


**COURSE CURRICULUM FOR THREE YEAR UG DEGREE/FOUR  
YEAR UG DEGREE (HONOURS WITHOUT RESEARCH)/ FOUR  
YEAR UG DEGREE (HONOURS WITH RESEARCH) IN ZOOLOGY**

**(AS PER NATIONAL EDUCATION POLICY, 2020)**

**Effective from Academic Session 2023-24.**



  
19/06/2023  
संयुक्त कुलसचिव (शैक्षणिक एवं सम्मेलन)  
राजीव गांधी विश्वविद्यालय  
Jt. Registrar (Acad. & Conf.)  
Rajiv Gandhi University  
Rono Hills, Doimukh (A.P.)

**DEPARMENT OF ZOOLOGY  
FACULTY OF LIFE SCIENCES  
RAJIV GANDHI UNIVERSITY  
RONO HILLS, DOIMUKH, ARUNACHAL PRADESH  
Pincode: 791112**

## Introduction


According to the **National Education Policy (NEP) 2020**, higher education is crucial for advancing both individual and societal well-being and for helping India become the democratic, just, socially responsible, cultured, and compassionate nation envisioned in its Constitution, one that upholds liberty, equality, fraternity, and justice for all. This strategy thus advocated for higher education to give students the chance to experience the complete range of holistic and multidisciplinary education in addition to a focus on their chosen major and minor courses in accordance with their preferences. In order for every graduate to have the qualities of a graduate, which include the ability to broaden one's knowledge base and skill set, acquire and apply new knowledge and skills, pursue further education on one's own, succeed in a chosen career, and contribute to society as a responsible citizen. As a result, this policy also advised that the undergraduate program's curriculum should include major stream courses, minor stream courses, multidisciplinary courses (courses from other disciplines), ability enhancement courses, skills enhancement courses (SEC), value-added courses (VAC), and a set of courses on environmental education, language, understanding India, digital and technological solutions, health and wellness, yoga education, and sports.

## Departmental committee for “Drafting UG-Zoology syllabus (as per NEP 2020)”

S.N.	Name and Designation	
1.	Dr. Daniel Mize (Head, <i>in-charge</i> ), Associate Professor	Chairman
2.	Prof. H.N Sarma, Professor	Member
3.	Prof. D.N. Das, Professor	Member
4.	Prof. J. Chakravorty, Professor	Member
5.	Dr. Pankaj Kumar, Associate Professor	Member
6.	Dr. Hiren Gogoi, Assistant Professor	Member
7.	Dr. Gunjan Kumar Saurav, Assistant Professor	Member
8.	Dr. Arnab Ghosh, Assistant Professor	Member

## Board of Studies (BOS) in Zoology

S.N.	Name, Designation and Address	
1.	Dr. Daniel Mize (Head, <i>in-charge</i> ), Associate Professor, Department of Zoology, RGU	Chairman
2.	Prof. H.N Sarma, Professor, Department of Zoology, RGU	Member
3.	Prof. D.N. Das, Professor, Department of Zoology, RGU	Member
4.	Prof. J. Chakravorty, Professor, Department of Zoology, RGU	Member
5.	Mr. M.S. Singh, Assistant Professor, RGU	Member
6.	Dr. Hiren Gogoi, Assistant Professor, RGU	Member
7.	Prof. SumpamTangjang, Professor, Department of Zoology, RGU	Member
8.	Prof. Hui Tag, Professor, Department of Zoology, RGU	Member
9.	Prof. S.R. Hajong, Professor, Department of Zoology, NEHU, Shillong	Member
10.	Prof. Robin Doley, Professor, Department of Molecular Biology and Biotechnology, Tezpur University.	Member
11.	Dr. Prashanta Nanda, Department of Zoology, DNGC, Itanagar	Member

  
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## **Term and conditions for award of UG Certificate/Diploma/Degree/ Degree (honours) with /without Research**

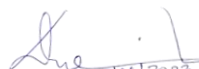
- **UG Certificate:** Students who leave the programme after earning 40 credits will receive a UG Certificate in the relevant discipline/subject provided they earn 6 credits from skill-based courses during the first and second semesters in addition to 4 credits from work-based vocational courses offered during the summer term or internships/apprenticeships.
- **UG Diploma:** Students who leave the programme with 80 credits will receive a UG Diploma in the pertinent discipline or subject. Students must earn 4 credits in skill-based vocational courses given during the first-year or second-year summer terms out of a total of 84 credits.
- **3-year UG Degree:** After successfully completing a three-year UG programme and earning 120 credits, students who choose to do so will be awarded a UG degree in the major discipline.
- **4-year UG Degree (Honours):** Those who complete a four-year degree plan with 160 credits will be given a four-year UG Honours degree in the major discipline.
- **4-year UG Degree (Honours with Research):** Students who complete a four-year degree programme with 160 credits, including 12 credits from a research project or dissertation in the major discipline, will be given a four-year UG Degree in Honours with Research.

## **Other terms and conditions for UG Programme**

- **Summer Internship/Apprenticeship:** All education students pursuing undergraduate certificates, UG diplomas, 3-year degrees, 4-year degrees with honours, and 4-year degrees with honours with research are required to complete a summer internship or apprenticeship. However, it must be finished for UG certificates during the summer break at the end of the second semester, for UG diplomas during the summer break at the end of the first semester or the fourth semester, and for other courses, it must be finished by the end of the fifth semester. From a variety of occupational courses offered in the common structure, the students will choose one for their internship.
- **Selection of Minor course:** The student from other major courses of allied department will be able to take zoology minor courses.
- **Selection of Multidisciplinary course:** Student with major in zoology must choose a multidisciplinary course from the selection offered in the common framework.
- **Selection of Compulsory Value-Added Course:** Zoology students are required to take a value-based course from the selection of value-based courses offered in the common structure.
- **Research at UG Programme:** Undergraduate research can be conducted in the fourth year for students who earned 8.5 CGPA or higher in the first six semesters.
- **For Honours students not undertaking Dissertation in 8<sup>th</sup> semester:** Student with major in zoology who choose not to complete a research project or dissertation must take three 12-credit courses in their place.

- **Exit and re-entry:** Students who have received an undergraduate certificate or undergraduate diploma are eligible for exit from and re-entry into the degree course in education at the second semester (first year) and fourth semester (second year), respectively. However, these students will be permitted to reapply to the degree programme within three years of their withdrawal, and they will be required to finish it within the full seven-year time frame.
- **Credit:** A unit by which the course work is measured. It determines the number of hours of instruction required in a module. As per NEP2020, 1 credit for lecture = 15 hours in a semester (15 weeks), 1 credit for tutorial = 15 hours in a semester (15 weeks) and credit for practical/practicum = 30 hours in a semester (15 weeks)

Course Structure for UG certificate/Diploma/ 3 years degree /4 years degree with honours /honours with research																	
NCrF Credit Level	Sem	Major		Minor		Multidisciplinary Course		Ability Enhancement Course		Skill Enhancement Course		Value-Added Course		Internship/ Research Project		Total Credit	
		Course	Credit	Course	Credit	Course	Credit	Course	Credit	Course	Credit	Course	Credit	Course	Credit		
4.5	1 <sup>st</sup>	Major 1 (ZOO-CC-1110)	4	Minor 1 (ZOO-MC-1110)	4	MDC (ZOO - MD-1110)	3	(Any one of the following) ENG-AE-1110 ** HIN-AE-1120** MIL-AE-1130**	4	SE 1 (ZOO-SE-1110)	3	VAC1*	2	--	--	20	
	2 <sup>nd</sup>	Major 2 (ZOO CC-1210)	4	Minor 2 (ZOO MC-1210)	4	MDC (ZOO - MD-1210)	3	EVS-AE-1210**	4	SE 2 (ZOO-SE-1210)	3	VAC2*	2	--	--	20	
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work-based vocational courses offered during the summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester.																	
5.0	3rd	Major 3 (ZOO - CC-2310)	4	Minor 3 (ZOO -MC-2310)	4	MDC (ZOO - MD-2310)	3	--	--	SEC 3 (ZOO-SE-2310)	3	VAC 3*	2	--	--	20	
		Major 4 (ZOO - CC-2320)	4														
	4th	Major 5 (ZOO - CC-2410)	4	Minor 4 (ZOO -MC-2410)	4	--	--	--	--	--	--	--	--	--	--	--	20
		Major 6 (ZOO - CC-2420)	4														
		Major 7 (ZOO - CC-2430)	4														
Major 8 (ZOO - CC-2440)	4																
Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credits in skill-based vocational courses offered during the first year or second year summer term.																	
5.5	5th	Major 9 (ZOO CC-3510)	4	Minor 5 (ZOO -MC-3510)	4	--	--	--	--	--	--	--	--	--	Internship (INT.-ZOO - 0010)	2	20
Major 10 (ZOO - CC-3520)	4																
Major 11 (ZOO CC-3530)	4																

  
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		Major 12 (ZOO - CC-3540)	2														
	6th	Major 13 (ZOO - CC-3610)	4	Minor 6 (ZOO -MC- 3610)	4	--	--	--	--	--	--	--	--	--	--	--	20
		Major 14 (ZOO - CC-3620)	4														
		Major 15 (ZOO - CC-3630)	4														
		Major 16 (ZOO - CC-3640)	4														

A student may exit this programme and awarded the degree, BACHELOR IN Zoology (B.Sc.), after securing 120 credits from 6 semesters.

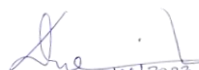
6.0	7th	Major 17 (ZOO - CC-4710)	4	Minor 7 (ZOO -MC- 4710)	4	--	--	--	--	--	--	--	--	--	--	--	20	
			Major 18 (ZOO - CC-4720)															4
			Major 19 (ZOO - CC-4730)															4
			Major 20 (ECO-CC- 4740)															4
		8th	Major 21 (ZOO - CC-4810)	4	Minor 8 (ZOO-MC- 4810)	4	--	--	--	--	--	--	--	--	--	--	--	20
			Major 22 (ZOO - CC-4820)	4														
			Major 23 (ZOO - CC-4830)	4														
			Major 24 (ZOO - CC-4840)	4														

A student may exit this programme and will be awarded the degree, BACHELOR IN ZOOLOGY HONOURS (BSc Hons.) after securing 160 credits from 8 semesters, if the student secure 8.5 CGPA I to VI semester or BACHELOR IN ZOOLOGY HONOURS with RESEARCH (B.Sc.-Hons. with Research) after securing 160 credits from 8 semesters with submission of Project Report / Dissertation, if the student secure more than 8.5 CGPA in I to VI semester.


			94		32		9		8		9		6		2		160
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\* For Value added courses (VAC), the zoology major students must compulsorily undergo the mentioned course offered by others/ specified departments.

\*\* For Ability Enhancement Course (AEC), the zoology major students must compulsorily undergo the mentioned course offered by others/ specified departments.

  
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NCrF level	Semester	Course Code, title and categories	Credit	Total Credit
4.5	1st	Major 1: ZOO-CC-1110- Systematics and Diversity of Protists and Non-Chordates	4	20
		Minor-1: ZOO-MC-1110- Animal Diversity	4	
		Multidisciplinary course-1: ZOO-MD-1110- Freshwater Ornamental fishery	3	
		Ability Enhancement Course-1: ENG-AE-1110 / HIN-AE-1120/MIL-AE-1130	4	
		Skilled Enhancement Course 1: ZOO-SE-0010- Apiculture	3	
		Value added Course 1 ( Courses offered in other departments in same framework)	2	
	2nd	Major 2: ZOO-CC-1210- Cell biology and Histology	4	20
		Minor 2: ZOO-MC-1210- Human Physiology	4	
		Multidisciplinary course 2: ZOO-MD-1210- Dairy Production and Technology	3	
		Ability Enhancement Course 1: EVS-AE-1210- Environmental studies	4	
		Skilled Enhancement Course 2: ZOO-SE-1120- Sericulture	3	
		Value added Course 2( Courses offered in other departments in same framework)	2	
Students exiting the programme after securing 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 4 credits in work-based vocational courses offered during the summer term or internship / Apprenticeship in addition to 6 credits from skill-based courses earned during the first and second semester.				
5.0	3rd	Major 3: ZOO-CC-2310-	4	20
		Major 4: ZOO-CC-2320-	4	
		Minor 3: ZOO-MC-2310-	4	
		Multidisciplinary course 3: ZOO-MD-2310	3	
		Skilled Enhancement Course 1: ZOO-SE-0030	3	
		Value added Course 1: ZOO-VA-0030	2	
	4th	Major 5: ZOO-CC-2410	4	20
		Major 6: ZOO-CC-2420	4	
		Major 7: ZOO-CC-2430	4	
		Major 8: ZOO-CC-2440	4	
		Minor 4: ZOO-MC-2410	4	
		Students exiting the programme after securing 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 4 credits in skill-based vocational courses offered during the first year or second year summer term.		
5.5	5th	Major 9: ZOO-CC-3510	4	20

  
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		Major 10: ZOO-CC-3520	4	
		Major 11: ZOO-CC-3530	4	
		Major 12: ZOO-CC-3540	2	
		Minor 5: ZOO-MC-3510	4	
		Internship/dissertation/seminar	2	
	6th	Major 13: ZOO-CC-3610	4	20
		Major 14: ZOO-CC-3620	4	
		Major 15: ZOO-CC-3630	4	
		Major 16: ZOO-CC-3640	4	
		Minor 6: ZOO-MC-3610	4	
Students who want to undertake a 3-year UG programme will be awarded UG Degree in the relevant Discipline /Subject upon securing 120 credits.				
6.0	7th	Major 17: ZOO-CC-4710	4	20
		Major 18: ZOO-CC-4720	4	
		Major 19: ZOO-CC-4730	4	
		Major 20: ZOO-CC-4740	4	
		Minor 7: ZOO-MC-4710- Research Methodology	4	
	8th	Major 21: ZOO-CC-4810	4	20
		Major 22: ZOO-CC-4820	4	
		Major 23: ZOO-DE-4830	4	
		Major 24: ZOO-DE-4840	4	
		Minor 8: ZOO-MC- 4810- Research publication ethics	4	
		Major course=24, Minor course=8, Multidisciplinary course=3, Ability Enhancement course=2, Skill Enhancement Course=3, Value added course=3 &Intership/dissertation/seminar=1		160



**I Semester**  
**Major Course (CC)**  
**ZOO-CC-1110- Systematics and Diversity of Protists and Non-Chordates**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit1**

**15 Lectures**

Systematics and taxonomy. Species concept, clades. Concept of type specimen, taxidermy and maintenance of museum specimens. Nomenclature and utility of scientific names. Classification: morphological and evolutionary (molecular). Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity

**Unit2**

**15 Lectures**

Structure and diversity in Protists. Origin of Metazoans: Diploblastic and triploblastic organization; symmetries; body cavities; protostomes and deuterostomes. Special features and structural diversity in sponges. Cnidarians: Special features; transition of third germ layer; polymorphism and division of labour; coral reef forming Cnidarians. The Bilateria: Basic characteristics. The acoelomates: Basic organization and adaptive radiations in flatworms.

**Unit3**

**15 Lectures**

Pseudo coelomates; Basic organization and adaptive radiations in roundworms. The coelomates: Basic organization and adaptive radiations in Arthropods- fossil arthropods. Adaptive radiations in Crustaceans, Insects, etc. Basic organization and diversity in Annelids and Molluscs. Canal system in Porifera. Locomotion and locomotory organs of Protozoa, Annelida and Mollusca. Respiratory & circulatory systems of Arthropod. Nervous systems of Mollusca. Larvae in echinoderms and their affinities with chordates. Locomotion system in Echinodermata. Coelom and its modifications in invertebrates.

**Practical**

**Unit 4**

**30 hours**

1. Study of animals through slides and museum specimens in the laboratory with details on their classification, biogeography and diagnostic features.
2. Study of animals in nature during a survey of a National Park or Forest area.
3. Collection of five species (preferably invertebrates, insects) belonging to a clade.
4. A project work on their generic identification, description and illustration with a note on their locality. Also, the assessment of their relationship by constructing a cladogram using characters and character states.
5. Microscopic study of structure of certain protists
6. Study of locomotory organs of protozoa and Annelida
7. Study of Respiratory organs in Arthropoda
8. Study of Nervous system in Mollusca
9. Description of polymorphic cnidarians with division of labour

**Recommended readings:**

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a 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.
4. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
5. Bushbaum, R. (1964) Animals without Backbones. University of Chicago Press.

**I Semester  
Minor Course (MC)  
ZOO-MC-1110- Animal Diversity**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit 1**

**15 lectures**

Kingdom Protista: Diversity concept and General characters and classification up to classes; Locomotory organelles and locomotion in Amoeba and Paramecium; Kingdom Animalia and diversity and forms ; Phylum Porifera- General characters and classification up to classes; Canal System in Sycon; Phylum Cnidaria - General characters and classification up to classes; Metagenesis in Obelia; Phylum Platyhelminthes-General characters and classification up to classes; Life history of *Taeniasolium*; Phylum Nematelminthes-General characters and classification up to classes; Life history of *Ascaris lumbricoides* and its adaptation

**Unit 2**

**15 lectures**

Phylum Annelida- General characters and classification up to classes; Metamerism in Annelida; Phylum Arthropoda-General characters and classification up to classes; Eye in Cockroach, Metamorphosis in Lepidoptera; Phylum Mollusca-General characters and classification up to classes; Respiration in Pila

**Unit 3**

**15 lectures**

Phylum Echinodermata- General characters and classification up to classes; Water vascular system in Asteroidea; Protochordates- General Characters; Pharynx and feeding mechanism in Amphioxus; Agnatha-General features of Agnatha and classification of cyclostomes up to classes; Pisces-General features and Classification up to orders; Osmoregulation in Fishes. Amphibia- General features and Classification up to orders; Parental care; Reptiles-General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism; Aves-General features and Classification up to orders; Flight adaptations in birds; Mammals-Classification up to orders; Hair, Horn & Antler, Nail & claw.

**Practical**

**Unit 4**

**30 hours**

1. Identification with reasons of the following specimens: Amoeba, Euglena, Paramecium, Sycon, Obelia, Aurelia, *Taeniasolium*, *Ascarislumbricoides* (Male and female), Aphrodite, Nereis, Hirudinaria, Palaemon, Cancer, Limulus, Apis, Chiton, Unio, Sepia, Octopus, Echinus, Cucumaria and Antedon, Balanoglossus, Branchiostoma, Petromyzon, Torpedo, *Labeorohita*, *Tor putitora*, *Schizothoraxrichardsoni*, *Exocoetus*, *Salamandra*, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja and Bat.
2. Observation and Key for Identification of poisonous and non-poisonous snakes
3. Study of anatomy of digestive system, salivary gland, mouth parts of Periplaneta
4. Study of reproductive system of female cockroach

**Recommended Readings:**

1. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W.; Spicer, J. I. (2002) The Invertebrates: a 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.
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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 Backbones. University of Chicago Press.
7. Young, J.Z. (2004). The Life of Vertebrates .III Edition. Oxford university press.
8. Jordan, E. L. and Verma, P. S. (2015) Chordate Zoology (14th edition).
9. Ganguly, Sinha and Adhikari. Biology of Chordates.
10. Kotpal, R.L. Vertebrates. Rastogi Publications
11. Jordan P.Nigam. Chordates. S.Chand
12. Jordan, E. L. and Verma, P. S. (2015) Chordate Zoology (14th edition).

**I Semester**  
**Multidisciplinary Course (MDC)**  
**ZOO-MD-1110- Aquaculture**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	02	Theory:	30
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	03	Total:	60

**Theory**

**Unit 1**

**15 Lectures**

Design and construction of aquaria and its accessories. Water quality management in aquarium systems and plants for Aquarium. Identification and biology of Important Fresh water and indigenous ornamental fishes. Sexual dimorphism in ornamental fishes. Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio.

**Unit 2**

**15 Lectures**

Brood stock management- selection of brooders, maintenance and management of brood stocks. Modern breeding techniques. Colour enhancement techniques. Food and feeding habits of ornamental fishes. Preparation and culture of live feed (Artemia, Infusoria, Spirulina). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes and its symptoms, treatment and prophylactic measures.

**Practical**

**Unit 3**

**30 hours**

1. Identification of common aquarium fishes
2. Groupings of light-bearers and egg-scatterer ornamental fish
3. Physico-chemical analysis of aquarium water
4. Identification of aquarium plants
5. Culture of live fish food and use of commercial formulated feed
6. Aquarium management using aquarium devices

**Recommended readings:**

1. Axelord, H.R. (1967). Breeding aquarium fishes, T F H Publications.
2. Mills, D. (1981). Aquarium Fishes, Arco publishing.
3. Mills, D. and Vevers, G. (1982). The Practical encyclopedia of fresh water, Tropical Aquarium fishes, Salamander Books limited, London.
4. Gahlawat, S.K., et.al. (2007). Manual of experimental Ichthyology, Daya publishing House, Delhi.
5. Brunner, G. (1973). Aquarium plants, T F H Publications, Inc. Ltd., Hongkong.
6. Hansen, J. (1979). Making your own aquarium, Bell and Hyman Ltd., London.
7. Lovell, T. (1998). Nutrition and feeding of fish second Ed. Kluwer Academicpublishers.
8. Talwar, P.K., and Jhingran, A.G. (1991). Inland fishes Oxford and IBH PublishingCo.,New Delhi.

**I Semester**  
**Skill Enhancement Course (SEC)**  
**ZOO-SE-1110- Apiculture**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Internal assessment :	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit 1**

**20 lectures**

Systematics and Beekeeping , Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Extent of Beekeeping in India, Limitations on the development of beekeeping, Advantages of extensive Beekeeping.

**Unit 2**

**25 lectures**

Beekeeping equipments: Bee box and tools, how to manage a colony, the manipulation of a colony. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. taking care of bee diseases and enemies, Routine management, Harvesting and marketing of bee products. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping.

**Practical**

**Unit 3**

**30 hours**

1. Identification of honey bees: *Apis laboriosa*, *Apis dorsata*, *Apis cerana*, *Apis mellifera*, *Apis florea* and *Apis andreniformes*
2. Identification of comb of honey bees.
3. Detailed study of wing venation, legs and antenna of *Apis cerana* and *Apis mellifera*.
4. Identification of different parts of movable beehive and beekeeping equipments.
5. Identification of major pollen and nectar plants.
6. Demonstration of swarm capture and honey harvesting.
7. Field visit to govt/ private Apiculture farm to understand the beekeeping.

**Recommended readings**

1. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal , D. (2015) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.

**II Semester**  
**Major Course (CC)**  
**ZOO-CC-1210- Cell Biology and Histology**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit 1**

**15 Lectures**

Cell biology, its scope in modern perspective. Cell theory and its modern version and interpretation. General structure of prokaryotes, bacteria, archaea and eukaryotes. Extra nuclear cell organelles: Ultrastructure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes. Mitochondria: Origin, structure, composition, genome organization and function. Cytoskeleton: composition and functions; microtubules and microfilaments. Nucleus: size, shape, structure and functions of interphase nucleus. Types of chromosome; Giant chromosome – Polytene & lampbrush. Ultrastructure of nuclear membrane and pore complex. Nucleolus: general organization, chemical composition and functions, nuclear sap/ nuclear matrix, nucleocytoplasmic interactions.

**Unit 2**

**15 Lectures**

Cell membrane organization: cell membrane: origin, structure, composition, models and function. Fluid mosaic model. Lipid Composition, inner and outer leaflets. Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins. Junctional complexes, membrane receptor modifications: microvilli, desmosomes and plasmodesmata. Transport across membrane: diffusion and osmosis. Active and passive transport, endocytosis and exocytosis Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Programmed cell death (Apoptosis). Cell regulation and Cell signaling: Signaling molecules and their receptors. Functions of cell surface receptors. Regulation of signaling pathways.

**Unit 3**

**15 Lectures**

Introduction to tissues. Epithelial tissue: types, structure and characteristics. surface modifications. Connective tissue cells. Structure and function of loose, dense and adipose tissue. Cartilage and bone: classification, and fine structure. Blood: plasma, blood cells, lymph – their structural and functional. Muscular tissue: ultrastructure of smooth, skeletal and cardiac muscles. Structure and classification of neurons. Types of supporting (glial) cells and their function. Myelin sheath and its formation.

**Practical**

**Unit 4**

**30 hours**

1. Study of prokaryotic and eukaryotic cell types with the help of chart, slide and video.
2. Disruption of cells, isolation and identification of subcellular components, isolation of nuclei (Demonstration).
3. Chromosome segregation in mitosis and meiosis.
4. Preparation of polytene chromosome from *Drosophila/Chironomus* larvae
5. Preparation of mitotic chromosome from Onion root tips
6. Preparation of chromosome squashes from grasshopper/cockroach testes for the observation of stages of meiosis.
7. Study of types of tissue through permanent slides: epithelial, connective, muscular, nervous etc.
8. Study of histology of tissues by preparing permanent stained slides through microtomy.

**Recommended readings**

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach. (5th edition) ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M.; Kleinsmith, L.J.; Hardin. J. and Bertoni, G. P. (2009) The World of the Cell. (7th edition) Pearson Benjamin Cummings Publishing, San Francisco.

**II Semester  
Minor Course (MC)  
ZOO-MC-1210- Animal Physiology**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit 1**

**15 Lectures**

Digestive glands: Structure and function. Digestion and absorption of nutrients: carbohydrates, fats and proteins. Neural and hormonal control of digestion. Excretory system: Functional anatomy of kidney. Mechanism of excretion and regulation of urine formation.

**Unit 2**

**15 Lectures**

Structure of smooth, skeletal and cardiac muscles. Neuromuscular junction. Mechanism of muscle contraction. Respiration: Ventilation, External and internal respiration. Transport of carbon dioxide and oxygen in blood and tissues. Factors affecting gaseous transport.

**Unit 3**

**15 Lectures**

Structure of heart. Coordination of heartbeat; control of heart beat (neural and hormonal) Blood cells and blood vessels. Cardiac cycle. ECG. Lymph and lymph vessels. Endocrine and reproductive physiology. Structure and function of endocrine glands viz., pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries and testes. Processes of spermatogenesis and oogenesis. Fertilization and implantation. Menstrual cycle. Pregnancy and Parturition.

**Practical**

**Unit 4**

**30 hours**

1. Temporary mount preparation of Neurons and Blood film.
2. Preparation of haemin and haemochromogen crystals.
3. Haemoglobin estimation using Sahli's haemoglobinometer.
4. Study of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, adrenal, kidney, thyroid, pancreas, testis, ovary.

**Recommended readings:**

1. Tortora, G.J. and Derrickson, B.H. (2009) Principles of Anatomy and Physiology (15<sup>th</sup> edition) John Wiley and Sons, Inc.
2. Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander's Human Physiology (9th edition) McGraw Hill.
3. Guyton, A.C. and Hall, J.E. (2011) Textbook of Medical Physiology (15th edition) Harcourt Asia Pvt. Ltd/ W.B. Saunders Company.
4. Marieb, E. (1998) Human Anatomy and Physiology (4th edition) Addison-Wesley.
5. Kesar, S. and Vashisht, N. (2007) Experimental Physiology, Heritage Publishers.

**I I Semester**  
**Multidisciplinary Course (MDC)**  
**ZOO-MD-1210- Dairy Production and Technology**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Theory**

**Unit 1**

**25 Lectures**

Breed selection: Breeds of cattle and buffalo, Native cow varieties, Indian exotic breeds their popularity and performance. Source of Feed and its composition– nutrients for milk production, Water Energy, Protein, Fibre, Vitamins, Energy and digestibility. Distribution map of dairy farming areas/ major milk producing regions in India. Dairy Products (Milk, cheese, yoghurt, gluten etc) and their nutritive value.; Dairy farm planning Management. Managing Dairy Cattle and its Housing and health. Cooling strategies, Cow comfort Management; Cleaning Management. Animal signs Management. Dairy herd Management and growth; Cow health and reproductive performance.

**Unit 2**

**20 lectures**

Breeding Dairy Cattle. Artificial insemination and conception; Maternity management, The Lactation Cycle. Calf management, Calf diseases; Common management procedures. Vaccination, dehorning, weaning etc. Milking Management. Gathering cow for milking; Milking machines for smallholders; cleaning and sanitizing dairy equipment; Milking procedure. Dry cow therapy; Milk filtration Management. Milking Hygiene; Post-harvest milk quality. Dairy business profit strategies. Common disorders in Dairy Cattle. Mastitis, metabolic disorders, hypermagnesemia, ketosis and fatty liver, Ruminant acidosis, metritis; Hoof management. Manure-handling. Cow Longevity; Dairy buffalo Production Management, Biosecurity; Farm level economics affecting productivity and profitability.

**Practical**

**Unit 3**

**30 hours**

1. Studying various breeds of cattle
2. Process of Setting up of a Dairy farm
3. Study preparation of various milk products Cheese, yogurt, gluten etc

**Recommended readings:**

1. Klaus, A. J. (2015) Dairy Farming: The Beautiful Way
2. Leitch, A. (2018) The Dairy Farm: Dairy Cattle Methods, and Dairy Farm Management

**I I Semester**  
**Ability Enhancement Course**  
**EVS-AE-1210: ENVIRONMENTAL STUDIES**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	04	Theory:	60
Assignment/sessional exam:	20	Practical:	00	Practical:	00
Total:	100	Total:	04	Total:	60

**Unit 1**

**15 Lectures**

Environment: Definition, scope and importance; Physical and biological components of environment and their interactions; Multidisciplinary nature of environmental studies. Ecosystem concept, Ecosystem structure, function and services.

**Unit 2**

**15 Lectures**

Land as a resource, land degradation, soil erosion and desertification, Forest Resources and their utilization, Deforestation - causes and impacts on environment; Water resources, Use and overexploitation of surface and ground water; Energy Resources, Renewable and non-renewable energy sources, growing energy needs and use of alternate energy sources.

**Unit 3**

**15 Lectures**

Biodiversity: Definition, levels (genetic, species and ecosystem diversity) and values; Biogeographic zones of India; Biodiversity hot spots. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**Unit 4**

**15 Lectures**

Environmental pollution: types, causes, effects and controls of air, water, soil, and noise. Global environmental issues: Climate change, ozone layer depletion, and desertification. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Convention on Biological Diversity (CBD) and Nagoya Protocol; Convention on Climate Change, and Paris agreement.

**Recommended readings:**

1. Acar, S., Yeldan, A.E. (2019). Handbook of Green Economics. Elsevier Science. Netherlands.
2. Ahluwalia, V.K. Environmental Studies. 2nd Ed. TERI Press.
3. Ambasht, R. S. and Ambasht, N.K. 2017. A textbook of Plant Ecology. 15th Ed. CBS Publishers and Distributors, New Delhi.
4. Ambasht, R. S. and Ambasht, P.K. 2017. Environment and Pollution an Ecological Approach 5th Ed. CBS Publisher and Distributors. Bharucha, E. 2020. Textbook for Environmental Science for undergraduate students. University Grants Commission, New Delhi.
5. Gupta Abhik and Gupta Susmita. 2021. Environmental Studies: Principles and Practices. 344 pages, SAGE Texts.
6. Kaushik Anubha and Kaushik, C.P. 2018. Perspectives in Environmental Studies. 6 th Ed. New Age International Pvt. Ltd.
7. Krishnamurthy, K. V. 2020. An advanced textbook on Biodiversity: Principles and Practice. CBS Publisher and Distributors
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
9. Zhou, S. W. W. (2020). Carbon Management for a Sustainable Environment. Germany: Springer International Publishing.



**I Semester**  
**Skill Enhancement Course (SEC)**  
**ZOO-SE-1210- Sericulture**

Marks		Credits		Contact hours	
End semester exam:	80	Theory:	03	Theory:	45
Assignment/sessional exam:	20	Practical:	01	Practical:	30
Total:	100	Total:	04	Total:	75

**Unit 1**

**25 Lectures**

Mulberry and non-mulberry Sericulture. Silkworm rearing technology. Types of mountages, Spinning, harvesting and storage of cocoons. Sericulture Types- natural and synthetic fibres- types of silk produced in India; Importance of mulberry silk. Silk industry in different states, potential in mulberry and non- mulberry sericulture.

**Unit 2**

**20 Lectures**

Introduction and classification of silkworm diseases, Protozoan disease, Bacterial, Viral and Fungal diseases: causative agents, symptoms, transmission prevention and control. Employment generation in sericulture: Role of women in sericulture

**Practical**

**Unit 3**

**30 Hours**

1. Identification of moths of mulberry and non-mulberry silkworms.
2. Identification of host plants of silkworms.
3. Identification of cocoons of silkworms
4. Identification of different larval stages of silkworms
5. Diagnosis of diseases of silkworm.
6. Demonstration of rearing technique of silkworms.
7. Demonstration of silk-reeling and spinning
8. Field visit to govt/ private sericulture farm to understand the silk production.

**Recommended readings:**

1. Manual on sericulture (1976). Rome: Food and Agriculture Organization of the United Nations, Agricultural Services Division.
2. Ullal, S.R. and . Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore.
3. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore.
4. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) FuziPub. Co. Ltd., Tokyo, Japan.
6. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production, CSB, Bangalore.
7. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore.

**DEPARTMENT OF ZOOLOGY  
RAJIV GANDHI UNIVERSITY  
RONO HILLS, DOIMUKHII**

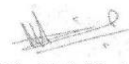
A meeting (online) of Board of studies (BOS) of department of zoology was held on 24<sup>th</sup> June 2023 to discuss and finalize the course curriculum for three year UG degree/ four year UG degree (honours without research / honours with research in Zoology as per National Education Policy, 2020. The following members attended the meeting:

- |  |                   |
|--|-------------------|
| 1. Dr. Daniel Mize, Head (i/c)                                     | : Chairman        |
| Department of Zoology, Rajiv Gandhi University                     |                   |
| 2. Prof. H. N. Sarma   | Member            |
| Department of Zoology, Rajiv Gandhi University                     |                   |
| 3. Prof. D. N. Das   | : Member          |
| Department of Zoology, Rajiv Gandhi University                     |                   |
| 4. Prof. Jharna Chakravorty  | . Member          |
| Department of Zoology, Rajiv Gandhi University                     |                   |
| 5. Prof. Robin Doley   | . External member |
| Department of Molecular Biology & Biotechnology, Tezpur University |                   |
| 6. Prof. S. R. Hajong  | External Member   |
| Department of Zoology, North Eastern Hill University               |                   |
| 7. Prof. SumpamTangiang  | Cognate Member    |
| Department of Botany, Rajiv Gandhi University                      |                   |
| 8. Prof. Hui Tag   | . Cognate member  |
| Department of Botany, Rajiv Gandhi University                      |                   |
| 9. Mr. M. S. Singh   | : Member          |
| Department of Zoology, Rajiv Gandhi University                     |                   |
| 10. Dr. Hiren Gogoi,   | : Member          |
| Department of Zoology, Rajiv Gandhi University                     |                   |

In the meeting, the chairman placed the 1<sup>st</sup> and 2<sup>nd</sup> semester draft syllabus of UG programme in Zoology recommended by Department Research Committee (DRC) before the members for discussion and finalization of the syllabus. In the meeting, the draft syllabus was discussed in detail and all the members gave inputs and suggestions to finalize the 1<sup>st</sup> and 2<sup>nd</sup> semester syllabus for BSc in Zoology. Thereafter, the members unanimously resolved to recommend the finalized syllabus to Rajiv Gandhi University authority for approval.

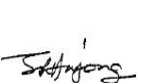
The meeting was ended with vote of thanks by the chairman


  
Dr. Hiren Gogoi  
Member


  
Mr. M. S. Singh  
Member


  
Prof. Hui Tag  
Cognate Member

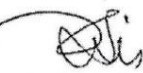
  
Prof. Sumpam Tangiang  
Cognate Member


  
Prof. S.R. Hajong  
External Member

  
Prof. Robin Doley  
External Member

  
Prof. Jharna Chakravorty  
Member

  
Prof. D.N. Das  
Member

  
Dr. H. N Sarma  
Member

  
Dr. Daniel Mize  
Chairman