornamental fishes
- Formulation of fish feeds
- Ornamental fish and Aquarium fish industry

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural					CO3	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3forhighest correlation,2formoderatecorrelation,and1forlowestcorrelation

Modes of internal assessment:

- Two theory examination(10marks)
- Practical examination(10marks)
- Group Discussion/Seminar(10marks)
- Assignments (5marks)
- Attendance (5marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Submission of collected specimens
- Viva-voce examination

Course content

UNITS	CONTENTS	L	T	P	Total Hours
1	Introduction:Exotic and endemic species of aquarium fishes, potential scope as a Cottage Industry in Northeast India,	5	-	-	5
2	Biology:Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as *Botia*, *Gourami*, *Channa bleheri*, *Channa barca*, *Channa stewartii*, Guppy, Molly, Sword tail, Gold fish,Angelfish,Bluemorph,Anemone fish and Butterfly fish,	5	-	-	5
3	Food and feeding : Use of live fish feed organisms. Preparation and composition of for mulated fish feeds Transportation of aquarium fish - fish handling, packing and forwarding techniques	10	-	-	10
4	Aquarium maintenance: General Aquarium maintenance – budget for setting up an Aquarium fish farm, scope of aquarium industry in Northeast India, Maintenance of water quality parameters in aquarium,	10	-	-	15
5	Practicals 1) Construction of Aquarium 2) Management of aquarium environment 3) Collection of indigenous ornamental fishes 4) Acclimatization of fish 5) Preparation of feed and feeding of aquarium fish	-	-	15	15

	5)Identification of aquatic plants				
	TOTAL	30	-	15	45

Where,L:LecturesT:TutorialsP:Practical

SUGGESTED READINGS

- S.S.Khanna ,H.R. Singh:ATextbook of Fish Biology and Fisheries
- Dr.Santosh kumarAbujam,Dr.BudhinGogoi,Dr.Hamen Saikia:Aquarium Fish Keeping
- S.H.Ahmad,A.K.Singh:Freshwater Aquaculture
- Dr.HemRaj:AText Book of Aquarium Fish Keeping

SEMESTER II

Title of the Course :Wildlife Management and Conservation
Course Code :ZO0-GEC-3-201
Nature of the Course : Generic Elective Course (GEC)
Total Credits : 03
Distribution of Marks :100(60End+ 40IA)

COs:

1. To discuss the concept of wild life and its management
2. To explain the importance of wildlife and its conservation
3. To apply conservation tools and methods

Learning outcomes:

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

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1,CO2	CO3			
Procedural						
Meta cognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3forhighestcorrelation, 2formoderatecorrelation,and1for lowest correlation

Modes of internal assessment:

- Two theory examination(20marks
- Group Discussion/Seminar(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination

UNITS	CONTENTS	L	T	P	Total Hours
1	**Introduction to WildLife** : Values of wild life - positive and negative: Conservation ethics; Importance of conservation;Causes of depletion; Global conservation strategies.	5	1	-	6
2	**Evaluation, and management of wildlife & its habitats:** Habitat analysis, Physical parameters: Topography,Soil and water;Biological Parameters: food, forage, browse and cover estimation: Standard evaluation procedures: remote sensing and GIS. Grazing logging; Mechanical treatment; Advancing the successional process; Cover construction; Preservation of general genetic diversity;Restoration of degraded habitats	9	1	-	10
		7	1	-	8
4	**Population estimation:** Population density, Natality and Mortality, Faecal analysis of ungulates and carnivores, Hair identification, Census methods.	7	1	-	8
5	**Management planning of wildlife in protected areas:** Estimation of carrying capacity; Care of Injured and diseased animal;Quarantine;Ecotourism, National parks & sanctuaries, Community reserve;Important features of protected areas in India with special reference to NE India.	5	1	-	6
		7	1	-	7
	TOTAL				45

Where, L:LecturesT:TutorialsP: Practicals

Suggested reading

- Reena Mathur:Wildlife Conservation and Management
- Tapashi Gupta: Ecology,Wildlife Conservation & Management
- Dr.Anup Kumar Doley:Wildlife Conservation and Management
- S. K.Singh:Textbook of Wildlife Management

SEMESTER III

Title of the Course **:Cell Biology**

Course Code **:ZOO-MAJ-04-301**
Code **:Major**
Total Credits **: 04**
Distribution of Marks **:100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1) Differentiate the structure and functions of cellular components
2) Evaluate the cell division mechanism and cell cycle.
3) Analyze cell signalling mechanism.

Learning Outcomes:

1) Understand the cell structure and functions of cell organelles.
2) Analyze cell division and cell cycle mechanisms.
3) Interpret the cell signaling mechanisms.

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3	CO2	
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs**:**

1. Continuous evaluation through in and end semester theory and practical examinations
2. Laboratory practices on cells,cellular organelles and cellular processes
3. Practical record book/field book

UNITS	CONTENTS	L	T	P	Total Hours
1	**Overview of cell:** Prokaryotic and Eukaryotic cells, Various models of plasma membrane, Structure and Functions of cytoskeleton, **Transport across membranes**: Active and Passive transport, Cell junctions: Tight junctions, Desmosomes, Gap junctions .	8	2	-	10
2	**Endomembrane System:Structure and Functions:** Endoplasmic Reticulum, Golgi Apparatus,Lysosomes	8	-	-	8
3	**Mitochondriaand Peroxisomes:**Mitochondria: Structure ,Semi-autonomous nature, Endo symbiotic hypothesis Mitochondrial Respiratory Chain, Chemi- osmotic Hypothesis ,Structure and functions of Peroxisomes	8	1	-	9
4	**Nucleus:**Structure of Nucleus:Nuclear envelope, Nuclear pore complex,Nucleolus, Euchromatin and Heterochromatin , DNA packaging (nucleosome).	8	1	-	9
5	**Cell Division and Cell Signalling** Concepts of cell cycle and its regulation,Mitosis and Meiosis, Cell surface receptor , GPCR and Role of second messenger (cAMP).	8	1	-	9
6	**Lab courses:** 1. Preparation of temporary squash of any suitable material to study various stages of mitosis. 2. Study of various stages of meiosis. 3. Preparation of permanent slide to demonstrate: Mucopolysaccharides by PAS reaction, Proteins by Mercurobromophenol blue/Fast Green, DNA by Feulgen reaction, DNA and RNA by MGP. 4. Preparation of permanent slide to show the presence of Barr Body in human female blood cells/cheek cells.	-	-	15	15
		40	5	15	60

Suggested Readings

- KarpG.,Cell and Molecular Biology:Concepts and Experiments,7thEdition(JohnWiley& Sons, Inc., 2013).
- Scott,M.P.etal,Molecular Cell Biology,6th Edition(W.H.Freeman,2007).
- Alberts,B.etal.,Molecular Biology of the Cell,5thEdition(GarlandPublishing,2008).
- Becker,W.M.etal.,The World of Cell,8thEdition(BenjaminCummings,2011).
- Molecular and Cell Biology(Schaum'sOutlines series special Indianedition) by W. D.Stansfield,J.S.C.Colome,R.J.Cano and R.N.Sharan(2010),Mc Graw Hill Education.
- Cooper,G.M.and Hausman,R.E.,The Cell:A Molecular Approach, 5th Edition(ASM Press and Sinauer Associates, Inc., 2009).
- C.B.Power,Cell Biology,Himalaya Publishing House

SEMESTER III

Title of the Course : Comparative Anatomy of Vertebrates (Major)
Course Code : ZOO-MAJ-4-302
Nature of the Course : Major
Total Credits : 04
Distribution of Marks : 100[60End(Theory: 45,Lab:15)+40IA(30+10Lab)]

Course Outcomes:

1. Discuss the anatomy of different systems in Vertebrates
2. Analyze the structural modifications in anatomy of different groups

Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation, 2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
1	**Integumentary System**:Structure, functions and derivatives of integument	8	1	-	9
2	**Skeletal System:**Over view of axial and appendicular skeleton, Visceral arches	8	1	-	9
3	**Digestive System and Urinogenital system:** Alimentary canal and associated glands, dentition, Succession of kidney, Comparative account on the types of urinogenital systems.	8	1	-	9
4	**Respiratory System& Circulatory System:** Skin,gills,lungs and air sacs;Accessory respiratory organs, General plan of circulation,evolution of heart	8	1	-	9
5	**Nervous System and Sense Organ:**Comparative account of brain,autonomic nervous system,brief Account of visual and auditory receptors in human.	8	1	-	9
6	**Lab Course:** **1.** Dissection of fish(carp) to study efferent and afferent branchial system(subject to permission) **2.** Study of placoid,cycloid and ctenoid scales through permanent slides / photographs. **3.** Study of Disarticulated skeleton of Frog, Varanms, Fowl, Rabbit. **4.** Study of Mammalian skulls: One herbivorous and one carnivorous animal **5.** Study of structure of any two organs (heart,lung,kidney,eye and ear)from video recording (may be included if Dissection not permitted)	-	-	15	15
	TOTAL	40	5	15	60

Where,L:LecturesT: TutorialsP:Practicals

SUGGESTEDREADINGS

- ZOOLOGYfor degree students by VKAgarwal,S .Chand
- Comparative Anatomy of Vertebrates by RK Saxena
- Modern Textbook of Zoologyby RL Kotpal

SEMESTER III

Title of the Course : Comparative Anatomy of Vertebrates (Minor)
Course Code : ZOO-MIN-4-301
Nature of the Course : Minor
Total Credits : 04
Distribution of Marks : 100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]
Course Outcomes:

3. Discuss the anatomy of different systems in Vertebrates
4. Analyze the structural modifications in anatomy of different groups

Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural						
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation, 2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
1	**Integumentary System**:Structure, functions and derivatives of integument	8	1	-	9
2	**Skeletal System:**Over view of axial and appendicular skeleton, Visceral arches	8	1	-	9
3	**Digestive System and Urinogenital System:** Alimentary canal and associated glands,dentition Succession of kidney,comparative account on the types of urinogenital system	8	1	-	9
4	**Respiratory System & CirculatorySystem:** Skin, gills,lungs and airsacs;Accessory respiratory organs, General plan of circulation,evolution of heart	8	1	-	9
5	**Nervous System and Sense Organ:** **C**omparative account of brain Autonomic nervous system, Brief Account of visual and auditory receptors in human	8	1	-	9
6	**LabCourse:** 1.Dissection of fish(carp) to study efferent and afferent branchial system(subject to permission) 2.Study of placoid,cycloid and ctenoid scales through permanent slides / photographs. 3.Study of Disarticulated skeleton of Frog, Varanms, Fowl, Rabbit. 4.Study of Mammalian skulls: One herbivorous and one carnivorous animal 5.Study of structure of any two organs (heart,lung,kidney,eye and ear)from video recording (may be included if Dissection not permitted)	-	-	15	15
	TOTAL	40	5	15	60

Where,L:LecturesT: TutorialsP:Practicals

SUGGESTED READINGS

- ZOOLOGY for degree students byVKAgarwal,S.Chand
- Comparative Anatomy of Vertebrates by RK Saxena
- Modern Textbook of Zoology by RLKotpal

SEMESTER III

Title of the Course :Fish and Fisheries
Course Code :ZOO-SEC-3-301
Nature of the Course : Skill Enhancement Course (SEC)
Total Credits : 03

Distribution of Marks :100[60End(Theory: 45,Practical: 15)+40 IA]

COs:

1. Analyze concept of fish and fisheries.

2. Study the morphology and physiology of fishes.

3. Discuss the fishes in research.

Learning Outcomes:

- Understand the fisheries management concept.
- Study the fishing crafts and gears.
- Understand fish morphology and physiology.

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3		
Procedural					CO2	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

3for highest correlation,2for moderate correlation, and1for lowest correlation

Modes of internal assessment:

- Two theory examination(10marks)
- Practical examination(10marks)
- Group Discussion/Seminar(10marks)
- Assignments (5marks)
- Attendance(5marks)

Attainment strategy of COs:

• Continuous evaluation through in and end semester theory examination

• In and end semester practical examination

• Submission of practical file

• Viva-voce examination

Course content

UNITS	CONTENTS	L	T	P	Total Hours
1	Classification and Morphology of fishes: Account of systematic classification of fishes (up to classes): Classification based on feeding habit, habitat and nature of reproduction. Types of fins and their modifications;Typesof Scales & their modification, Use of scales in Classification of fish.	5	1	-	6
2	Fish biology and ecology :Growth of fishes: Isometric and allometris; Gills and gas exchange; Swim Bladder: types and role in Respiration, buoyancy; Accessory respiratory organ, osmoregulation, Age determination of fish, Reproductive strategies (special reference to Indian fishes); Schooling; Parental care; Locomotion in fishes;Migration, Role of biotic and abiotic factors in fisheries and productivity in fish pond	7	1	-	8
3	Fisheries: Inland Fisheries; Marine Fisheries; Commonly used traditional fishing crafts and gears; Causes of depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations.	7	1	-	8
4	Fish in research:Commonly used fishas model organism in research.Transgenic fish,Recent development in fish biotechnology (Chromosomal manipulation,sex reversal,hormonal manipulation)	6	2	-	8

5	Practicals: 1) Morphometric and meristic characters of fishes 2) Study of Petromyzon,Myxine,Pristis,Chimaera, Exocoetus,Hippocampus,Sardinella,Tenualosa, Mugil, Gambusia, Labeo, Heteropneustes, Anabas 3) Study of different types of scales(through permanent slides/ photographs). 4) Study of crafts and gears used in Fisheries 5) Water quality criteriafor Aquaculture:Assessment of pH, DO, turbidity, alkalinity, hardness 6) Study of air breathing organs in Channa, Heteropneustes, Anabas and Clarias 7) Project Report on a visit to any fish farm/ pisciculture unit.	-	-	15	15
	TOTAL	25	5	15	45

Where,L:LecturesT:TutorialsP:Practicals

SUGGESTED READINGS

- S.S.Khanna, H.R.Singh:A Textbook of Fish Biologyand Fisheries
- K.P. Biswas:ATextBook of Fish, Fisheries&Technology
- R. P.Parihal:Fish Biology and Indian Fisheries
- AzadAli: Basic Concept of Fish and Fisheries.

SEMESTER III

Title of the Course	**:**	**Insect Vectors and Diseases**
Course Code	**:**	**ZOO-GEC-3-301**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03**
Distribution of Marks	**:**	**100(60End+40IA)**

Course Outcomes:

1. Analyze the concept of insects as vectors of diseases
2. Evaluate the general features of insects
3. Examine the role of different insects in transmission

of diseases

Learning Outcomes:

- Explain the concept to f insects as vectors of diseases
- Analyze insect features and their role in disease transmission

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3	CO2	
Procedural						
Meta cognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(20marks
- Group Discussion/Seminar(10marks)
- Assignments(5 marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester examination
- Viva-voce examination
- Submission of Assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Introduction to insects and concept of vector:** General features of insects; **:** Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity	6	1	-	7
2	**Dipterans as important insect vectors** – General characteristics of Diptera. Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases and its control – Malaria, Dengue, Viral encephalitis. Study of sand fly-borne diseases and its control – Leishmaniasis;. Study of housefly as vector and its control	5	1	-	6
		8	1	-	9
3	**Siphonaptera as vectors**:,General characteristicsof Siphonaptera, Study of Flea-borne diseases– Plague ,Typhus fever;Control of fleas.	7	1	-	8
4	**Siphunculata and Hemiptera as disease vectors:** General characteristics of Siphunculata, Studyof louse-borne diseases–relapsing fever,trench fever and control of human louse	**8**	**1**	**-**	**9**
	General characteristics of Hemiptera, blood-sucking bugs;Chagas disease,Control and prevention measures	**5**	**1**	**-**	**6**
	TOTAL	**39**	**6**	**-**	**45**

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

SUGGESTED READINGS:

- Imms,A.D.(1977).A General Text Book of Entomology.Chapman & Hall ,UK
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge, University Press, UK
- Pedigo L.P.(2002).Entomology and Pest Management.Prentice Hall Publication.
- Mathews,G.(2011).Integrated Vector Management:Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

SEMESTER IV

Title of the Course : Biochemistry

Course Code : ZOO-MAJ-4-401
Nature of the Course : Major
Total Credits : 04
Distribution of Marks :100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]

COs:

1. Differentiate the biomolecules of living organisms,their interactions for perpetuation of life
2. Analyze structure-function relationships of nucleic acids and protein
3. Distinguish between replication,transcription and translation in prokaryotes and eukaryotes and interpret the gene expression mechanisms
4. Evaluation of biochemical constituents

Learner Outcome:

1) Identify the various biomolecules and understand their function
2) Differentiate the cellular processes such as replication,transcription and translation
3) Understand gene expression mechanism

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2, CO3		
Procedural					CO4	
Metacognitive						

Mapping of Course outcomesto Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
CO4	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.5	1.5	1.5	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs**:**

1. Continuous evaluation through in and end semester examinations
2. Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Introduction to Biochemistry:** Chemical basis of life, functional groups, types of chemical bonds and biomolecules in biological systems; pH,buffer solution; Laws of thermodynamics, concept of free energy, energy coupling reactions, ATP as energy currency molecule, redox reactions,	7	1	-	8
2	**Proteins:** Classification and functions of proteins. structural organisation of protein and protein stabilizing bonds. Protein denaturation and renaturation. **Aminoacids**:Types ,properties, and functions. Peptide bonds and peptide groups Catabolic reactions of amino acids (Transamination, oxidative deamination and decarboxylation, Urea cycle).	10	2	-	12
3	**Carbohydrates:** Structure, classification, and biological functions. Catabolic pathways of carbohydrate (Glycolysis, Krebs cycle, Electron transport chain , Pentose phosphate pathway, gluconeogenesis, glycogen metabolism) **Lipids:** Structure, classification, biological functions and membrane lipid. **Fatty acids:** Classification; structure , saturated and unsaturatedfattyacids;essentialandnon-essentialfatty acids. beta-oxidation of fatty acids.	11	2	-	13

4	**Enzymes:** Structure of enzyme: holoenzyme, apoenzyme, cofactors,coenzymes and prostheticgroup; Classification of enzymes; Features of active site, substrate specificity, mechanism of enzyme action , Michaelis-Menten equation, enzyme inhibition and factors affecting enzyme activity.	10	2	-	12
5	**Lab Course:** 1. Preparation of different biochemical solutions, dilutions, preparation of buffer solution. 2. Qualitative tests of functional groups in carbohydrates, proteins and lipids. 3. Paper chromatography of amino acids. 4. Action of salivary amylase under optimum conditions. 5. Effect of pH, temperature and inhibitors on the action of salivary amylase. 6. Demonstration of proteins separation by SDS-PAGE(theoretically).	-	-	15	15
		38	7	15	60

SUGGESTED READING

- Cox,M.Mand Nelson,D.L.(2008).Lehninger's Principles of Biochemistry, VEdition,W.H. Freeman and Co., New York.
- Berg,J.M.,Tymoczko ,J.L.and Stryer,L.(2007).Biochemistry,VI Edition,
- W.H. Freemanand Co.,New York.
- Murray,R.K.,Bender,D.A.,Botham,K.M.,Kennelly,P.J.,Rodwell,V.W.andWell,P.A. (2009).Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames,B.D.and Hooper,N.M.(2000).Instant Notes in Biochemistry,IIEdition,BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008).MolecularBiologyoftheGene,VIEdition,ColdSpringHarborLab.Press, Pearson
- J.L.Jain,S.Jain,N.Jain, Fundamentals of Biochemistry, S.CHAND

SEMESTER IV

Title of the Course : **Animal Physiology (Major)**

Course Code : **ZOO-MAJ-4-402**
Nature of the Course : **Major**
Total Credits : **04**
Distribution of Marks :**100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1. Describe the different systems of vertebrates
2. Distinguish between the mechanisms of various physiological systems
3. Examine the body parameters based on the knowledge

Learning outcomes:

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural					CO3	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3forhighest correlation, 2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Digestive System, Urinogenital System and Excretory System** Structural organization and functions of gastrointestinal tract and associated glands; Digestion and absorption of carbohydrates, lipids and proteins;Hormonal control of enzyme secretion in Gastrointestinal tract. Structure of kidney and its functional unit; Mechanism of urine formation. Hormonal control of urine formation.	12	2	-	14
2	**Respiratory System** Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves($O_2$and CO_2)andthe factors influencing it.Carbon monoxide poisoning.	8	1	-	9
3	**Blood and Cardiovascular System** Components of blood and their functions; Structure and functions of haemoglobin, Haemostasis, Blood clotting system,Haemopoiesis ,Blood groups: Rh factor,ABO and MN system of blood grouping. Coronary circulation; Structure and conduction of myocardial fibers. Origin and conduction of cardiac impulses,Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram.	12	1	-	13
4	**Reproductive system** Histology of testis and ovary; comparative structure of male and female reproductive system, physiology of reproduction in human, puberty, estrus cycle, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation	**8**	**1**	**-**	**9**
5	**Lab course:** 1. Determination of Blood groups 2. RBC Count and WBC count 3. Study permanent slides of Ovary and Testes. 4. Preparation of haemin and hemochromogen crystal from fish/mammals	**-**	**-**	**15**	**15**
		40	**5**	**15**	**60**

Suggested Readings

- Halland Hall,2020, Guyton and Hall Textbook of Medical Physiology,14th Edition, ISBN:13:978- 0323597128
- Barrettetal.,2019,Ganong'sReviewofMedicalPhysiology,26thEdition, ISBN:13:978-1260122404
- Vander A,ShermanJ.andLucianoD.(2014).Vander's Human Physiology:TheMechanism of Body Function. XIII Edition, McGraw Hills
- Kenneth,S.Saladin,2017,AnatomyandPhysiology:TheUnityofFormandFunction,8th Edition, ISBN:13:978-1259277726
- RastogiS.C.(2023)Essentialof Animal Physiology(3rd Edition)NewAge International(p)Limited Publisher ,New Delhi

- Routray,N.(2023)Physiology-ControllingandCo-ordinatingSystem,KalyaniPublishers

SEMESTER IV

Title of the Course: Genetics and Evolutionary Biology
Course Code :ZOO-MAJ-4-403
Nature of the Course :Major
Total Credits : 04
Distribution of Marks :100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]

COs:

1) Interpret the basic patterns of inheritance
2) Evaluate genetic disorders and mutations
3) Relate evolutionary forces leading to the variations and diversification of species
4) Examine evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.

Learning Outcome:

1) Understand the concept of inheritance
2) Analyze mutations and genetic disorders
3) Examine forces of evolution
4) Interpret evidences of evolution

Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1		
Procedural				CO3, CO4	CO2	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
CO4	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.5	1.5	1.5	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Mendelian Genetics and its Extensions:** Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, penetrance and expressivity, Epistasis, Phenocopy, Pleiotropy, Polygenic Inheritance, Sex-linked, Sex- influenced, and Sex-limited inheritance.	9	1	-	10
2	**Linkage, Crossing Over and Chromosome Mapping and sex determination:** Linkage and crossing over, Cytological basis of crossing over, Recombination frequency as a measure of linkage intensity, two-factor and three-factor crosses, Linkage map, Coefficient of Coincidence and Interference, Gene mapping **Basis of sex determination**: Concept of sex determination. Genetic and environmental factors; Sex determination in human; Mechanism of dosage compensation .Comparison of nuclear and extranuclear inheritance, maternal effects with examples.	9	1	-	10
3	**Chromosomal and gene mutation and Extra-chromosomal Inheritance:** Types of gene mutations, Mutagens: Physical and chemical, molecular basis of spontaneous and induced mutations, Chromosomal aberrations: Structural Variations in chromosomes, Aneuploidy & Polyploidy. Transposons and its significance	9	1	-	10

4	**Evolutionary Concepts and Beginning of Life and Evidences of Evolution:** Lamarckism, Darwinism, Neo-Darwinism, Synthetic theory of evolution, Chemogeny, RNA world, biogeny, endo-symbiotic theory, geological timescale; evolution of horse; Molecular Evolution. **Process and Product of Evolution:** Variations and their role in evolution; Natural selection and its types, sexual selection, adaptive radiation(Convergent and divergent);Hardy-Weinberg law and its application, genetic drift(founder'seffect, bottleneck phenomenon), role of migration and mutation in evolution; Speciation :micro-evolutionary changes, species concept, isolating mechanisms;Mass extinctions(events, causes and effects), K.T extinction.	13	2	-	15
5	**Labcourse:** 1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test. 2. Study of Human Karyotypes (normal and abnormal)by pictorial demonstration. 3. Pedigree analysis of some human inherited traits 4. Preparation of Polytene chromosomes from Chironomous / Drosophila larvae 5. Study of fossils (types, forms and dating) from models/pictures 6. Study of homology, analogy and homoplasy from suitable specimens	-	-	15	15
		40	5	15	60

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Suggestive readings

- Snustad,D.P.,Simmons,M.J.(2009).Principles of Genetics. VEdition .John WileyandSonsIn.
- Klug,W.S.,Cummings,M.R.,Spencer,C.A.(2012).ConceptsofGenetics.XEdition.Benjamin Cumming
- Pierce,B.A.(2012).Genetics-AConceptualApproach.IVEdition.W.H.FreemanandCompany
- AnthonyJ.F.Griffiths,SusanR.Wessler,RichardC.Lewontin,SeanB.Carroll(2007). Introduction to Genetic Analysis. 9th Edition. W H Freeman.
- Roberts,A.(2018)Evolution:the human story,Dorling,KindersleyLtd.
- Hall,B.K.andHallgrimson,B.(2013).Evolution.VEdition,JonesandBarlettPublishers.
- BartonN.H.,BriggsD.E.G.,EisenJ.A.,GoldsteinD.B.andPatelN.H.,(2007)1stEd.Evolution, Cold Spring Harbor Laboratory Press.
- Rastogi,VeerBala,OrganicEvolution1stEditorKedarNathRaroNath,Meerut

SEMESTER IV

Title of the Course : Molecular Biology
Course Code : ZOO-MAJ-4-404
Nature of the Course : Major
Total Credits : 4
Distribution of Marks :100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]

COs:

1. Analyze biochemical solutions
2. Estimation of DNA
3. Examine the principles of gene interactions
4. Differentiate between various fossils, homologous and analogous organs
5. Distinguish between blood groups and analyze blood parameters

Learning Outcome:

- Compare biochemical solutions
- Analyze DNA
- Discuss the principles of gene interactions
- Compare between various fossils,homologous and analogous organs
- Understand the blood groups and test blood parameters

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1,CO3, CO4		
Procedural					CO2,CO5	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
CO4	3	2	2	2	2	2	2	2.14
CO5	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.4	1.6	6	2	2	

3forhighest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments
- Submission of practical record book

UNIT	CONTENT	L	T	P	Total Hours
1	**Nucleicacids:** Constituent monomers (nucleotides and nucleoside), Structure ofDNA and RNA , Types and functions of DNA andRNA. DNA as genetic material,	7	1	-	8
2	**DNA replication:**Mechanism of DNA replication in prokaryotes and eukaryotes. Semi conservative nature of DNA replication	8	2	-	10
3	**Transcription and Operon Concept:** Types of RNA polymerases, mechanism of transcription in prokaryotes and eukaryotes (initiation, elongation, and termination). Operon Concept: *lac* and *trp* operons in bacteria	10	2	-	12
4	**Translation:** Genetic code and Wobble hypothesis, Translation in prokaryotes and eukaryotes:(initiation, elongation,t ermination), **rDNA technology:** Concept of Recombinant DNA technology and gene Cloning	13	2	-	15
5	**LabCourse:** 1. Estimation of DNA by Diphenylamine method 2. Quantitative estimation of RNA by Orcinol method 3. Study of DNA replication mechanisms through photographs (rolling circle, theta replication, and semi-discontinuous replication)	-	-	15	15

	4.Study of steps of genetic engineering for production of Bt-cotton, golden rice,Flavr Savr tomato through photographs				
		38	**7**	**15**	**60**

Suggested Readings:

- Becker,W.M.,Kleinsmith,L.J.,Hardin.J.and Bertoni,G.P.(2009).*TheWorldoftheCell.*VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
- Bruce Alberts,AlexanderJohnson,JulianLewis,MartinRaff,KeithRoberts,PeterWalter: *Molecular Biology of the Cell*,IVEdition.
- Cooper G.M.and Robert E.HausmanR.E.*The Cell:A Molecular Approach***,**VEdition,ASM Press and Sinauer Associates.
- De Robertis,E.D.P.and DeRobertis,E.M.F.(2006).*Cell and Molecular Biology*.VIIIEdition. Lippincott Williams and Wilkins, Philadelphia.
- Karp,G.(2010)*Cell and Molecular Biology:Concepts and Experiments*.VIEdition.John Wiley and Sons. Inc.
- LewinB.(2008).*Gene XI*,Jones and Bartlett
- McLennanA.,BatesA.,Turner,P.and White M.(2015).*Molecular Biology* IVEdition.GS,Taylor and Francis Group,NewYorkand London.

SEMESTER IV

Title of the Course : **Animal Physiology (Minor)**

Course Code : **ZOO-MIN-4-401**
Nature of the Course : **Minor**
Total Credits : **04**
Distribution of Marks :**100[60End(Theory:45,Lab:15)+40IA(30+10Lab)]**

COs:

1.Describe the different systems of vertebrates
2.Distinguish between the mechanisms of various physiological systems
3.Examine the body parameters based on the knowledge

Learning outcomes:

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural					CO3	
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation, 2for moderate correlation ,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5marks)

Attainment strategy of COs:

Continuous evaluation through in and end semester examinations

- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Digestive System, Urinogenital System and Excretory System** Structural organization and functions of gastro intestinal tract and associated glands; digestion and Absorptions of carbohydrates, lipids, proteins; Hormonal control of enzyme secretion in Gastrointestinal tract. Structure of kidney and its functional unit; Mechanism of urine formation. Horomonal control of urine formation	12	2	-	14
2	**Respiratory System** Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities ;Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves(O_2 and CO_2)and the factors influencing it.Carbon monoxide Poisioning	8	1	-	9
3	**Blood and Cardio vascular System** Components of blood and their functions; Structure and functions of haemoglobin Haemostasis, Blood clotting system, Haemopoiesis, Blood groups: Rh factor, ABO and MN system of blood grouping. Coronary circulation; Structure and conduction myocardial fibers. Origin and conduction of cardiac impulses, Cardiac cycle ;Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram.	12	1	-	13
4	**Reproductive system** Histology of testis and ovary; comparative structure of male and female reproductive system, physiology of reproduction in human, puberty,estrus cycle, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation	**8**	**1**	**-**	**9**
5	**Lab course:** 5. Determination of Blood groups 6. RBC Count and WBC count 7. Study permanent slides of Ovary and Testes. 8. Preparation of haemin and hemochromogen crystal from fish/mammals	**-**	**-**	**15**	**15**
		40	**5**	**15**	**60**

Suggested Readings

- HallandHall,2020,Guyton and Hall Textbookof Medical Physiology,14th Edition, ISBN:13:978-0323597128
- Barrettetal.,2019,Ganong'sReview of MedicalPhysiology,26thEdition,ISBN:13:978-1260122404
- VanderA,ShermanJ.and LucianoD.(2014).Vander'sHuman Physiology:TheMechanism of Body Function. XIII Edition, McGraw Hills
- Kenneth,S.Saladin,2017,Anatomy and Physiology:The Unity of Formand Function, 8th Edition, ISBN:13:978-1259277726
- RastogiS.C.(2023)Essential of Animal Physiology(3rdEdition)NewAge International(p) Limited Publisher ,New Delhi
- Routray,N.(2023)Physiology-Controlling and Co-ordinating System,KalyaniPublishers

SEMESTER V

Title of the Course :Developmental Biology
Course Code :ZOO-MAJ-4-501
Nature of the Course :Major
Total Credits :04
Distribution of Marks :100 [60End(Theory:45,Practical:15)+ 40IA(30+10Lab)]

COs:

1. Understand and analyse the basic principles and concepts in the developmental processes from a single cell system to a multi-cellular system
2. Distinguish the embryonic and post embryonic developmental processes
3. Analyze the developmental process of a single fertilized egg into a fully developed complex organism

Learning Outcome:

- Describe developmental processes of animal system
- Compare various embryonic developmental processes

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1,CO2		
Procedural			CO3			
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.1
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	3	1	1	2	2	2.0
CO4	3	3	2	2	2	1	1	2.0
AVERAGE	3.0	2.2	2.2	1.7	1.7	1.7	1.7	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Introduction** Historical perspectives and basic concepts: Phases of development, Pattern formation, Potency, commitment, specification, Differentiation and growth,	10	1	-	11
2	**Early Embryonic Development** Gametogenesis: oogenesis, spermatogenesis; Types of eggs, Egg membranes; Mechanism of Fertilization,Blocks to polyspermy in sea urchin;Planes and patterns of cleavage; Blastulation and Gastrulation in frog and chick, Embryonic induction and competence, primary organizers.	10	1	-	11
3	**Late Embryonic Development** Fate maps; Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure, types, and functions of placenta.	10	1	-	11
4	**Post Embryonic Development** Metamorphosis and its hormonal regulation in amphibians and insects; Regeneration: brief concept of regeneration, epimorphosis,morphallaxis and compensatory regeneration (with one example each); Teratogenesis: Teratogenic agents and their effects on embryonic development.	10	2	-	12
5	**Lab Course** 1. Study of whole mounts and sections of developmental stages of Amphibia through permanent slides:Cleavage stages, blastula, gastrula, neurula. 2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage3(Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours,Stage7-24hours,Stage8-28hours,Stage10-33hours,Stage11-40hours, Stage 13-48 hours, Stage 19-72 hours and Stage 24-96 hours of incubation. 3. Model/chart preparation on embryonic development in insect/fish/amphibia/chick.	**-**	**-**	**15**	**15**
		40	**5**	**15**	**60**

Suggested readings

- Slack,J.M.W.(2013)Essential Developmental Biology.IIIEdition,Wiley-Blackwell.
- Gilbert,S.F.(2010)Developmental Biology.IX Edition,Sinauer Associates,Inc .Publisers, Sunderland, Massachusetts, USA
- Carlson,B.M.(2007) Foundations of Embryology.VI Edition,Tata Mc Graw-Hill Publishers.
- BalinskyB.I.and Fabian B.C.(2006).An Introduction to Embryology.VIII Editi on, International Thompson Computer Press.

SEMESTER V

Title of course. **:Animal Behaviour and Chronobiology**
Course Code **:ZOO-MAJ-4-502**
Nature of the Course **:Major**
Total Credits **:04**
Distribution of Marks **:100[60End(Theory:45,Practical:15)+40IA(30+10Lab)]**
Course outcomes:

1. Analyzebehaviourpatternsinthebrain,genes,andhormones,aswellasthesurrounding ecological and social environments
2. Interpret the concept of chronobiology.
3. Evaluate the phenomena of seasonal migration and

hibernation

Learning Outcomes:

- Distinguish various behavior patterns of animals
- Understand chronobiology concept
- Analyze different behaviours such as migration and hibernation

Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural			CO3			
Metacognitive						

Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Introduction to Animal Behaviour** Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour	10	1	-	11
2	**Patterns of Behaviour and Communication** Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, Habituation, Imprinting. Importance of communication; Role of Chemical, Tactile, Auditory, Visual stimuli in communication.	10	1	-	11
3	**Social and Sexual Behaviour** Concept of Society, Social insect, bee communication and the senses; Altruism, Hamilton Rule, Sexual Behaviour: Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care. Aggressive behaviour.	10	1	-	11
4	**Introduction to Chronobiology** Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and insects.Relevance of biological clocks; Chronomedicine, Chronotherapy.	10	2	-	12
5	**Lab Course** **1.** To study nests and nesting behavior of the birds and social insects. **2.** To study the taxis behavior in insect larvae. **3.** To study colouration patternin fishes. **4.** To study habituation in mosquito larvae **5.** Observation of animal architects:Termites, wasp, Harvester ant and any bird.	**-**	**-**	**15**	**15**
		40	**5**	**15**	**60**

Suggestive Readings:

- Alcock,J.(2013)Animal Behaviour,XthEdition,Sinauer Associates Inc., USA.
- Manning,A.and Dawkins,M.S,(2012)An Introduction toAnimal Behaviour,VIth Edition, Cambridge University Press, UK
- McFarland,D.(1985)Animal Behaviour,Pitman Publishing Limited,London,UK
- Binkley,S.(2020).Biological clocks:Your owner's manual.CRCPress.
- Vinod Kumar(2017):Biological Time keeping:Clocks,Rhythms and Behaviour.

SEMESTER VI

Title of the Course **:Controlling and Co-ordinating Physiology and Immunology**
Course Code **:ZOO-MAJ-4-601**
Nature of the Course **:Major**
Total Credits **:04**
Distribution of Marks **:100[60End(Theory:45,Practical:15)+40IA(30+10Lab)]**

COs:

1. Examine the internal working of organs and organ systems.
2. Evaluate the functioning of various organ systems such as muscular,nervous,blood and endocrine systems in vertebrates.
3. To explain the basic principle of immunology

Learning Outcomes:

- Discuss the working of organ and organ systems
- Analyze the functioning of the various systems
- Describe the role of endocrine system
- Analyse the basic principle of Immunology

MappingofCOwithBloomTaxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1	CO2, CO3	
Procedural						
Metacognitive						

MappingofCourseoutcomestoProgrammeoutcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3for highest correlation,2for moderate correlation,and1for lowest correlation

Modes of internal assessment

- Two theory examination(10marks)
- Group Discussion/Seminar(10marks)
- Practical examination(10marks)
- Assignments(5marks)
- Attendance(5 marks)

Attainment strategy of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	**Tissues,Bone andCartilage** Structure, location, classification and functions of epithelial tissue,connective tissue,muscular tissue and nervous tissue, Structure and types of bones and cartilages	5	1	-	6
2	**Muscle and Nervous system** Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basisofmusclecontraction;Characteristics of muscle twitch; Motor unit, summation and tetanus Types of nerves and nervous system,Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers;Typesof synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc	10	1	-	11
3	**Endocrine System** Endocrine glands in vertebrates-pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their functions; Classification of hormones, mode of hormone action, Neuro-endocrine system and feedback mechanism.	**10**	1	**-**	**11**
4	**Over view of Immune System** Cells and organs of the Immune system. Innate immunity, Adaptive immunity (Cell mediated and humoral), Passive and active Immunity.	5	1	**-**	5
5	**Antigen and Antibody** **A**ntigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-cell epitopes, Stucture and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays (ELISA and RIA)	10	1	-	11

6	**Lab Course** 1. Recording of muscle twitch with electrical stimulation (or virtual) 2. Demonstration of the unconditioned reflex action (Deep tendon Reflex such as knee jerk relex) 3. Examine sections of mammalian nerves, different types of muscles, and study of permanent slides of bone, cartilage, tissues, neurons, pituitary, pancreas, adrenal, thyroid, hypothalamus and parathyroid. 4. Demonstration of lymphoid organs(by video) 5. Histological study of spleen, thymus and lymph nodes through slides/ photographs 6. Demonstration of ELISA			-	15
		40	**5**	**15**	**60**

SUGGESTED READINGS

- Kardong,K.V.(2005)Vertebrates 'Comparative Anatomy,Function and Evolution.IV Edition. McGraw-Hill Higher Education.
- Kent,G.C.andCarr R.K.(2000).Comparative Anatomy of theVertebrates.IXEdition.The McGraw-Hill Companies.
- Hilderbr and,Mand GaslowG.E.Analysis of Vertebrate Structure,JohnWiley and Sons.
- Walter,H.E.andSayles,L.P;BiologyofVertebrates,KhoslaPublishingHouse.
- Tortora, G.J. - and Derrickson, B.H. (2009). Principles of Anatomyand Physiology, XIIEdition, John Wiley & Sons, Inc.
- Widmaier,E.P.,Raff,H.andStrang,K.T.(2008)Vander'sHumanPhysiology,XIEdition., McGraw Hill
- Guyton,A.C.andHall,J.E.(2011).Textbook of Medical Physiology,XIIEdition,Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg,J.M.,Tymoczko,J.L.andStryer,L.(2006).Biochemistry.VIEdition.W.H Freeman and Co.