BENGALURU CITY UNIVERSITY

Palace Road, Bengaluru-560001

Syllabus for

B.Sc. Zoology (UG)

CHOICE BASED CREDIT SYSTEM (CBCS)

Framed According to the National Educational Policy (NEP 2020)

V & VI SEMESTERS

[To implement from the academic year 2023-24]

Guidelines For Model Curriculum

1. The Universities shall promote Double Major model as prescribed in the Model Curriculum Table.
2. For Arts/Humanities/Social Science - V & VI sem, three core papers (DSC) to be selected in each semester.
   For Science – Ensure two core papers (DSC) should get minimum of 12 credits/or 2 major subjects of 24 credits (4+2 patterns) (1 hour of Lecture or 2 hours of practical/field work per week in a semester is assigned one credit and core subject theory courses/papers will have 4 credits, while practical are assigned 2 credits)
3. Formative assessment and summative assessment to be followed in the ratio of 40:60.
4. Selection of Open electives: The university shall follow curriculum and credit frame work for Undergraduate program of published by UGC. **Open Electives – Courses from other Disciplines (9 Credits)**
   - Students are not allowed to choose or repeat courses as open electives already undergone at the higher secondary level (12th class)
   - All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below.

Natural and Physical Sciences	Mathematics, Statistics, & Computer Applications	Library, Information, and Media Sciences	Commerce and Management	Humanities and Social Sciences:
Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc.	Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools	Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)	Courses include business management, accountancy, finance, financial institutions, fintech, etc.,	The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behavior, society, and nation. Students be introduced to survey methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses that can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political Economy and Development, Sustainable Development, Women's and Gender Studies, etc. will be useful to understand society.

BSc.-Science: Curriculum and Credit Framework for Undergraduate Programme

Sem.	Discipline Specific Courses - Core (DSC), Elective (DSE)(Credits) (L+T+P)	Minor/ Multidisciplinary/ Open Elective (OE) Courses(Credits) (L+T+P)	Ability Enhancement Courses (AEC)(Credits)(L+T+P) (Languages)	Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship.		Total Credits
I	DSC-A1(4), A2(2) DSC-B1(4), B2(2)	OE-1 (3)	L1-1(3), L2-1(3) (4 hrs each)	**SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3)	Health, Wellness & Yoga (2) (1+0+2)	25/26
II	DSC-A3(4), A4(2), DSC-B3(4), B4(2)	OE-2 (3)	L1-2(3), L2-2(3) (4 hrs each)	Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2)	Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4)	26/25
Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year.						
III	DSC-A5(4), A6(2), DSC-B5(4), B6(2)	OE-3 (3)/ India and IndianConstitution (3)	L1-3(3), L2-3(3) (4 hrs. each)	**SEC-2**:AI/Cyber Security/Finan-cial Edu. & Inv. Aw. (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G) /Cultural (2) (0+0+4)/ SEC (2)	25
IV	DSC-A7(4), A8(2), DSC-B7(4), B8(2)	India and Indian Constitution (3) / OE-3(3)	L1-4(3), L2-4(3) (4 hrs. each)	**SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2)	Sports/NCC/NSS/R&R(S&G)/ Cultural (2) (0+0+4)/ SEC (2)	25
Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term.						
V	DSC-A9(4), A10(2), A11(4), A12(2);	DSC-B9(4), B10(2), B11(4), B12(2)		**SEC-4**: Employability Skills/Cyber Security (3) (2+0+2)		27
VI	DSC-A13(4), A14(2), A15(4), A16(2);	DSC-B13(4), B14(2), B15(4), B16(2)		Internship (2)		26
Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed.						

Internship for graduate Programme (As Per UGC & AICTE)

Course title	Internship Discipline specific
No of contact hours	90
No credits	2
Method of evaluation	Presentations/Report submission/Activity etc.,

- Internship shall be Discipline Specific of 90 hours (2 credits) with a duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during 6^{th} semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

SUBJECT EXPERT COMMITTEE MEMBERS -KSHEC

S. No.	Name and Organization	Designation
1	Prof. K. Vijaykumar, Department of Zoology, Gulbarga University, Kalaburagi. Ph:.9480060508,katepaga63@gmail.com	Chairman
2	Prof. P.M Basha, Department of Zoology, Bangalore University, Bengaluru Ph:.9448701652, pmbashabub@rediffmail.com	Member
3	Prof. Vijaykumar B Malashetty, Department of Zoology, VSK University, Ballari. Ph:.9343011567,vijaymalashetty@gmail.com	Member
4	Prof. S. Basavarajappa, Mysore University, Mysuru. Ph:.9449203241, E-mail: ornithoraj11@gmail.com	Member
5	Prof. Nagaraj, Department of Zoology, Kuvempu University, Shivamogga. Ph:.9620485338	Member
6	Prof. Kareemunnisa Syed, Nrupathunga University, Bengaluru, Ph:.9964300991, kareemunnisa66@gmail.com	Member
7	Prof. B. Vasanthkumar, Department of Zoology, Sir MVGovt. College,Bhadravathi,Shimoga	Member
8	Prof. B.K. Meera, Professor, Maharani Cluster University, Bengaluru Ph:.9886409382.	Member
9	Dr. D. Gangadhara Rao, Professor, Govt. Women's College, Kolar. Ph:.9448984956	Member
10	Prof. Shankarappa S.Hatti, Govt. College, Dept. of Zoology, SedamRoad,Kalaburagi.9980391964	Member
11	Dr. Zeba Parveen Dept. Of Zoology, Bi Bi Raza Women's Degree College, Kalaburagi. Ph:.9448092786	Member
12	Dr. Asiya Nuzhath F.B, Associate Professor, Dept. Of Zoology, Tumkur University, Tumakuru. Ph:.9844029441	Member
13	Ms. Akshatha, Special Officer, KSHEC, Bengaluru. Ph:.9535487108	Member Convener

Bengaluru City University Subject Committee BOS members for Zoology

SN	Name& Organization	Designation
1	Dr. P. MAHABOOB BASHA, Prof. of Zoology, Bangalore University, Bangalore-560056.	Chairman
2	Dr. HEMALATHA A. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001.	Member
3	Dr. SHABANA BEGUM. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001	Co-opted Member(E)
4	Dr. LATHA, V. Asso. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001	Co-opted Member(E)
5	Mr. CHANDRAPPA, Associate Prof. of Zoology, GFGC, Yelahanka, Bangalore. 9886884996.	Member
6	Mrs. DHANALAKSHMI. N, Asst. Prof of Zoology, Vijaya College, RV Road, Bangalore-560004.	Member
7	Dr. C.E. TRIVENI, V.V. Puram College of Science, K. R. Road, Bangalo	Member
8	Dr. SHUBHA M, Assistant Professor in zoology, BMS College for Women, Bengaluru-560004.	Member
9	Dr. BHUSHANAM. Asso. Prof. of Zoology, Maharani Cluster Universit Bangalore- 560001	Co-opted Member(E)

Note:

1. Sl. No 3-4 & 9 were co-opted in the place of Superannuated BOS members.

(P. MAHABOOB BASHA)
Chairman, BOS (UG)Zoology, BCU

V SEMESTER B.Sc., ZOOLOGY THEORY SYLLABUS
DISCIPLINE SPECIFIC CORE COURSE (DSCC)

THEORY PAPER: NON-CHORDATES AND ECONOMIC ZOOLOGY

1. Course Description

Program Name	**B.Sc.,**	Semester	V
Course Title	**Non-Chordates and Economic Zoology (Theory)**		
Course Code:	DSC**C5 ZOO -T5**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Objectives:

- To learn the morphological characters and structure of animals
- To inculcate the identification abilities in the learners of no- chordate diversity
- To acquire the knowledge of economic animals

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Out comes (POs)

Course Out comes(COs)/(POs)	DSC**C5 ZOO -T5**	**ZOO C5P**	**ZOO C6T**	**ZOO C6P**	**ZOO C7T**	**ZOO C7P**	**ZOO C8T**	**ZOO C8P**
I Core competency	X							
II Critical thinking	X							
III Analytical reasoning	X							
IV Research skills	X							
V Team work	X							

Course Articulation Matrix relates course outcomes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the inter section cell if a course outcome addresses a particular program

Course Out comes (COs): After the successful completion of the course, the student will be able to:

CO1. Group animals on the basis of their morphological characteristics/structures.
CO2. Demonstrate comprehensive identification abilities of Non-Chordate diversity

CO3.Explain structural and functional diversity of Non-Chordates

CO4. Develop the knowledge of economic animals.

Contents	60 Hrs
Unit-I	**15**
Chapter 1: Protozoa to Cnidaria **Phylum Protozoa** • *Paramecium caudatum*- Morphology, Reproduction- Binary fission & Conjugation. **Phylum Porifera** • *Sycon*- Canal system. **Phylum Coelenterata:** • *Obelia*- Morphology and Reproduction.	
Chapter 2: Ctenophora to Nemathelminthes **Ctenophora:** • Salient feature and affinities. **Phylum Platyhelminthes:** • *Taenia solium*- Morphology and reproduction. **Phylum Nemathelminthes** • *Ascaris lumbricoides*-Morphology and Reproduction.	
Unit-II	**15**
3. Annelida • *Hirudinaria granulosa* (Leech)-Morphology and Reproduction	
4. Arthropoda • *Palaemon* (Prawn)- Morphology, Appendages, Nervous System and reproduction	
Unit-III	**15**
6. Mollusca to Hemichordata **Mollusca** • *Pila globosa*- Morphology, Shell, Respiration, Nervous System and Reproduction **Echinodermata** • *Pentoceros*- Morphology and Water Vascular System **Sub Phylum: Hemichordata** • Type Study of *Balanoglossus*–Habit and Habitat, Morphology, Coelom. • Tornaria larva. • Systematic position of Hemichordata.	
Unit-IV	**15**
7. Economic Zoology Part -I Life cycle and control of: • Gundhi Bug • Sugarcane leaf hopper • Mosquitoes	
8. Economic Zoology part II • Lac culture and Vermitechnology	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
House Examination/Test	15
*Written Assessment/Presentation/Project/Term Papers/Seminars	15
Classroom Performance/Participation	10
Total	**40 Marks**

Topics suggested for Continuous Internal Assessment Presentation/ Seminars

- **Patterns of Organization (Definition and examples).**
- Levels of organization: Protoplasmic, cellular, tissue, organ and organ system grade.
- Body symmetry: Bilateral, Radial and Biradial.
- Germ layers: Diploblastic and Triploblastic.
- Body coelom: Acoelom, Pseudocoelom and Eucoelom.
- General characters of all phyla from Protozoa to Hemichordata and classification up to classes with suitable examples.
- Canal system of sponges
- **Onychophora- Salient features and affinities**
- Soil protozoa, Spongiculture, Economic importance of corals, Vermi-technology, Importance of Honey bees as pollinators and their by-products, Chank Fisheries and economic importance of Echinodermata.
- Pisciculture: Procedure, Composite fish farming, Fish processing and preservation
- Poultry: Indigenous and exotic breeds, Poultry products and by-products
- Dairy: Artificial insemination and MOET, Milk and its by-products, Gobar gas
- Life cycle and control of termites and rodents

PRACTICAL PAPER: NON-CHORDATES AND ECONOMIC ZOOLOGY

Course Title	**Non-Chordates and Economic Zoology (Practical)**	Practical Credits	**2**
Course Code	DSC**C5 ZOO -P5**	Contact Hours	**4**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Course Pre-requisite(s):

1. **To understand the basics of** classification of non-chordates.
2. To learn the diversity of habit and habitat of these species.
3. To develop the skills to identify different classes and species of animals.
4. To know uniqueness of a particular animal and its economic importance

Course Outcomes(COs):

At the end of the course the student should be able to:

1. Understand basics of classification of non-chordates.
2. Learn the diversity of habit and habitat of these species.
3. Develop the skills to identify different classes and species of animals.
4. Know uniqueness of a particular animal and its importance

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Out comes (POs)

Course Out comes(COs)/(POs)	**ZOO C5T**	DSCC**5ZOO -P5**	**ZOO C6T**	**ZOO C6P**	**ZOO C7T**	**ZOO C7P**	**ZOO C8T**	**ZOO C8P**
I Core competency		X						
II Critical thinking		X						
III Analytical reasoning		X						
IV Research skills		X						
V Team work		X						

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X'in the intersection cell if a course outcome addresses a particular program outcome.

Practical Content	**15**
1. Preparation and observation of protozoan culture. 2. **Protozoa**: *Amoeba*, *Euglena*, *Noctiluca*, *Paramecium* and *Vorticella* (Permanent slides). 3. **Porifera:** *Sycon, Euplectella, Hyalonema, Spongilla* and *Euspongia*	1

(Specimens). Study of permanent slides of T.S of *Sycon*, spicules and gemmules. 4. **Coelenterata:** *Aurelia* and *Metridium* (Specimens). Slides of *Hydra, Obelia*-polyp and medusa, and *Ephyra* larva, T.S. of *Metridium* passing through mesenteries. 5. **Stud y of Corals** - *Astraea, Fungia, Meandrina, Corallium, Gorgonia, Millepora* and *Pennatula.* 6. **Helminthes:** *Planaria, Fasciola hepatica* and *Taenia solium*, *Ascaris*-Male and female (Specimens). Slides of T.S. of *Planaria*, T.S of male and female *Ascaris*. 7. **Annelida:** *Nereis, Sabella, Aphrodite* and Leech (Specimens) Slide of T.S. of Earthworm through typhlosole. 8. **Arthropoda**: *Palaemon, Astracus,* Scorpion, Spider, *Limulus, Peripatus, Millipede, Centipede,* Praying mantis, Termite Queen, Moth, Butterfly, Dung beetle / Rhinocerous beetle (Any six specimens). Crustacean Larvae-Nauplius, Zoea and Mysis. 9. **Mollusca:** *Chiton, Mytilus, Aplysia, Pila, Octopus, Sepia* (Specimens) and Glochidium larva (Slide). 10. **Shell Pattern**-*Unio, Ostrea, Cypraea, Murex, Nautilus, Patella, Dentalium,* Cuttlebone. (Any four) 11. **Echinodermata**: Systematics of Sea-star, Brittlestar, Sea Urchin, Sea cucumber, Sea lily (Specimens). Slides of Bipinnaria larva, Echinopluteus larva and Pedicellaria. **12**. *Balanoglossus* and its T. S. through proboscis **13. Beneficial Non-chordates:** • **Sericulture:** Lifecycle of *Bombyx mori*, Uzifly, Cocoon, Raw silk. • **Apiculture**: Any 2 Species of honeybee and bee wax. • **Pearl Culture**: Pearl Oyster and Natural Pearls. **14. Virtual Dissection/Cultured specimens:** Earthworm – Digestive system, Nervous system, Leech-Digestive System 15. **Virtual Dissection/Cultured specimens:** Prawn-Nervous system. Cockroach-Salivary Apparatus and Digestive system.	1 1 1 1 1 1 1 3 2 2

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	10
Written Assessment/Presentation/Project/Term Papers/Seminars	10
Class room Performance/Participation	5
Total	**25 Marks**

References	
1	Barnes, R.S.K.; Calow,P.; Olive,P.J.W.; Golding,D.W.; Spicer, J.I.(2002) The Invertebrates: Synthesis, Blackwell Publishing.
2	Hickman,C.; Roberts,L.S.; Keen,S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.
3	Holland, P.(2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
4	Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
5	Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
6	Bushbaum, R. (1964). Animals without Back bones. University of Chicago Press.

THEORY PAPER: CHORDATES AND COMPARATIVE ANATOMY

Program Name	**B.Sc.,**	Semester	**V**
Course Title	**Chordates and Comparative Anatomy (Theory)**		
Course Code:	DSC**C5 ZOO –T6**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2 hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Objectives

- To inculcate identification abilities of chordate diversity
- To explain structural and functional diversity of chordate diversity
- To understand evolutionary relationship amongst chordates

Course Outcomes (COs): After the completion of the course, the student will be able to:
CO1. Demonstrate comprehensive identification abilities of chordate diversity
CO2. Explain structural and functional diversity of chordate diversity
CO3. Understand evolutionary relationship amongst chordates
CO4. Take up research in biological sciences.
CO5. Realize that very similar physiological mechanisms are used in very diverse organisms.
CO6. Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Out comes(COs)/(POs)	**ZOO C5T**	**ZOO C5P**	DSC**C5ZOO –T6**	**ZOO C6P**	**ZOO C7T**	**ZOO C7P**	**ZOO C8T**	**ZOO C8P**
I Core competency			X					
II Critical thinking			X					
III Analytical reasoning			X					
IV Research skills			X					
V Team work			X					

Course Articulation Matrix relates course outcomes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Contents	**60Hrs**
Unit-I	**10 hrs**

Chapter 1: Chordata

- General characters of chordates and classification upto classes with suitable examples (Basic features to be emphasized).

Chapter 2: Urochordata

- Type Study of *Herdmania*- Habit and Habitat, Morphology, Ascidian Tadpole-structure and its retrogressive metamorphosis.

Chapter 3: Cephalochordata

- Type Study of *Branchiostoma* (*Amphioxus*)- Habit and Habitat, Morphology, Digestive system, Feeding mechanism, excretory and circulatory systems.

Chapter 4: Agnatha • General characters of Agnatha and classification up to classes. • Salient features of Cyclostomata with examples • Ammocoete larva and its significance.	
Unit-II	**16 hrs**
Chapter 5: Vertebrates • General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) upto living orders with examples. • Differences between Chondrichthyes and Osteichthyes. • Interesting features and evolutionary significance of Dipnoi. • Salient features of Placodermi and Ostracodermi with examples. • Interesting features of *Sphenodon*,and *Archaeopteryx*. • Interesting features of Mammalian orders (Insectivora, Carnivora, Chiroptera, Cetacea, Proboscidia, Ungulata–Perissodactyla and Artiodactyla, and Primates) with examples.	
Unit-III	**19 hrs**
Chapter 6: General account of Chordates • Origin of Chordates. •Types of caudal fins, scales and swim bladder in fishes. •Origin of Amphibia. •Neoteny and Paedogenesis. •Adaptive radiation in extinct reptiles with suitable examples. •Temporal fossae in reptiles. •Poison apparatus in snakes. •Parental care in Pisces and Amphibians. •Flight adaptations in birds. •Dentition in mammals. Evolution of molar tooth. •Migration in Pisces and Birds. •Economic zoology- Poultry	
Unit-IV	**15 hrs**
Comparative Anatomy of Vertebrates **Chapter 8: Respiratory system** • Comparative account of respiratory system in vertebrates: Pisces (*Scolidon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man). **Chapter 9: Circulatory System** • Comparative account of heart and aortic arches in vertebrates: Pisces (*Scoliodon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man). **Chapter 10: Excretory System** • Succession of kidney in vertebrates (Pronephros, Mesonephros and Meta nephros kidney). **Chapter 11: Nervous system** • Comparative account of brain in vertebrates: Pisces (*Scoliodon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man).	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
House Examination/Test	15
*Written Assessment/Presentation/Project/Term Papers/Seminars	15
Classroom Performance/Participation	10
Total	**40 Marks**

Topics suggested for Continuous Internal Assessment Presentation/ Seminars

- General characters of Urochordata and Cephalochordata.
- Interesting features of crocodile
- Economic zoology- Diary, Pisciculture
- Comparative anatomy of Skeletal system: Axial and appendicular.
- Comparative account of heart in vertebrates
- Comparative account of brain in vertebrates

Practical Paper: Chordates and Comparative Anatomy Zoology

Course Title	**Chordates and Comparative Anatomy Zoology (Practical)**	Practical Credits	**2**
Course Code	DSC**C5 ZOO –P6**	Contact Hours	**4**
Formative Assessment	**25 Marks**	Summative Assessment	**25 Marks**

Course Pre-requisite(s): Objectives

- To inculcate identification abilities of chordate diversity
- To explain structural and functional diversity of chordate diversity
- To understand evolutionary relationship amongst chordates

Course Outcomes (COs): After the completion of the course, the student will be able to:
CO1. Demonstrate comprehensive identification abilities of chordate diversity
CO2. Explain structural and functional diversity of chordate diversity
CO3. Understand evolutionary relationship amongst chordates

Practical Content	**15 units**
1. **Protochordata** Ascidia/*Herdmania* and Amphioxus, T.S. of *Amphioxus* through pharynx and intestine.	**1**
2. **Cyclostomata** *Petromyzon*, Ammocoete larva and *Myxine.*	
3. **Pisces** Cartilaginous Fishes – *Narcine, Trygon, Pristis, Myolobatis* Bony Fishes–Zebra fish, *Hippocampus, Muraena, Ostracion, Tetradon, Pleuronectus, Diodon, Echeneis*. (Any four).	**1**
4. **Ornamental fishes** Siamese, Koi, Oscar, Betta Sp., Neon tetra, Guppies, Goldfish, Angle fish, Rainbow fish, Mollies (Locally available any five aquarium fishes).	**1**
5. **Accessory respiratory organs** *Saccobranchus, Clarias* and *Anabas.*	**1**
6. **Amphibia** - *Rana, Bufo, Ambystoma, Axolotl larva, Necturus and Ichthyophis.*	
7. **Reptilia** Turtle, Tortoise, *Mabuya, Calotes*, Chameleon, *Varanus*.	**1**
snakes–*Dryophis*, Rat snake, Brahmini, Cobra, Krait, Russell's viper and *Hydrophis* (Any 4)	**1**
8. **Aves** Beak and feet modifications in Duck, Crow, Sparrow, Parrot, Kingfisher, Eagle or Hawk. (Any four)	**1**
9. **Mammalia** Mongoose, Squirrel, Pangolin, Hedge Hog, Rat and Loris. (Any four)	**1**
10. **Virtual Dissection/Cultured specimens** Shark/Bony fish: Afferent and efferent branchial systems, glosso-pharyngeal and vagus nerves. Rat: Dissection (only demonstration) – Circulatory system (arterial and venous), Urogenital system.	**3**
11. **Skeletal System in Frog and man (Comparative Anatomy):** Skull, vertebrae, girdles and limb bones (Except hands and feet)	**2**
12. Integumentary System (Comparative Anatomy) Structure of skin in Fish, Frog, Bird and mammal Integumentary derivatives in mammals.	**2**

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	10
Written Assessment/Presentation/Project/Term Papers/Seminars	10
Classroom Performance/Participation	5
Total	**25 Marks**
Formative Assessment as per NEP guidelines are compulsory	

References	
1	Colbert *et al*: Colbert's Evolution of the Vertebrates:A history of the back boned animals through time. (5th ed 2002, Wiley–Liss).
2	Hildebrand: Analysis of vertebrate Structure (4thed 1995, JohnWiley)
3	Kenneth V. Kardong (20015) vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
4	McFarland *et al.,*: Vertebrate Life (1979, Macmillan publishing)
5	Parker and Haswell: Text Book of Zoology, Vol. II(1978,ELBS)
6	Romerand Parsons: The Vertebrate Body (6thed1986, CBS Publishing Japan)
7	Young: The Life of vertebrates (3rded 2006,ELBS/Oxford)
8	Weichert C. K. and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills
9	Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4thedition), McGraw-Hill.

Scheme of Practical Examination

V Semester

PAPER V: DSC**C5 ZOO P5: Non- Chordata & Economic Zoology**

(Practical based on DSC**C5 ZOO -T5)**

Duration: 03 Hours Max. Marks: 25

I. Dissect & display/ Chart
   Earthworm/Cockroach: Nervous system/Digestive system (08 M)
II. Dissect & display/ Chart
   Leech: Digestive system/ Cockroach: Salivary gland apparatus (05M)
III. Identify, classify & comment on spots A, B, C and D (3X4 = 12 M)
   (One from Economic Zoology and one slide is compulsory)

Scheme of Valuation

I – Dissection – 06M; Display – 02 M/ Comments with diagram-8M
II – Mounting – 03M; Comments – 02M/ Comments with diagram-6M
III – Identification & classification – 01M; Diagram & comments – 02M for Each

V Semester

PAPER VI: DSC**C5 ZOO P6: Chordata & Comparative Anatomy**
(Practical Based on DSC**C5 ZOO –T6)**

Duration: 3 Hours Max. Marks: 25

Scheme of Examination

I. Flag labeling of the display/ Chart given (ONE) [08M]

a. Shark – Afferent/Efferent/Cranial nerves
b. Rat – Circulatory system/Urinogenital system (Arterial/venous) (Male/Female)

II. Comparative anatomy (ONE) [05M]

a. Skeletal system or Integumentary system for comparison
b. Any TWO derivatives of mammalian integument

III. Identification and comment on spotters A to D [3X4 = 12 M]

a. (Slides & Specimens from Protochordates to Mammalia)
b. One slide is compulsory

Scheme of Valuation

I. Identification of the system – 02M; Flag labeling – 06M (Minimum 06 labels)/ Comments with diagram-8M
II. Diagram & Comments – 05M
III. Identification with classification – 01M; Diagram & Comments – 02 M for each

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VI SEMESTER CURRICULUM

Program Name	**B.Sc.,**	Semester	**VI**
Course Title	**Evolutionary & Developmental Biology (Theory)**		
Course Code:	DSC**C5 ZOO –T7**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/ Exam	**2hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Objectives

- To understand the biological evolution on the earth
- To understand various forces influencing the evolution
- To understand how the single cell formed at fertilization forms an embryo and then a full adult organism.

Course Outcomes(COs): After the successful completion of the course, the student will be able to:

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change.
- Understand how the single cell formed at fertilization forms an embryo and then a full adult organism.
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science.

Course Articulation Matrix: Mapping of Course Out comes (COs) with Program Out comes (POs)

Course Out comes(COs)/(POs)	**ZOO C5T**	**ZOO C5P**	**ZOO C6T**	**ZOO C6P**	DSC**C5 ZOO –T7**	**ZOO C7P**	**ZOO C8T**	**ZOO C8P**
I Core competency					X			
II Critical thinking					X			
III Analytical reasoning					X			
IV Research skills					X			
V Team work					X			

Contents	60Hrs
Unit-I	**15**
1. **Theories of Evolution** • Origin of Life (Contributions of Oparin, Haldane, Stanley Miller's experiment). • Historical review of evolutionary concept: Lamarckism, Darwinism, Modern synthetic theory • Adaptive radiations: Patterns of evolution (Divergence, Convergence, Parallel, Co-evolution)	
2. **Population Genetics** • Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy- Weinberg equilibrium • Forces of evolution: Mutation, Natural Selection (Introduction, Types- Stabilising selection, Disruptive selection, Directional selection), Genetic drift (Introduction, Types- Founder's effect, Bottle neck effect).	
Unit-II	**15**
3. **Direct Evidences of Evolution:** • Fossils- Types of fossils (Petrifactions, Preservations, Impressions, Moulds and casts), Dating of fossils (Carbon-14 dating method and U-Pb dating method) • Phylogeny of horse (Eohippus, Mesohippus, Merichippus, Pliohippus and Equus).	
4. **Species Concept and Extinction**: • Biological species concept (Advantages and Limitations) • Modes of Speciation-Allopatric and Sympatric speciation (Pre- zygotic and Post Zygotic reproductive isolating mechanisms to be emphasized). • Mass extinction (Causes, Names of five major extinctions).	
Unit-III	**15**
5. **Gamete, Fertilization and Early Development:** Gametogenesis (mechanism of Spermatogenesis and oogenesis), Fertilization, Cleavage pattern, Gastrulation and fate map and morphogenesis- General account in the light of evolution to be emphasized.	
6. **Developmental Genes:** • General concepts of Organogenesis-I (Neurulation process) • Introduction to genetic basis of embryonic development and Developmental control genes (Homeobox genes)	
Unit-IV	**15**
7. **Early Vertebrate Development**: • Early development of mammals including Placentation, metamorphosis, regeneration (Limb in frog), environmental regulation in Frog.	
8. **Late Development**: • Development of eye and kidney • Mammalian female reproductive cycles- estrous cycle and menstrual cycle and their regulation • Aging: biology of senescence (causes of ageing to be emphasized)	

Formative Assessment for Theory	
Assessment Occasion /type	**Marks**
House Examination/ Test	15
Written Assessment /Presentation/Project/Term Papers/Seminars	15
Classroom Performance/Participation	10
Total	**40 Marks**
Formative Assessment as per NEP guidelines are compulsory	

Topics suggested for Continuous Internal Assessment Presentation/ Seminars

- Incomplete fossil record.
- Planes of cleavage
- Types of cleavage
- Influence of yolk on cleavage
- Historical embryology
- Cleidoic egg and its significance
- Mosaic and regulative eggs
- Theories of ageing
- Blastulation – a general account

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Practical Paper: Evolutionary & Developmental Biology

Program Name	**B.Sc.,**	Semester	**VI**
Course Title	**Evolutionary & Developmental Biology(Practical)**		
Course Code:	DSC**C5 ZOO –P7**	No. of Credits	**2**
Contact hours	**60 Hours**	Duration of SEA/ Exam	**3 hours**
Formative Assessment Marks	**25**	Summative Assessment Marks	**25**

Course Pre-requisite(s): Course Pre-requisite(s): Objectives

- To understand the biological evolution on the earth
- To understand various forces influencing the evolution
- To understand how the single cell formed at fertilization forms an embryo and then a full adult organism.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Out comes(COs)/(POs)	**ZOO C5T**	**ZOO C5P**	**ZOO C6T**	**ZOO C6P**	**ZOO C7T**	DSC**C5 ZOO –P7**	**ZOO C8T**	**ZOO C8P**
I Core competency						X		
II Critical thinking						X		
III Analytical reasoning						X		
IV Research skills						X		
V Team work						X		

Course Articulation Matrix relates course out comes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the inter section cell if a course outcome addresses a particular program outcome.

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Written Assessment/Presentation/Project/Term Papers/Seminars	10
Class room Performance / Participation	10
Total	**25 Marks**
Formative Assessment as per NEP guide lines are compulsory	

	Practical Content	15
1.	Study of fossils from models/ pictures.	2
2.	Study of homology and analogy from suitable specimens	2
3.	Study and verification of Hardy-Weinberg Law by chi square analysis.(Any three problems)	1
4.	Types of eggs based on quantity and distribution of yolk: Sea urchin, insect, frog , Chick.	2
5.	Study of adaptive radiations in feet of birds and mouth parts of insects.	2
6.	Study of mammalian placenta- Histological and morphological types	2
7.	Chick Embryology: Egg, Sperm, Primitive streak, 24H, 36H and 48 Hours embryo whole mount.	2
8.	Evolution of man- Ramapithecus, Australopithecus, Neanderthal man and Cromagnon man	2

References

1	Ridley, M (2004) Evolution (3rd edition) Black well Publishing
2	Hall, B.K. and Hallgrimson, B (2008) Evolution (4th edition) Jones and Barlett Publishers
3	Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
4	Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings.
5	Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
6	Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi
7	Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).
8	Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences.
9	Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019).

PAPER: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT &CONSERVATION (THEORY)

Program Name	**B.Sc.,**	Semester	**VI**
Course Title	**Environmental Biology, Wildlife Management &Conservations (Theory)**		
Course Code:	DSC**C5 ZOO –T8**	No. of Credits	**4**
Contact hours	**60 Hours**	Duration of SEA/Exam	**2Hours**
Formative Assessment Marks	**40**	Summative Assessment Marks	**60**

Course Pre-requisite(s): Objectives

- **To understand the interaction between the animals and abiotic factors in the environment**
- To use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
- **To** gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.

Course Outcomes (COs): After the successful completion of the course, the student will be able to:

CO1. Develop an understanding of how animals interact with each other and their natural environment.
CO2. Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
CO3.Develop the ability to work collaborative team-based projects.
CO4.Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.
CO5.Develop an ability to analyze, present and interpret wildlife conservation Management in formation.

Course Out comes(COs)/(POs)	**ZOO C5T**	**ZOO C5P**	**ZOO C6T**	**ZOO C6P**	**ZOO C7T**	**ZOO C7P**	DSC**C5 ZOO – T8**	**ZOO C8P**
I Core competency							X	
II Critical thinking							X	
III Analytical reasoning							X	
IV Research skills							X	
V Team work							X	

Contents	**60 Hrs**
Unit-I	**15**
1 **Ecology:** • Introduction to ecology, Definition, ecosystem, trophic levels, food chain and food web. • Aquatic environment (Pond and marine) • Biomes – definition, Terrestrial (Tundra, alpine, forest, tropical savanna, grassland, desert, wetland) • Ecological factors (Biotic and Abiotic)	

Unit-II	15
2. **Pollution:** • Definition, types (air, soil, water and thermal), ozone layer depletion, bioaccumulation, Biomagnification and bioremediation. • Effects of all pollution types on animals and plants	
Unit-III	**15**
3. **Wildlife Conservation:** Causes and depletion of wildlife, Ex-situ and in-situ conservation, National parks, Wildlife sanctuaries, biosphere reserve. Project tiger. Project Elephant, Project Lion, breeding in captivity, Zoological gardens, Wildlife Protection Act 1972.	
Unit-IV	**15**
4. Wildlife Management: Values of wildlife, inventory and classification of wetlands and their biotic components, general strategies and issues, concept of home range, wildlife corridors and territory, animal census, tracing movement and remote sensing and GIS.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs1-15)

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Theory	
Assessment Occasion/type	**Marks**
House Examination/Test	15
Written Assessment/Presentation/Project/Term Papers/Seminars	15
Classroom Performance/ Participation	10
Total	**40Marks**
Formative Assessment as per NEP guidelines are compulsory	

Topics suggested for Continuous Internal Assessment Presentation/ Seminars

- Adaptive features of plants and animals to different environment
- Factors: Weather, Climate, Light, soil, temperature
- Biodiversity- Types, hotspots and methods of preservation

PAPER: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT &CONSERVATIONS (PRACTICAL)

Course Title	**Environmental Biology, Wildlife Management & Conservation (Practicals)**	Practical Credits	**2**
Course Code	DSC**C5 ZOO –P8**	Contact Hours	**4 Hours**
Formative Assessment	**25Marks**	Summative Assessment	**25 Marks**

Course Out comes(COs)/(POs)	**ZOO C5T**	**ZOO C5P**	**ZOO C6T**	**ZOO C6P**	**ZOO C7T**	**ZOO C7P**	**ZOO C8T**	**ZOO C8P**
I Core competency								X
II Critical thinking								X
III Analytical reasoning								X
IV Research skills								X
V Team work								X

Practical Content	**15**
1. **Water quality parameters assessment:** Collection of water sample, Dissolved Oxygen (O_2), Carbon dioxide (CO_2), Biological Oxygen Demand (BOD) Chemical Oxygen Demand (COD), chlorides, Hardness and salinity estimation in water. (Any four)	5
2. **Analysis of physico-chemical parameters of soil:** pH, soil moisture, soil temperature, organic matter in soil.	3
3. Analysis of air pollution: Air monitoring for particulate matter	1
4. Visit of pond and lakes: Collection and identification of fauna of selected ecosystems. Collection, preservation of phytoplanktons, zooplanktons and insect larva.	1
5. Demonstration of field equipments used in wildlife census: Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of cameras and lenses.	2
6. Identification wild animals: Wild animal's pugmarks, hoof marks scars, pellet groups, nest, antlers. Demonstration of field techniques for wild fauna.	1
7. Field visit to nearby National park/ Wildlife sanctuary/ any National laboratory at the end of semester is compulsory and the report of this is to be submitted along with practical record as a part of practical examination.	2

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

Formative Assessment for Practical	
Assessment Occasion/type	**Marks**
House Examination/Test	05
Written Assessment /Presentation/Project/Term Papers/Seminars	10
Classroom Performance /Participation	10
Total	**25Marks**
Formative Assessment asper NEP guidelines are compulsory	

References	
1	Colinvaux, P. A.(1993) Ecology (2nd edition)Wiley, John and Sons, Inc.
2	Krebs,C. J.(2001)Ecology(6th edition) Benjamin Cummings.
3	Odum,E.P., (2008) Fundamentals of Ecology. IndianEdition. Brooks/Cole. (3rd Edition) BlackwellSci.
4	Kendeigh, FC.(1984) Ecology with Special Reference to Animal and Man. Prentice HallInc.
5	Caughley,G. and Sinclair, A.R.E.(1994)Wildlife Ecology and Management. Blackwell Science.
6	Woodroffe,R., Thirgood, S. and Rabinowitz,A. (2005) People and Wildlife, Conflict Or Co-existence? Cambridge University.
7	Bookhout,T.A. (1996) Research and Management Techniques for Wildlife and Habitats (5th edition) The Wildlife Society,Allen Press.
8	Sutherland, W.J. (2000)The Conservation Handbook: Research, Management and Policy. Blackwell Sciences
9	Hunter M.L., Gibbs,J.B. and Sterling,E.J.(2008) Problem solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing

Scheme of Practical Examination

VI Semester

Paper VII: DSCC5 ZOO –P7; Evolutionary and Developmental Biology
(Practical Based on DSC**C5 ZOO –T7)**

Duration: 03 Hours **Max. Marks 25 M**

Practical Examination Scheme

I. Identify and comment on spotters A and B 3X2 = 06M
(Homologous/Analogous organ/Fossil Model) (Any Two)

II. Problem on Hardy-Weinberg Law- Chi square analysis (Problems related to evolution) 04 M

III. Identify and comment on slide C, D and E 3X4 = 12M
(Frog/Chick embryology slides)

IV. Identify and comment on F 03M
(Any one Human fossil)

Scheme of Valuation

I. Identification -01 M; Comments - 02M for each

II. Problem 04 M

III. Identification 01 M; Comment with diagram 03 M

IV. Identification 01M; Comments 02M

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VI Semester

Paper VIII: DSC**C5 ZOO –P8 :Environmental Biology Wildlife Management and Conservation**
(Practical Based on DSC**C5 ZOO –T8)**

Duration: 3 hours **Max. Marks: 25**

I. Estimation of given Water sample for (any one) 12 M
(Dissolved O_2/CO_2/Hardness/Chloride)

II. Detect the Physico-chemical parameter of the soil (any one) 04 M
(pH, Moisture, Soil temperature, Organic matter)

III. Identify and Comment of the spot A & B 3X2 = 06 M
(Zooplanktons & Fauna of any ecosystem).

IV. Identify the spot C 03 M
(Binocular, Compass, Lens, Camera, GPS and Spotting Scope).

Scheme of Valuation

I. Principle and procedure -06 M
Conducting experiments – 04M
Result & Comment - 02M

II. Physical parameter - 03M
Comment - 01M

III. Identification - 01M
Comment - 02 M

IV. Identification - 01M
Comment with Application - 02M

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For B.Sc., III Year V and VI semesters

ZOOLOGY AND ANOTHER SUBJECT AS DOUBLE MAJORS IN THIRD YEAR

Sem	Disp.	Paper Code	Title	C	T	P	Ex	IA	E	T
V	DSC	**C5 ZOO -T5**	Non-chordates and Economic Zoology	4	4		2 hr	40	60	100
		C5 ZOO -P5	Practical Based on Zoo **C5 ZOO -T5**	2		4	3 hr	25	25	50
		C5 ZOO -T6	Chordates and Comparative Anatomy	4	4		2 hr	40	60	100
		C5 ZOO -P6	Practical Based on **C5 ZOO -T6**	2		4	3 hr	25	25	50
VI	DSC	**C5 ZOO -T7**	Evolutionary & Developmental Biology	4	4		2 hr	40	60	100
		C5 ZOO -P7	Practical Based on **C5 ZOO -T7**	2		4	3 hr	25	25	50
		C5 ZOO -T8	Environmental Biology,Wildlife Management & Conservation	4	4		2 hr	40	60	100
		C5 ZOO -P8	Practical Based on **C5 ZOO -T8**	2		4	3 hr	25	25	50

(C: credits; T: theory; P: Practical; Ex: Exam Duration; IA: Internal Assessment; E: Exam marks; T: Total)

Internship Allotment:

Since Double Majors Programme Being Followed in Third Year, Students Can Opt/choose Eighter Zoology Or Another Subject as Internship topic.