Syllabus For

Four-Year Undergraduate Programme (FYUGP)

As per Provisions of NEP-2020

Zoology

(Major, Advance Major, Minor from Discipline, Minor from Vocational and MDC)

Effective from Session 2022-26 (Sem-III onwards), 2023-27 and 2024-28

For

All Constituents / Affiliated Colleges Under

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY,

DHANBAD, JHARKHAND

MEMBERS OF BOARD OF STUDIES OF UNDER GRADUATE (FYUGP)-NEP 2020 SYLLABUS OF BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY

Effective from session 2023 onwards and Session 2022 Semester III onwards.

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INDEX

S. No.	Topic/Title	Page No.
Part-I	**Summary of Curriculum Framework and Credit System**	**1**
1	Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand	**2**
2	Table 2: Courses of Study for Four-Year Undergraduate Programme (FYUGP) with Honours/Honours with Research	**3-5**
3	Table 3: Marks Distribution	**5**
4	Table 4: List of Major and Advance Major Paper for Zoology	**6**
5	Table 5: List of Minor from Discipline and Vocational Paper in Zoology	**7**
Part-II	**Syllabus for Major (MJ) and Advance Major (AMJ) for Zoology**	**8**
6	Major Paper Semester-I (MJ-1)	**9-11**
7	Major Paper Semester-II (MJ-2 & MJ-3)	**12-16**
8	Major Paper Semester-III (MJ-4 & MJ-5)	**17-20**
9	Major Paper Semester-IV (MJ-6, MJ-7 & MJ-8)	**21-28**
10	Major Paper Semester-V (MJ-9, MJ-10 & MJ-11)	**29-34**
11	Major Paper Semester-VI (MJ-12, MJ-13, MJ-14 & MJ-15)	**35-43**
12	Major Paper Semester-VII (MJ-16, MJ-17, MJ-18 & MJ-19)	**44-52**
13	Major and Advance Major Paper Semester-VIII (MJ-20, AMJ-1, AMJ-2 & AMJ-3)	**53-59**
Part-III	**Syllabus for Minor from Discipline (Zoology)**	**60**
14	Minor from Discipline Semester I/II (MN-1A)	**61-63**
15	Minor from Discipline Semester III/IV (MN-1B)	**64-66**
16	Minor from Discipline Semester V/VI (MN-1C)	**67-69**
17	Minor from Discipline Semester VII/VIII (MN-1D)	**70-72**
Part-IV	**Syllabus for Minor from Vocational (Zoology)**	**73**
18	Minor from Vocational Semester-II (MN-2A)	**74-76**
19	Minor from Vocational Semester-IV (MN-2B)	**77-79**
20	Minor from Vocational Semester-VI (MN-2C)	**80-83**
21	Minor from Vocational Semester-VIII (MN-2D)	**84-86**
Part-V	**Multi-Disciplinary Course (MDC)**	**87**
22	Multi-Disciplinary Course Semester-I/II/III (Zoology MDC-1/2/3)	**88-90**
Part-VI	**Appendix**	**91**
23	Appendix-I: Question Paper Format	**92-94**

PART-I

Summary of NEP-2020 Curriculum and Credit Framework for Four-Year Undergraduate Programme (FYUGP) with Honours/Honours with Research

Note: For updated and detailed curriculum framework, regulations and guidelines check University FYUGP (NEP-2020) Guideline

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 160]

Level of Courses	Semester	MJ: Discipline Specific Courses – Core or Major (80)	MN: Minor from discipline (16)	MN: Minor from vocational (16)	MDC: Multidisciplinary Courses [Life sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	AEC: Ability Enhancement Courses (Modern Indian Language and English) (6)	SEC: Skill Enhancement Courses (9)	VAC: Value Added Courses (6)	IAP: Internship/ Dissertation (4)	RC: Research Courses (12)	AMJ: Advanced Courses in lieu of Research (12)	Credits	Double Major (DMJ)
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	I	4	4		3	2	3	4				**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/ Project (4 credits)												
200-299: Intermediate-level courses	III	4+4	4		3	2	3					**20**	4+4
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma provided with Summer Internship in 1st or 2nd year/ Project (4 credits)												
300-399: Higher-level courses	V	4+4+4.	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	VII	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Hons. with Research											**160**	**224**

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation.

Table 2: Courses of Study for Four-Year Undergraduate Programme (FYUGP) with Honours/Honours with Research

Sem	Code	Paper	Credit	Full Marks
I	AEC-1	Academic Enhancement Course-1: Hindi/English	2	50
	VAC-1	Value Added Course-1	4	100
	SEC-I	Skill Enhancement Course-1	3	75
	MDC-1	Multi-disciplinary Course-1	3	75
	MN-1A	Minor from Discipline-1	4	100
	MJ-1	Major Paper-1	4	100
II	AEC-2	Academic Enhancement Course-2: - English/Hindi	2	50
	SEC-2	Skill Enhancement Course-2	3	75
	MDC-2	Multi-disciplinary Course-2	3	75
	MN-2A or MN-1A	Minor from Vocational or Discipline-2	4	100
	MJ-2	Major Paper-2	4	100
	MJ-3	Practical-I based on MJ-1 & MJ-2 (Major-3)	4	100
III	AEC-3	Academic Enhancement Course-3: Hindi/English/ Urdu/Bangla/TRL	2	50
	SEC-3	Skill Enhancement Course-3	3	75
	MDC-3	Multi-disciplinary Course-3	3	75
	MN-1B	Minor from Discipline-1	4	100
	MJ-4	Major Paper-4	4	100
	MJ-5	Practical based on MJ-4 (Major Paper-5)	4	100
IV	AEC-3	Academic Enhancement Course-4: Hindi/English/ Urdu/Bangla/TRL	2	50
	VAC-2	Value Added Course-2	2	50
	MN-2B/MN-1B	Minor from Vocational or Discipline-2	4	100
	MJ-6	Major Paper-6	4	100
	MJ-7	Major Paper-7	4	100
	MJ-8	Practical based on MJ-6 & MJ-7 (Major Paper-8)	4	100
V	MN-1C	Minor from Discipline-1	4	100
	MJ-9	Major Paper-9	4	100
	MJ-10	Major Paper-10	4	100
	MJ-11	Practical based on MJ-9 & MJ-10 (Major Paper-11)	4	100
	IAP	Internship/Apprenticeship/Field Work/Dissertation/ Project	4	100

VI	MN-2C/MN-1C	Minor from Vocational/Discipline-2	4	100
	MJ-12	Major Paper-12	4	100
	MJ-13	Major Paper-13	4	100
	MJ-14	Major Paper-14	4	100
	MJ-15	Practical based on MJ-12, 13 & 14 (Major Paper-15)	4	100
VII	MN-1D	Minor from Discipline-1	4	100
	MJ-16	Major Paper-16	4	100
	MJ-17	Major Paper-17	4	100
	MJ-18	Major Paper-18	4	100
	MJ-19	Practical based on MJ-16, 17 & 18 (Major Paper-19)	4	100
VIII	MN-2D or MN-1D	Minor from Vocational or Discipline-2	4	100
	MJ-20	Major Paper-20	4	100
	RC* or	Research Courses - Research Internship/Field Work/Dissertation	12/	300/
	AMJ-1	Advance Major-1	4	100
	AMJ-2	Advance Major-2	4	100
	AMJ-3	Practical based on AMJ-1 & 2 (Advance Major-3)	4	100
		Total Credit =	160	

*Note: Honours students not undertaking research will do 3 courses (AMJ) for 12 credits in lieu of a Research project/Dissertation.

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आवश्यक सूचना

विषय - FYUGP (Four Year Under Graduate Programme) पाठ्यक्रम से संबंधित।

- **Minor from Discipline (MN-1) और Minor From Vocational (MN-2) -**

समसत्र	विषय
समसत्र – I	MN-1a
समसत्र – II	MN-2a / MN-1a
समसत्र – III	MN-1b
समसत्र – IV	MN-2b/ MN-1b
समसत्र – V	MN-1c
समसत्र – VI	MN-2c/ MN-1c
समसत्र – VII	MN-1d
समसत्र – VIII	MN-2d/ MN-1d

टिप्पणी

1. यदि छात्र समसत्र -2 में Minor From Vocational का चयन करते है तो वे अपने संकाय से MN-2a विषय/पत्र का चयन करेंगे और पढ़ेंगे।
   यदि छात्र Discipline 2 का चयन करते है तब भी अपने संकाय के MN-1a का चयन करेंगे। समसत्र I में पढे MN-1a पत्र का चयन नहीं करेंगे
2. जो विषय मेजर में पढ़ रहे उसका भी चयन Minor विषय के रूप में नहीं करेंगे। किन्तु Minor विषय अपने संकाय का ही होना चाहिए।
3. सेमेस्टर-1 और सेमेस्टर-2 में रखे विषय / पत्र को ही छात्र आगे के समसत्र में पढ़ेंगे।

- **Ability Enhancement Courses (AEC)** – AEC पत्र समसत्र I से समसत्र – IV तक पढ़ना है। छात्र- छात्राएं AEC पत्र का चयन निम्नलिखित तालिका के अनुसार करेंगे –

समसत्र	विषय	टिप्पणी
समसत्र – I	हिन्दी या अंग्रेजी	यदि छात्र ने समसत्र – I में हिन्दी विषय का चयन किया है तो समसत्र – II में अंग्रेजी विषय का चयन करेंगे।
समसत्र – II	अंग्रेजी या हिन्दी	
समसत्र – III	अंग्रेज/ हिन्दी/ उर्दू / बांग्ला / क्षेत्रीय भाषा	समसत्र III में जिस विषय का चयन छात्र करेंगे वही समसत्र IV में भी पढ़ेंगे।
समसत्र – IV		

- **Value Added Courses (VAC)** – विश्वविद्यालय द्वारा इस पत्र हेतु तीन विषयों को विकल्प के रूप में रखा है, यह सेमेस्टर-I और सेमेस्टर-IV में पढ़ना है। विवरणी तालिका अनुसार है –

समसत्र	विषय	टिप्पणी
समसत्र – I	1. Understanding India or 2. Health & Wellness, Yoga Education, Sports & Fitness	छात्र इन दो विषयों में से किसी एक का चयन करेंगे।
समसत्र – IV	1. Environment Studies	

समसत्र – 1 की परीक्षा पद्धति निम्नवत होगी –
प्रश्न प्रकार – बहुविकल्पी प्रश्न, प्रश्न संख्या – 50, पूर्णांक – 100, अंक वितरण – 2 अंक प्रतिप्रश्न होंगे, समयावधि – 3 घंटा ।
समसत्र – 4 की परीक्षा पद्धति निम्नवत होगी –
प्रश्न प्रकार – बहुविकल्पी प्रश्न, प्रश्न संख्या – 50, पूर्णांक – 50 , अंक वितरण – 1 अंक प्रतिप्रश्न होंगे, समयावधि – 2 घंटा ।

- **Skill Enhancement Courses (SEC)** - इस पत्र के लिए दो विषय का विकल्प विश्वविद्यालय द्वारा तैयार किया गया है जिसे छात्र को समसत्र I से III तक पढ़ना है।
  1) Digital Education
  or
  2) Mathematical and Computational Thinking & Analysis
  छात्र उपर्युक्त में से कोई एक विषय तीनों समसत्र में पढ़ेंगे।

- **Multidisciplinary Courses (MDC)** – इस पत्र को प्रथम तीन समसत्र (I से III) तक छात्रों को पढ़ना है , तीनों समसत्र में अलग अलग विषय का चयन करना है। यह पत्र कक्षा 12 वीं में पढ़े विषय से भिन्न होनी चाहिए।

Table 3: Marks Distribution *(Pass Marks shown in bracket)*

Subject		Semester	Credit	Full Marks	Theory		Practical*
					End Semester	Internal	End Semester
Major (MJ) Theory Paper		All	4	100	75 (30)	25 (10)	-
Major (MJ) Practical Paper		All	4	100	-	-	100 (40)
Advance Major (AMJ) Theory		VIII	4	100	75 (30)	25 (10)	-
Advance Major (AMJ) Practical		VIII	4	100	-	-	100 (40)
Minor from Discipline (MN-1)		All	4	100	60 (24)	15 (6)	25 (10)
Minor from Vocational (MN-2)		II, IV, VI, VIII	4	100	75 (30)	-	25 (10)
Ability Enhancement Courses (AEC)		I-IV	2	50	50 (20)	-	-
Value Added Courses (VAC)		I	4	100	100 (40)	-	-
		IV	2	50	50 (20)	-	-
Skill Enhancement Courses (SEC)		I-III	3	75	75 (30)	-	-
Multi-disciplinary Course (MDC)		I-III	3	75	75 (30)	-	-
Research Courses (RC)	Research Methodology	VIII	4	100	75 (30)	25 (10)	-
	Synopsis, Thesis & Others		8	200	200 (80)	-	-

**There is no internal exam in practical*

Table 4: List of Major (MJ) and Advance Major (AMJ) Paper for Zoology

Sem	Code	Paper	Credit	Full Marks
I	MJ-1 (Theory)	Systematic & Diversity of Non-Chordates	4	100
II	MJ-2 (Theory)	Systematic & Diversity of Chordates	4	100
	MJ-3 (Practical)	Practical-I based on MJ-1 & MJ-2	4	100
III	MJ-4 (Theory)	Cell Biology & Basics of Microbiology	4	100
	MJ-5 (Practical)	Practical-II based on MJ-4	4	100
IV	MJ-6 (Theory)	Biochemistry & Genetics	4	100
	MJ-7 (Theory)	Mammalian Physiology & Endocrinology	4	100
	MJ-8 (Practical)	Practical-III based on MJ-6 & MJ-7	4	100
V	MJ-9 (Theory)	Evolution & Population Genetics	4	100
	MJ-10 (Theory)	Immunology	4	100
	MJ-11 (Practical)	Practical-IV based on MJ-9 & MJ-10	4	100
VI	MJ-12 (Theory)	Human Reproductive system & Developmental Biology	4	100
	MJ-13 (Theory)	Ecology & Toxicology	4	100
	MJ-14 (Theory)	Economic Zoology	4	100
	MJ-15 (Practical)	Practical-V based on MJ-12, MJ-13 & MJ-14	4	100
VII	MJ-16 (Theory)	Animal Behaviour	4	100
	MJ-17 (Theory)	Applied Medical Zoology (with reference to Human Diseases)	4	100
	MJ-18 (Theory)	Biostatistics & Introductory Bioinformatics	4	100
	MJ-19 (Theory)	Practical-VI based on MJ-16, MJ-17 & MJ-18	4	100
VIII	MJ-20 (Theory)	Tools and Techniques in Biological Science	4	100
	AMJ-1 (Theory)	Molecular Biology & Biotechnology	4	100
	AMJ-2 (Theory)	Wildlife and Biodiversity Conservation & Sustainable Development	4	100
	AMJ-3 (Practical)	Practical based on AMJ-1 & AMJ-2	4	100

Table 5: List of Minor from Discipline and Vocational Paper in Zoology

Sem	Code	Paper	Credit	Full Marks
I	MN-1A (Minor from Discipline-1)	Animal Classification & Diversity and Cell Biology	4	100
II	MN-2A (Minor from Vocational) or	Apiculture – Entrepreneurship in Bee-Keeping	4	100
	MN-1A (Minor from Discipline-2)	Animal Classification & Diversity and Cell Biology		
III	MN-1B (Minor from Discipline-1)	Genetics, Ecology and Evolution	4	100
IV	MN-2B (Minor from Vocational) or	Aquaculture and Fishery	4	100
	MN-1B (Minor from Discipline-2)	Genetics, Ecology and Evolution		
V	MN-1C (Minor from Discipline-1)	Biochemistry, Physiology & Endocrinology	4	100
VI	MN-2C (Minor from Vocational) or	Vermiculture and Vermicomposting Technology	4	100
	MN-1C (Minor from Discipline-2)	Biochemistry, Physiology & Endocrinology		
VII	MN-1D (Minor from Discipline-1)	Developmental Biology, Animal Behaviour and Economic Zoology	4	100
VIII	MN-2D (Minor from Vocational) or	Agrochemical and Pest Management	4	100
	MN-1D (Minor from Discipline-2)	Developmental Biology, Animal Behaviour and Economic Zoology		

Note: If subject for Minor from Discipline-1 is opted as Zoology, the same subject (Zoology) cannot be opted as Minor from Discipline-2.

MDC in Zoology

Sem	Code	Paper	Credit	Full Maks
I/II/III	MDC-1/2/3	MDC in Zoology	3	75

Note: For detailed curriculum framework, regulations and guidelines check University FYUGP (NEP-2020) Guideline

Part-II

Syllabus for

Major and Advance Major

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester I

Major-1 (MJ-1): Systematics and Diversity of Non-Chordates
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to non - chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

Units	Topics	No. of Periods
1	**Systematics (Animal Taxonomy):** 1.1 Acoelomate and Coelomate 1.2 Protostomes and Deuterostomes	4

	1.3 Bilateria and Radiata 1.4 Onychophora and Hemichordates	
2	**Protozoa:** 2.1 General Features and Life history of *Paramecium*, *Plasmodium* and *Leishmania* 2.2 Nutrition 2.3 Reproduction	**8**
3	**Porifera:** 3.1 Canal System in Sponges 3.2 Skeleton	**5**
4	**Coelenterata:** 4.1 Structure, Life Cycle & Metagenesis in *Obelia* 4.2 Polymorphism in *Syphonophora* 4.3 Coral reefs and their formation	**8**
5	**Platyhelminthes:** 5.1 General features and life history of *Fasciola and Taenia* and their pathogenicity 5.2 Parasitic adaptation	**6**
6	**Nemathelminths:** 6.1 General features 6.2 Life history and parasitic adaptations in *Ascaris and Wuchereria*	**4**
7	**Annelida:** 7.1 General features and life history of Earthworm 7.2 Coelom and metamerism	**7**
8	**Arthropoda:** 8.1 Larval forms in Crustacea 8.2 Respiration in Prawn 8.3 Book lungs in scorpion 8.4 Compound eye in cockroach 8.5 Comparative Study of Mouth parts: (a) Cockroach (b) Mosquito – ***Culex, Anopheles***	**8**
9	**Mollusca:** 9.1 General features and life history of Pila 9.2 Respiration 9.3 Locomotion 9.4 Torsion and Detorsion in Gastropods	**5**
10	**Echinodermata:** 10.1 General features and life history of *Asterias*	**5**

	10.2 Larval forms of Echinodermata 10.3 Water Vascular System	
		Total Lectures/Hours/Periods = 60

Books Recommended:

Systematics (Animal Taxonomy):

1. Dalela& Sharma: Animal Taxonomy and Museology (1976, Jai Prakash Nath).
2. Kapoor: Theory and Practical of Animal Taxonomy (1988, Oxford & IBH).
3. Simpson: Principles of Animal Taxonomy (1962, Oxford).
4. Mayer & Ashlock: Principles of Systematic Zoology (1991, McGraw Hill).

Non-Chordates:

1. Ruppert and Barnes, RD(2006) Invertebrate Zoology, VIII edition .Holt Saunders International edition
2. Barnes, R.S.K., Calow, P. Olive., Golding, D.W. and Spicer, J.LI.(2002) The Invertebrates; E.J.W, III Edition, Blackwell Science
3. Nigam: Biology of Non-chordates (1997, S Chand)
4. Miller and Harley: zoology (6th Ed. 2005, W.C. Brown)
5. Parker & Haswell: Text Book of Zoology, Vol. I (2005, Macmillan)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester II

Major-2 (MJ-2): Systematics and Diversity of Chordates
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon.
- Understand how morphological change due to change in environment helps drive evolution over a long period of time.
- The project assignment will also give them a flavour of research to find the process involved in studying biodiversity and taxonomy besides improving their writing skills. It will further enable the students to think and interpret individually due to different animal species chosen.

Units	Topics	No. of Periods
1	**Protochordates:** 1.1: Origin of Chordates; General features of chordates 1.2: Life history of Herdmania; Filter feeding in *Branchiostoma*	8

2	**Pisces:** 2.1: Basic organization and Diversity of Fishes; Dipnoi 2.2: Structure of Gills and Respiration; Accessory Respiratory Organs in Teleosts	**10**
3	**Amphibia:** 3.1: Amphibian's Diversity and classification up to living order and Adaptability to Dual Mode of Life. 3.2: Origin & Evolution of Amphibia; Neoteny in Axolotl Larva.	**6**
4	**Reptilia:** 4.1: Origin of Reptiles, Skull types, Dinosaurs and causes of their extinction. 4.2: Poisonous Apparatus in Snakes 4.3: Types of Venom & their Toxic Effects	**8**
5	**Aves:** 5.1: Flight Adaptations in Birds 5.2: Mechanism of Flight	**6**
6	**Mammalia:** 6.1: Origin, General Characters, Classification & Affinities 6.2: Special features of- •Prototheria •Metatheria •Eutheria	**11**
7	**Comparative Anatomy of Vertebrates** 7.1: Heart and Aortic Arches 7.2: Kidney 7.3: Integument and its derivatives	**11**
		Total Lectures/Hours/Periods = 60

Books Recommended:

Chordates:

1. Miller & Harley: Zoology (6th ed. 2005, W.C. Brown
2. Nigam: Biology of Chordates (1997, S Chand)
3. Parker & Haswell, A Text Book of Zoology Vol.II (2005, Macmillan)
4. Sinha, A.K., & Adhikari, S and Ganguli, B.B. Biology of Animals Vol.II New Central Agency, Calcutta
5. Vishwanath – vertebrate Zoology

Online Tools and Web Resources

1. Swayam (MHRD) Portal
2. Animal Diversity https://swayam.gov.in/courses/5686-animal-diversity

3. Advances in Animal Diversity, Systematics and Evolution
   https://swayam.gov.in/courses/5300-zoology
4. ePGPathshala (MHRD)Module 10, 18, 19 of the paper P-08 (Biology of Parasitism)
   https://epgp.inflibnet.ac.in/ahl.php?csrno=35

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester II (Practical)

Major-3 (MJ-3): Practical based on MJ-1 & MJ-2 (Systematics and Diversity of Life – Protists to Chordates)

Credit – 4 **Lectures – 120 Hours**

Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]

Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Dissection: (one from Non -Chordate and one from Chordates)	**10 x 2 = 20**
2. Slide Preparation (Mounting with Procedures & Comments): (one from Non-Chordate and one from Chordates)	**10 x 2 = 20**
3. Spotting:	**3 x 10 = 30**
a. Museum Specimen (4) (Two from Non-Chordate and two from Chordates	
b. Slides (4) (Two from Non-Chordate and two from Chordates)	
c. Bones (02) (One from Amphibia & one from Mammals)	
4. Class record	**10**
5. Viva Voce	**10**
6. Project/Model	**10**
	Total = 100 Marks

Suggested Practical

Study of Available Museum Specimen of animals:

Non-Chordates:

Sycon, Physalia, Metridium, Fasciola, Taenia solium, Nereis, Aphrodite, Pheretima, Lingula, Chiton, Pila, Unio, Sepia, Loligo, Octopus, Eupagurus, Limulus, millipedes, centipedes, Palaemon, Antedon, Asterias, Echinus, Holothuria

Chordates:

1. **Protochordate**: Balanoglossus, Herdmania
2. **Agnatha**: Petromyzon and Myxine
3. **Pisces**: *Scoliodon, Torpedo, Chimaera, Labeo rohita, Cirrhinus mrigala, Labeo bata, Hippocampus, Exocoetus, Syngnathus, Heteropneutes, Clarias batrachus, Anabas, Echeneis, Channa, Notopterus*

4. **Amphibia**: *Necturu, Proteus, Ambystoma, Axolotl larva, Salamandra, Alytes, Hyla, Bufo* (Toad), *Rana* (Frog)
5. **Reptiles**: Kachuga, *Calotes, Draco, Phrynosoma, Chameleon, Typhlops, Naja naja, Bungarus* (Krait), *Vipera* (Chandrabora), *Hydrophis, Crocodylus,* Python.
6. **Aves**: *Columba livia*, *Psittacula* (Parrot), *Bubo* (Great Horned Owl), *Alcedo* (Kingfisher), *Dinopium* (Woodpecker), *Passer* (House Sparrow), *Pycnonotus* (Bul- Bul), Ostrich model. Types of beaks and claws
7. **Mammals**: Prototheria Models of Duck-Bill Platypus, Spiny Anteater, *Pteropus* (Megachiroptera), *Manis* (Pangolin), *Funambulus* (squirrel), *Hystrix* (Porcupine), *Cavia* (Guinea Pig), *Rattus rattus* (rat).

Study of the following through permanent slide

Non-Chordates:

Paramecium (W.M), Conjugation of *Paramecium*, *Obelia* colony, Medusa, Gemmules of Sponges, T.S of Earthworm through various region, Ovary of earthworm Miracidium larva, Sporocyst larva, Redia larva, Cercaria larva, Trochophore larva, Glochidium larva, Nauplius, Zoea larva, Mysis larva, Megalopa larva, Bipinnaria larva, Echinopluteus larva, Ophiopluteus larva,

Chordates: Amphioxus (WM), T.S of Oral Hood Amphioxus, Placoid & Cycloid scales

Dissection:

Non- Chordate: Earthworm, Cockroach, Prawn

Chordates: Local Bony Fishes.

Mounting:

Mounting of Nephridia & Ovary of Earthworm, Trachea and Salivary Gland of *Periplaneta americana*.

Cycloid and Placoid Scale

Bones: Amphibia & Mammals (Girdles & Limbs)

Collection of five species (preferably invertebrates, insects) belonging to a clade. 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.

Study of animals in nature during a survey of a National Park or Forest area.

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester III

Major-4 (MJ-4): Cell Biology & Basics of Microbiology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- Acquire the detailed knowledge of different pathways related to cell signalling and apoptosis thus enabling them to understand the anomalies in cancer.
- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms understand the disease-causing potential of bacteria and viruses, and the responses of the immune system.

Units	Topics	No. of Periods
Unit 1: Prokaryotic and Eukaryotic Cells		
1.1	General structure of Prokaryotes, Bacteria, Archaea and Eukaryotes.	**2**
1.2	**Ultrastructure and Functions:** 1.2.1: Endoplasmic Reticulum 1.2.2: Ribosome 1.2.3: Golgi Apparatus 1.2.4: Lysosome	**8**

1.3	**Mitochondria:** Origin, Structure, Composition and Function	**4**
1.4	**Nucleus:** Size, Shape, Structure and Functions	**4**
Unit 2: Cell Membrane and Transport Mechanism		
2.1	**Plasma Membrane:** 2.1.1: Origin 2.1.2: Structure 2.1.3: Composition 2.1.4: Function 2.1.5: Fluid Mosaic Model	**6**
2.2	**Membrane Transport:** 2.2.1: Transport Across Membrane: Diffusion and Osmosis. 2.2.2: Active And Passive Transport, Endocytosis and Exocytosis	**6**
Unit 3: Cell Cycle and Cell Signaling		
3.1	3.1.1: Cell Cycle, Cell Division- Mitosis and Meiosis. 3.1.2: Cell Divisions Check Points and Their Regulation. Role of Growth Factors	**8**
3.2	Programmed Cell Death (Apoptosis).	**4**
3.3	Cell Regulation and Cell Signaling: Signaling Molecules and their Receptors.	**4**
Unit 4: Basics of Microbiology		
4.1	Prokaryotic cell: Structure and characteristics: 4.1.1: Eubacteria 4.1.2: Cyanobacteria 4.1.3: Archaebacteria	**4**
4.2	Virus: Structure Characteristics and Life Cycle: 4.2.1: DNA Viruses 4.2.2: RNA Viruses	**6**
4.3	Bacteriophage: 4.3.1: Structure & Characteristics 4.3.2: Lytic & Lysogenic Cycle	**4**
		Total Lectures/Hours/Periods = 60

Books Recommended

Cell Biology:

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.

Microbiology:

1. M. J. Pelczar, E.C.S. Chan and N.R. Kreig, Tata McGraw Hill
2. Prescott, Harley, Klein, McGraw Hill International Edition

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Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester III (Practical)

Major-5 (MJ-5): Practical based on MJ-4 (Cell Biology & Basics of Microbiology)
Credit – 4 **Lectures – 120 Hours**
Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]
Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Preparation of Temporary slides through onion root tip to study various stages of mitosis.	**15**
2. Gram Staining of Bacterial cells	**15**
3. Study of following from models/ photographs	**5x2 = 10**
a. Prokaryotes cells (Eubacteria, Cyanobacteria & Archaebacteria)	
b. Eukaryotic Cells (Unicellular Organisms)	
4. Spotting:	**3x10 = 30**
a. various stages of Meiosis/ Mitosis through permanent slides	
b. Structure of virus through photographs / Models	
5. Class record	**10**
6. Viva Voce	**10**
7. Project & Model	**10**
	Total = 100 Marks

Suggested Practical

Cell Biology

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study of slides of prokaryotic-Eubacteria, Cyanobacteria & Archaebacteria
3. Study of slides of Unicellular Eukaryotic cells
4. Study of various stages of cell division through permanent slides Mitosis and Meiosis.
5. Study of virus: HIV, Retrovirus, Corona Virus, Bacteriophage.

Microbiology

1. Vectors (Bacteria): Salmonella typhi, Mycobacterium tuberculosis & Vibrio cholerae.
2. Vectors (Virus): HIV &-Varicella-zoster Virus

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester IV

Major-6 (MJ-6): Biochemistry & Genetics
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the concept of enzyme, its mechanism of action and regulation
- Learn the preparation of models of peptides and nucleotides.
- Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
- Learn measurement of enzyme activity and its kinetics.
- Understand how DNA encodes genetic information and the function of mRNA and tRNA
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Discuss and analyse the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity, etc.

Units	Topics	No. of Periods
	BIOCHEMISTRY	
Unit 1: Biochemistry: Carbohydrates, Lipids and Proteins		
1.1	**Carbohydrates:** 1.1.1: Carbohydrates: Structure, Classification and Biological Importance. 1.2.1: Glycolysis 1.2.2: Krebs cycle	8
1.2	**Lipids:** 1.2.1: Lipids - Structure and Biological significance. 1.3.2: Fatty acids - Types, Nomenclature (Saturated and Unsaturated) and Classification	8
1.3	**Proteins:** 1.3.1: Amino acids – Structure, Classification and Properties 1.3.2: Protein - Confirmational structure, Composition and Biological significance	2
1.4	**Enzymes:** 1.4.1: Nomenclature and Classification 1.4.2: General Properties 1.4.3: Specificity 1.4.4: Cofactors & Isozymes. 1.4.5: Mechanism of enzyme action	8
Unit 2: Nucleic Acids		
2.1	**Chemical Constituents of Nucleic Acids:** Bases, nucleosides and nucleotides.	2
2.2	**Types of Nucleic Acids:** 2.2.1: DNA Structure: Watson & Crick Model 2.2.2: Types of RNA: m-RNA, t- RNA & r- RNA	6
	GENETICS	
Unit 3: Concept of Genes, Genomics, Inheritance & Interaction of Genes		
3.1	**Classical and Modern concept of:** 3.1.1: Gene (Cistron, Muton, Recon) 3.1.2: Alleles	1
3.2	**Classical Genetics:** 3.2.1: Mendel's laws of inheritance 3.2.2: Chromosomal basis of inheritance and its applications	4
3.3	**Exceptions to Mendelian Inheritance:** 3.3.1: Incomplete dominance 3.3.2: Codominance 3.3.3: Multiple allelism & Lethal alleles	4

	3.3.4: **Epistasis** - Recessive, Double recessive and Double Dominant. 3.3.5: Pleiotropy	
Unit 4: Concept of Linkage, Recombination, Genetic Disorders, Sex-Linked Inheritance		
4.1	Linkage and Crossing Over	**2**
4.2	**Sex Chromosomes and sex-linkage:** 4.2.1: XX/XO, XX/XY, ZZ/ZW 4.2.2: Haploidy/Diploidy Types 4.2.3: Gene Dosage Compensation 4.2.4: Epigenetics	**4**
4.3	**Chromosomal Aberrations:** 4.3.1: Structural Alterations of Chromosomes 4.3.2: numerical Alterations of Chromosomes, **Genetic Disorders:** 4.3.3: Chromosomal Aneuploidy (Down, Turner and Klinefelter Syndromes) 4.3.4: Chromosome Translocation (Chronic Myeloid Leukemia) 4.3.5: Deletion, Gene Mutation (Sickle Cell Anemia).	**6**
4.4	**Autosomal & Sex-Linked Inheritance:** 4.4.1: Autosomal Dominant and Autosomal recessive, 4.4.2: X-linked Dominant, and X-linked recessive. 4.4.3: Haplodiploidy, Genic Balance Theory, Intersex & Gynandromorphs. 4.4.4: Role of environmental factors- Crocodile	**4**
4.5	Analysis of Pedigree Chart	**1**
		Total Lectures/Hours/Periods = 60

Books Recommended:

Biochemistry:

1. Boyer: Concepts in Biochemistry (3rd ed. 2006, Brooks/Cole)
2. Lehninger, Nelson & Cox: Principles of Biochemistry (4th ed, 2007, Worth),
3. Murray et al: Harper's Biochemistry (25th ed. 2000, Appleton & Lange)
4. Stryer: Biochemistry (5th ed. 2001, Freeman)
5. Harper's illustrated biochemistry
6. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition)

Genetics:

1. Brooker- Genetics: Analysis and Principles (1999, Addison-Wesley,)
2. Gardner et al: Principles of Genetics (1991, John Wiley)
3. Griffith et al· An Introduction to Genetic Analysis (2005, Freeman)
4. Hartl & Jones: Essential Genetics: A Genomic Perspective (2002, Jones & Baiilet)
5. Russell: Genetics (2002, Benjamin Cummings
6. Lewin: Genes IX (2008, Jones & Bartlett)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester IV

Major-7 (MJ-7): Mammalian Physiology & Endocrinology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Understand the organization of nervous system and process of nerve conduction.
- Learn the determination of haemoglobin content, blood groups and blood pressure.
- Understand neurohormones and neurosecretions.
- Learn about hypo-thalamus and hypophysial axis.
- Understand about different endocrine glands and their disorders.
- Understand the mechanism of hormone action.

Units	Topics	No. of Periods
Unit 1: Mammalian Physiology: Digestion & Excretion Reproduction		
1.1	**Nutrition:** 1.1.1: Concept of BMR	**2**

	1.1.2: Concept of Balanced Diet	
1.2	**Physiology of Digestion & Absorption:** 1.2.1: Carbohydrates 1.2.2: Proteins 1.2.3: Fats	5
1.3	**Physiology of Excretion:** 1.3.1: Anatomy of Kidney 1.3.2: Physiology of Urine Formation	3
1.4	**Reproductive Physiology:** 1.4.1: Histo-Physiology of Testis 1.4.2: Histo-Physiology of Ovary	3
Unit 2: Respiration, Circulation & Nervous System		
2.1	**Body Fluids:** 2.1.1: Composition & Function of Lymph 2.1.2: Composition & Function of Blood 2.1.3: Blood Clotting Factors 2.1.4: Blood Clotting Mechanism	8
2.2	**Respiration:** 2.2.1: Mechanism & Regulation of Breathing	4
2.3	**Transport of Gases:** 2.3.1: Transport of Oxygen 2.3.2: Oxygen Dissociation Curve 2.3.3: Transport of Carbon Dioxide 2.3.4: Carbon Dioxide Dissociation Curve	4
2.4	**Nerve Physiology:** 2.4.1: Structure & Types of Neurons	4
2.5	**Origin of Action Potential and its Propagation** 2.5.1: Myelinated & Non – Myelinated Nerve Fibers 2.5.2: Saltatory Conduction	4
2.6	**Synapse:** 2.6.1: Types of Synapses and Synaptic Transmission	2
Unit 3: Endocrinology: Hormones & Endocrine Glands		
3.1	**Hormones:** 3.1.1: Hormones, Properties & Classification of Hormones 3.1.2: Nature and Mechanism of Hormones	4
3.2	**Endocrine Glands:** 3.2.1: Structure & Histo-Physiology of Thyroid 3.2.2: Structure & Histo-Physiology of Pituitary 3.2.3: Structure & Histo-Physiology of Adrenal	8

	3.2.4: Structure & Histo-Physiology of Endocrine Pancreas	
3.3	**Gastrointestinal Hormones:** 3.3.1: Gastrin 3.3.2: Cholecystokinin 3.3.3: Secretin 3.3.4: Motilin	**4**
Unit 4: Disease Associated with Hormonal Abnormality		
4.1	4.1.1: Cretinism, Goiter & Myxedema 4.1.2: Gigantism, Dwarfism & Acromegaly 4.1.3: Diabetes Insipidus Vs Diabetes Mellitus 4.1.4: Addison's Disease & Grave Disease	**5**
		Total Lectures/Hours/Periods = 60

Books Recommended:

Mammalian Physiology

1. Nielson: Animal Physiology – Adaptation and Environment (5th ed. 2008, Cambridge)
2. Marshall and Hughes: Physiology of Mammals and Vertebrates (2nd ed. 1980, Cambridge)
3. Prosser: Comparative Animal Physiology (4th ed. 1991, Satish Book)
4. C. C. Chatterjee Medical physiology
5. Guyton– a book on medical physiology

Endocrinology

1. Hadley: Endocrinology (5th ed. 2000, Prentice Hall)
2. Turner and Bagnara: General Endocrinology, 6th ed.1984, Saunders)
3. C. C. Chatterjee Medical physiology

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester IV (Practical)

Major-8 (MJ-8): Practical based on MJ-6 (Biochemistry & Genetics) and MJ-7 (Mammalian Physiology & Endocrinology)

Credit – 4 **Lectures – 120 Hours**

Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]

Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	Marks Distribution
1. **Physiological Experiment: (2)**	10×2 = 20
2. **Biochemistry (2)**	10×2 = 20
3. **Genotype analysis through Pedigree chart/ Ishihara test/ Structural of chromosomal aberrations**	10
4. **Spotting:**	10x3 = 30
a. **Permanent slides (Mammalian Physiology) (05)**	
b. **Permanent slides (Endocrinology) (05)**	
5. **Class record**	10
6. **Viva Voce & Project / Model**	10
	Total = 100 Marks

Suggested Practical

Mammalian Physiology:

1. Preparation of Haemin Crystal
2. RBC count by using haemocytometer
3. Estimation of Haemoglobin using Sahil's method
4. Record of blood pressure by Sphygmomanometer
5. Determination of Bleeding time in human
6. Determination of Coagulation time in human
7. Study of permanent slide of section of organs: T.S of Stomach, lung, liver, kidney, intestine

Endocrinology:

1. Study of permanent slide of Endocrine gland: T.S of Thyroid, Pancreas, Adrenal, Pituitary, testis, ovary, uterus and Thymus.

Biochemistry:

1. Detection of biomolecules in the unknown sample-
   a. Benedict's test for reducing sugars.

b. Ninhydrin test for α amino acids.
c. Iodine test for starch

2. Preparation of model of nitrogenous bases, nucleosides and nucleotides.

Genetics:

1. Study of Pattern of Inheritance in Human Population of the Traits Rolling of Tongue and Mid Digital Hair, Hypertrichosis, Widow's Peak
2. Genotype Analysis in the Pedigree Chart of the Victorian Family Affected with Haemophilia Study of Colour Blind by Ishihara Chart.
3. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs
4. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester V

Major-9 (MJ-9): Evolution & Population Genetics
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Acquire knowledge about the diversity and relationships of the animal kingdom.
- Gain a comprehensive understanding of animal phylogeny and adaptations.
- Understand how the universe and life have evolved.
- Knowledge of the theories and procedures of evolutionary biology.
- Become interested in the discussions and arguments occurring in the subject of evolutionary biology.

Unit	Topic	No. of Periods
Unit 1: Geological History and Evidence of Evolution		
1.1	Geological Time, Scale & Geological Era	**03**
1.2	Fossils 1.2.1: Types of Fossils 1.2.2: Modes of formation of fossils. 1.2.3: Age determination of fossils	**08**
1.3	Fossil history of evolution of horse	**02**

1.4	Evolution of Man	**02**
Unit 2: Theory & Sources of Evolution		
2.1	Theories of Evolution 2.1.1: Lamarckism 2.1.2: Neo-Lamarckism 2.1.3: Darwinism 2.1.4: Neo-Darwinism	**08**
2.5	Sources of variation: Mutation & Recombination	**05**
2.6	Reproductive isolation and its role in evolution; Modes of Speciation	**06**
Unit 3: Population Genetics		
3.1	Hardy-Weinberg Law of Equilibrium	**03**
3.2	Genetic Drift 3.2.1: Bottle-Neck Phenomenon 3.2.2: Founder's Principle	**06**
Unit 4: Levels & Pattern of Evolution		
4.1	Levels of Evolution 4.1.1: Microevolution 4.1.2: Macroevolution 4.1.3: Mega-evolution	**08**
4.2	Basic pattern of Evolution 4.2.1: Divergent evolution 4.2.2: Adaptive radiation 4.2.3: Parallel evolution 4.2.4: Convergent evolution	**09**
		Total Lectures/Hours/Periods = 60

Books Recommended:

1. Rastogi: Organic Evolution (1988, Kedarnath & Ramnath)
2. Mathur, Tomar, Singh. Evolution and Behaviour. Rastogi Publication, Meerut
3. P. S. Verma and V. K. Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Revised Edition. S. Chand Publication (2004).
4. Theodore H., Jr Eaton. Evolution. 1st Edition. W. W. Norton Publication. (1970).
5. Strickberger's Evolution. Prentice Hall. (2002).

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester V

Major-10 (MJ-10): Immunology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms understand the disease-causing potential of bacteria and viruses, and the responses of the immune system.
- Know how resistance development and resistance transfer occur.
- Identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- Understand how are immune responses by CD4 and CD8 T cells, and B cells, initiated and regulated.
- Understand how does the immune system distinguish self from non-self.
- Gain experience at reading and evaluating the scientific literature in the area.

Unit	Topic	No. of Periods
Unit 1: Introduction to Human Immune System and Immunity		
1.1	1.1.1: Immunity: Definition 1.1.2: Types of Immunity: Innate Immunity & Acquired Immunity	**6**

1.2	**Cells of Immune System:** 1.2.1: Immuno-Competent Cells: • Granulocytes: (Eosinophils, Basophils & Neutrophils) • Agranulocytes: ○ Lymphocytes (B- Cells & T- Cells) (Structure and Differentiation) ○ Monocytes 1.2.2: Accessory Cells: Macrophages & Dendritic cells	**10**
1.3	**Organs of Immune System: Lymphoid Organs** 1.3.1: Primary Lymphoid organs: Thymus, Bone marrow, Bursa Fabricius. 1.3.2: Secondary Lymphoid Organs: Lymph Nodes, Spleen, Tonsil, MALT & GALT	**10**
Unit 2: Humoral Immune Response or Antibody Mediated Immune Response (AMI)		
2.1	**Antigens:** 2.1.1: Definition, Properties and Structure & Types 2.1.2: Antigenicity and Immunogenicity 2.1.3: Antigen Determinants/ epitopes, Hapten	**8**
2.2	**Antibodies:** 2.2.1: Structure and Classes of Immunoglobulins 2.2.2: Properties and Functions of Immunoglobulins 2.2.3: Antigen and Antibody Reaction	**6**
Unit 3: Cell Mediated Immunity (CMI)		
3.1	**Major Histocompatibility Complex:** 3.1.1: Structural Organization of MHC complex 3.1.2: MHC Type I 3.1.3: MHC Type II	**7**
3.2	**Complement System:** 3.2.1: Structure, Properties and Functions	**4**
3.3	Monoclonal Antibody	**2**
3.4	Elementary concept of Immune Disorders (Autoimmune and Immunodeficiency Disorders)	**4**
Unit 4: Vaccines and Vaccination		
4.1	4.1.1: Active and Passive Immunization 4.1.2: Types of Vaccines	**3**
		Total Lectures/Hours/Periods = 60

Books Recommended:

1. Abbas A K, Lichtman A H, Pillai S. 2007. Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt's Essential Immunology. 11th edition Wiley – Blackwell Scientific Publication, Oxford.
3. Goldsby, R.A.; Kindt, T.J. and Kuby, J. (2006) Immunology (6th edition).
4. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester V (Practical)

Major-11 (MJ-11): Practical based on MJ-9 (Evolution & Population Genetics) & MJ-10 (Immunology)

Credit – 4 **Lectures – 120 Hours**

Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]

Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Genotypic Analysis using Hardy-Weinberg equation	**10**
2. Comment on given Fossil	**10**
3. Comment on Analogous/ Homologous/ Adaptive radiations	**10**
4. Study of serial homology exhibited in Prawn	**08**
5. Study of immune cells through blood smear preparation	**10**
6. Determination of Blood group to study Antigen -Antibody reaction	**10**
7. Spotting:	**4x3 =12**
a. Immune Cells (2)	
b. Histological Slides (lymphoid Organs) (2)	
8. Class record	**10**
9. Viva voce	**10**
10. Project/Model	**10**
	Total = 100 Marks

Suggested Practical

Evolution & Population Genetics

1. Genotypic analysis of taster and non-taster for PTC in human population to estimate allele frequencies by Hardy-Weinberg equation.
2. Fossil study: *Trilobite*, *Archaeopteryx*, *Tyrannosaurus rex*, *Stegosaurus*
3. Study of Homologous and Analogous organ (wings of birds and insects, forelimbs of bat and rabbit).
4. Study of adaptive radiations in feet & beak of birds.
5. Study of serial homology exhibited by appendages of Prawn.

Immunology:

1. Study of various types of immune cells (Basophils, Neutrophils, eosinophils, lymphocytes, monocytes, Macrophages & Dendritic cells) through blood smear.
2. Study of Antigen- Antibody reaction through blood group (Anti serum A, B & D)
3. Histological study of lymphoid organs - T.S. of Spleen, T. S. of Thymus & T. S lymph nodes of Mammals through permanent slides.

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VI

Major-12 (MJ-12): Human Reproductive Physiology and Developmental Biology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Learn about human reproductive physiology.
- Understand about early embryonic development.
- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.
- Comprehend the late embryonic development.
- Gain knowledge about post embryonic development.
- Understand about the reproductive technologies and their application.

Units	Topics	No. of Period
Unit 1: Reproductive Physiology		
1.1	Histophysiology of testis	**04**
1.2	Structure of sperm and Spermatogenesis	**04**
1.3	Histophysiology of ovary	**04**

1.4	Structure of Ovum; Oogenesis and ovulation	**04**
1.5	Menstrual Cycle in Human Female	**02**
Unit 2: Early Embryonic Development		
2.1	Fertilization: Attraction of Gametes, Fertilizin and Anti Fertilizing Reaction, Capacitation, Acrosomal Reaction, Amphimixis, Cortical Reaction	**04**
2.2	Types of Cleavage and Role of Yolk in Cleavage	**04**
2.3	Fate Map 2.3.1: Fate Map of Frog	**04**
Unit 3: Late and Post Embryonic Development		
3.1	Extra Embryonic Membrane in Chick	**04**
3.2	Placenta: Structure, Types and Functions	**04**
3.3	Metamorphism in Amphibia with special reference to tadpole larva	**04**
3.4	Types of Regeneration (e.g. Planaria)	**04**
Unit 4: Reproductive Technology		
4.1	Collection and Cryopreservation of Gametes	**02**
4.2	Artificial Insemination	**04**
4.3	*In Vitro* Fertilization and Embryo Transfer Technique	**04**
4.4	Elementary concept of embryonic stem cell	**04**
	Total Lectures/Hours/Periods = 60	

Book Recommendation

Human Reproductive Biology

1. Austin, C.R. and Short, R.V. Reproduction in Mammals. Cambridge University Press.
2. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
3. Gerard J. Tortora and Bryan Derrickson Principles of Anatomy and Physiology (12ed. 2009 Wiley)
4. Gayatri Prakash. Reproductive Biology. (2007, Narosa Publishing House)

Developmental Biology

1. Balinsky: An Introduction to Embryology (1981, CBS)
2. Gilbert: Developmental Biology (8th ed., 2006, Sinauer)
3. Wolpert: Principles of Development (3rd ed. 2007, Oxford)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VI

Major-13 (MJ-13): Ecology and Toxicology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Know the evolutionary and functional basis of animal ecology.
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavor.
- Engage in field-based research activities to understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
- Analyze a biological problem, derive testable hypotheses and then design experiments and put the tests into practice.
- Solve the environmental problems involving interaction of humans and natural systems at local or global level.

Unit	Topic	No. of Periods
Unit 1: Overview of Ecology and Ecosystem		
1.1	Introduction and Scope of Ecology	**3**
1.2	Concept and Dynamics of Ecosystem 1.2.1: Structure, Type, Component and function of ecosystem 1.2.2: Pond Ecosystem	**9**

	1.2.3: Food chain and Food web; Ecological pyramid; Energy flow in ecosystem	
1.3	Habitat and Niche Concept, Ecotone and Edge effect; Introduction to Biome	**4**
1.4	Biogeochemical cycle- Carbon, Nitrogen and Water	**4**
Unit 2: Biotic Community, Characteristics and Relationship		
2.1	Community characteristics- Abundance, Dominance, Evenness, Distribution, Species Diversity and Richness; Diversity Index	**4**
2.2	Ecological Relationship and Interactions e.g. Commensalism, Amensalism, Mutualism, Predation, Parasitism; Inter and Intra-specific competition	**5**
2.3	Ecological succession-Xerosere and Hydrosere	**4**
Unit 3: Population Ecology & Environmental Conservation		
3.1	Introduction to population and its attributes-Density, Natality, Mortality, Fecundity and Age-sex ratio	**3**
3.2	Factors regulating population growth and dispersal; Exponential and Logistic growth	**4**
3.3	Environmental ethics & Conservation; Environmental education and public awareness; Environmental movements-Chipko, Silent Valley & Big Dam Movements	**5**
Unit 4: Basic Concept of Toxicology & Environmental Pollution		
4.1	Definition of Toxicology; Poison and Toxicant, Classification of toxicant; Mode of action of toxic agents; Xenobiotics, Bio-accumulation and Bio-magnification	**7**
4.2	Pollution, type, cause, its impact and control-Air, Water and Soil; Bioremediation	**8**
		Total Lectures/Hours/Periods = 60

Books Recommended

1. Krebs, C. J. (2001) Ecology (6th edition) Benjamin Cummings.
2. Odum, E.P., (2008) Fundamentals of Ecology. Indian Edition. Brooks/Cole.
3. Ricklefs, R.E. (2000) Ecology (5th edition) Chiron Press.
4. Southwood, T.R.E. and Henderson, P.A. Ecological Methods (3ed, 2000) Blackwell Sci.
5. Kendeigh, F C. (1984) Ecology with Special Reference to Animal and Man. Prentice Hall Inc
6. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
7. Klaassen, C. The Basic Science of Poisons. Mcgraw-Hill.
8. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publication

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Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VI

Credit – 4

Major – 14 (MJ - 14) Economic Zoology **Lectures – 60 Hours**

FM= 100 [75+25] [End Semester = **75**] [Internal Examination = **25** (Written Examination =**20** + Class Performance & Attendance = **05**)]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B.**
- **Group A** is compulsory which shall contain three questions.
- **Question no. 1** will be very short answer type consisting of five questions of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type covering the whole syllabus. There will be **four options** of which **any two** to be answer each carrying equal marks.

Learning Outcomes

After successfully completing this course, the students will be able to:

- To develop concepts to understand important aspects of applied zoology.
- To learn understand the Bee keeping equipment, method and apiary management.
- To understand the economic status and importance of honey production in India.
- To learn types of silk worm in India, silkworm rearing and their products.
- To understand the economic status and importance of silk-production in India.
- To gain knowledge and expertise on the pest management and their modes of action and their fates in the agroecosystem.
- To have the knowledge of pesticide families and be able to differentiate among families based on their specific modes of activity.
- To develop appropriate pesticide management strategies by evaluating specific pest type.
- To understand the culture techniques of prawn, pearl and fish.
- To understand importance of lac culture.
- To learn concept and management of dairy/poultry farming.

Unit	Topic	No. of Periods
Unit 1: Apiculture		
1.1	Varieties of Honey Bees in India, Stingless Honey Bee and Bee Pasturage.	3

1.2	Bee-keeping: Setting up an Apiary, Rearing Equipment, Handling of Bees, Artificial Diet.	6
1.3	Diseases of Honey Bee, and Their Management	3
1.4	Economic Importance of Honey and other beneficial products of from bee)	3
Unit 2: Sericulture		
2.1	Different types of silk and silkworms in India	2
2.2	Rearing of *Bombyx mori* - Host plants, Rearing Racks and Trays, Disinfectants, Rearing Appliances, Black Boxing, Chawki Rearing, Bed Cleaning, Mountages, Harvesting of Cocoons	6
2.3	Silkworm diseases & their management: Pebrine, Flacherie	4
2.4	Silkworm pests & parasites and their management: Uzi fly, Dermestid Beetles	3
Unit3: Lac Culture & Dairy/Poultry Farming		
3.1	Lac Insect, Method of Lac Cultivation, Preparation of Shellac	6
3.2	Economic Importance of Lac	2
3.3	Common Breeds of Cattle	3
3.4	Commercial Importance of Dairy and Poultry Farming	3
Unit4: Pest Management		
4.1	Definition, classification, morphology, life cycle and nature of damage of common agricultural pests – Paddy, Sugarcane, Stored grains	8
4.2	Integrated Pest Management: Cultural, Chemical, Biological, Genetic Control	4
4.3	Common Pesticides and Insecticides, Entry and mode of their action	4
		Total Periods = 60

Books Recommended

1. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
2. Sericulture, FAO Manual of Sericulture.
3. Sardar Singh, Beekeeping in India, Indian council of Agricultural Research, New Delhi.
4. Pradhan, S. (1969). Insect Pests of Crops. National Book Trust, India Book House.
5. Atwal, A.S. (1993) Agricultural pest of India and South East Asia. Kalyani Pub., New Delhi.
6. Dennis, S. Hill. (2005) Agricultural Insect pests of the tropics and their management, Cambridge University press.
7. Pedigo L. P. (2002). Entomology and Pest Management, Prentice Hall Publication

8. Robert F. Norris, Edward P. Caswell-Chen and Marcos Kogan, Concepts of Integrated Pest Management, Prentice Hall of India.
9. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
10. Roberts, D. A. (1978) Fundamentals of Plant Pest Control.
11. De Bach, P. (1964) Biological Control of Insect Pests and Weeds, Chapman & Hall, New York.

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VI (Practical)

Major-15 (MJ-15): Practical Based on MJ-12 (Human Reproductive System & Developmental Biology) MJ-13 (Ecology & Toxicology) and MJ-14 (Economic Zoology)
Credit – 4 **Lectures – 120 Hours**
Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]
Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Study of structure of sperm/ovum/phases of menstrual cycle through photograph.	**5×2=10**
2. Study of types of placenta through photographs	**10**
3. Determination of pH or dissolved oxygen from water samples	**10**
4. Study of Pests – damage and its control	**10**
5. Study of pond ecosystem available nearby. **Or Graphical representation of species area curve by Quadrate Sampling method.**	**10**
6. Spotting Identify and Comment	**2x10 = 20**
a. Human Reproductive System (slides-2)	
b. Embryological slides (slides-2)	
c. Chick Embryology (slides-3)	
d. Economic Zoology (3)	
7. Class Record	**10**
8. Viva Voce	**10**
9. Project & Model	**10**
	Total = 100 Marks

Suggested Practical

Human Reproductive Physiology & Developmental Biology

1. Study and identification of stained sections of mammalian tissues: T. S. of testis and ovary
2. Study of chick embryological slides (18, 24, 28, 36, 48 and 72 hours of incubation)
3. Study of WM & section of developmental stages of frog through permanent slides Morula, Gastrula, Cleavage, Neurula & Tadpole (Internal and External gills)
4. Study of different section of placenta (photographs/slides)
5. Study of structure of sperm/ovum/phases of menstrual cycle through photograph.

Ecology and Toxicology

1. Determination of pH & dissolved oxygen from water samples.
2. Study of Pond Ecosystem
3. Study of species curve through Quadrate sampling method
4. Field visit to familiarize students with ecology and ecosystem type found in and around college campus.

Economic Zoology

1. Silk or Tasar Cocoon
2. Study of Infested Lac Stick, Cocoon, Honey Comb.
3. Life Cyle of *Apis* and *Bombyx mori*
4. Different types of poultry
5. Report on field visit to sight of Sericulture, Apiculture, Lac Culture and Dairy/Poultry Farm.
6. Paddy Pests, Pests of Sugarcane and Stored Grain Pests

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VII

Major-16 (MJ-16): Animal Behaviour
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop concepts and skills to understand important aspects of animal behaviour.
- Learn innate behaviour of animal and its roles in survival.
- Learn acquired behaviour of animal and its roles in survival.
- Understand various pattern of animal behaviour.
- Understand social behaviour and communication among animals.
- Learn migratory behaviour in animals and their roles in food search and reproduction.
- Acquire knowledge about parental care in animals necessary to survive and grow.
- Understand the role of biological rhythm in the development and regulation of animal behaviour.

Unit	Topic	No. of Periods
Unit 1: Introduction, Concept & Patterns of Behaviour		
1.1	Ethology: Origin & Study of Animal Behaviour	**3**
1.2	Types of Behaviour	
	1.2.1: Innate/ Instinct Behaviour	**5**

	2.1.2: Acquired/ Learned Behaviour	**5**
1.3	Patterns of Behaviour: Taxes, Reflexes, Orientation, Instinct, Habituation, Imprinting & Motivation	**5**
Unit 2: Social Organization, Communication		
2.1	Social Organization in Honey Bee and Termites	**6**
2.2	Communication in Animals; Chemical (Pheromones), Audio, Visual and Tactile	**5**
2.3	Selfishness, Altruism and Kin Selection	**3**
Unit 3: Migration and Parental Care		
3.1	Migration in Fishes	**5**
3.2	Migration in Birds	**5**
3.3	Parental Care in Fishes	**5**
3.4	Parental Care in Amphibia	**5**
Unit 4: Biological Rhythm		
4.1	Circadian Rhythm	**4**
4.2	Circannual Rhythm	**4**
	Total Lectures/Hours/Periods = 60	

Books Recommended:

1. John Alcock: Animal Behaviour (2001, Sinauer Associates, Inc).
2. Drickamer & Vessey: Animal Behaviour – concepts, processes and methods (2nd ed. 1986, Wadsworth,)
3. Mcfarland: Animal Behaviour, Psychology, Ethology and Evolution (1985, Pitman).
4. Goodenough et al.: Perspectives on Animal Behaviour (1993, Wiley)
5. Grier: Biology of Animal Behaviour (1984, Mosby)
6. Lorenz: The Foundation of Ethology (1981, Springer)
7. Manning & Dawkins: An Introduction to Animal Behaviour (5th ed. 1998, Cambridge).
8. Slater: An Introduction to Ethology (1985, Cambridge).
9. Reena Mathur: Animal Behaviour (2014, Rastogi Publications).

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VII

Major-17 (MJ-17): Applied Medical Zoology (with reference to Human Diseases)
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop awareness about the causative agents and control measures of commonly occurring diseases
- Understand the mechanisms for transmission, virulence and pathogenicity in pathogenic micro-organisms.
- Assess the importance of incidence, prevalence and epidemiology in microbiological diagnostic activities.
- The students will understand the concepts of pathogenic and pathological basis of diseases including infectious diseases caused by viruses, prokaryotes, protozoans, helminthes, vector borne and zoonotic diseases.
- Undertake measures or start awareness programme for maintenance of hygienic conditions, avoidance of contact from vector, destruction of breeding spots in the vicinity by public health education campaign.

Unit	Topics	No. of Periods
Unit 1: Protozoan parasite: Life cycle, disease caused, pathogenicity, prophylaxis and treatment		
1.1	*Plasmodium vivax*	**04**
1.2	*Entamoeba histolytica*	**04**
1.3	*Leishmania donovani*	**04**
UNIT 2. Helminthes Parasites: Life cycle, disease caused, pathogenicity, prophylaxis and treatment		
2.1	*Taenia solium*	**04**
2.2	*Wuchereria bancrofti*	**05**
2.3	*Ascaris lumbricoides*	**05**
Unit 3: Bacterial and Viral disease: Causative agent, pathogenesis, diagnosis, prophylaxis		
3.1	Tuberculosis, Typhoid	**08**
3.2	Dengue, SARS, HIV, COVID	**10**
Unit 4: Eradication Program		
4.1	National Vector Borne Diseases Control Programme (NVBDCP)	**08**
4.2	National AIDS Control Program (NACP)	**08**
		Total Lectures/Hours/Periods = 60

Books Recommended:

1. K. D. Chatterjee. Parasitology. 21st edition
2. C.P. Baveja & V. Baveja. Parasitology. 5th edition
3. K. D. Chatterjee Parasitology-Protozoology and Helminthology - 13e (2011, CBS Publisher)
4. Park's Textbook of Preventive and Social Medicine (25ed, 2019, M/s Banarsidas Bhanot Publishers)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VII

Major-18 (MJ-18): Biostatistics & Introductory Bioinformatics
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop concepts and skills to understand important biostatistical analysis.
- learn sampling, collection and presentation of biological data.
- Calculate and use of various methods of average.
- Understand the calculation and applications of various measure of dispersion like standard deviation, variance etc.
- Validate experimental data through various test of significance.
- Know the theory behind fundamental bioinformatics analysis methods. Be familiar with widely used bioinformatics databases.
- Know about various biological databases, their storage and retrieval.
- Analysis and interpret the biological data using various bioinformatics tools.
- Apply the knowledge of biostatistics and bioinformatics in future course of their career development in higher education and research

Unit	Topic	No. of Periods
	BIOSTATISTICS	
Unit 1: Sampling (Data Collection)		
1.1	Primary and Secondary Data, Frequency Distribution	**6**
1.2	Representation of Data (Histogram, Pie Diagram)	**6**
Unit 2: Measurement of Central Tendency and Variation		
2.1	Measurement of Central Tendency: Mean, Median and Mode	**6**
2.2	Measurement of Dispersion, Standard Deviation, Standard Error of Mean, Coefficient of Variation	**6**
Unit 3: Test of Significance		
3.1	Chi Square Test and Student 't' test	**6**
3.2	Analysis of Variance (ANOVA)	**4**
3.3	Correlation	**3**
3.4	Regression	**3**
	INTRODUCTORY BIOINFORMATICS	
Unit 4: Introductory Bioinformatics		
4.1	Introduction and scope of bioinformatics, Importance and applications of Bioinformatics	**2**
4.2	Introduction to data archiving systems (FASTA format, Accession Number);	**2**
4.3	Biological database: Nucleic acid sequences databases (GenBank, EMBL, and DDBJ), Genome databases, Protein database, Literature databases (NCBI-PUB MED).	**6**
4.4	Database Retrieval System: Entrez and sequence retrieval system (SRS)	**4**
4.5	Sequence alignment: Pair wise and Multiple Sequence Alignment; Introductory concept of BLAST, Clustal W and phylogenetic tree construction tool (PHYLIP)	**6**
		Total Lectures/Hours/Periods = 60

Books Recommended:

Biostatistics

1. Daniel, W. W (2005): Biostatistics- A foundation for analysis in the Health Sciences, John Wiley & Sons, 7th edition.
2. Zar, J.H. (2007): Biostatistical Analysis, Pearson Education 4th edition
3. Satguru Prasad: Fundamentals of Biostatistics (Biometry), EMKAY Publications, Delhi.

4. Rastogi, V. B.: Methods in Biostatistics, MedTec, New Delhi.

Bioinformatics

1. Ghosh and Mallick (2008): Bioinformatics: Principles and Applications (Oxford University Press)
2. Barnes, M.R. and Gray, I.C. (2003): Bioinformatics for geneticists. (Wiley)
3. Mount, D.W. (2006): Bioinformatics (2nd edition) CBS.
4. Jin Xiong (2006): Essential Bioinformatics (Cambridge)

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VII (Practical)

Major-19 (MJ-19): Practical Based on MJ-16 (Animal Behaviour) MJ-17 (Applied Medical Zoology) and MJ-18 (Biostatistics & Introductory Bioinformatics)

Credit – 4 **Lectures – 120 Hours**

Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]

Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Experiment on Geotaxis/Phototaxis	**10**
2. Study of bacteria and virus through photographs	**2x5 = 10**
3. Mouth parts of arthropods vectors	**10**
or FASTA File format or Home page of NCBI/Entrez	
4. Spotting Identify and Comment	**3x10 = 30**
a. Animal Behaviour (4)	
b. Pathogenic Protozoan (3)	
c. Pathogenic Helminths (3)	
5. Calculate or present the given data as per instruction	**10**
6. Class Record	**10**
7. Viva Voce	**10**
8. Project & Model	**10**
	Total = 100 Marks

Suggested Practical

Animal Behaviour

1. Study of Geo-Taxis, Photo-Taxis, Hygro-Taxis in Animals
2. Study of Bee Hive and Mound of Termites
3. Study of Caste of Honey Bees
4. Specimen Showing Behaviour – Prey Mantis, Hippocampus, Alytes, Migratory Fish

Applied Medical Zoology

1. Study of pathogenic protozoa by photographs/Slides (*Plasmodium sp., Entamoeba histolytica, Leishmania donovani*)
2. Study of museum specimens/slides of Helminth parasites (*Taenia*, *Ascaris*, *Wuchereria bancrofti*)
3. Study of disease specific bacteria and viruses through pictures/photographs (*Mycobacterium tuberculosis*, *Salmonella typhi*, HIV, Corona Virus

4. Study of mouth parts of arthropod vectors associated with human diseases: *Anopheles*, *Aedes*, *Culex*, *Phlebotomus*.

Biostatistics

1. Determination of Mean, Median and Mode.
2. To Perform Chi-Square Test for A Given Set of Data.
3. To Learn Graphical Representations of Statistical Data with The Help of Computers (eg.MS Excel).
4. Determination of Standard Deviation.

Bioinformatics

1. Study of home page: NCBI, BLAST & ENTREZ
2. Creating a file format for Protein and Nucleic acid (Gen bank & FASTA)
3. Sequence Analysis through BLAST

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VIII

Major-20 (MJ-20): Tools and Techniques in Biological Science
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand the purpose of the technique, its proper use and possible modifications/ improvement.
- Students are taught to deal with different tools & techniques applicable in biological research including various types of microscopes, Chromatography, Blotting, Electrophoresis & Spectroscopy.
- Understand the theoretical basis of technique, its principle of working and its correct application.
- Learn the maintenance laboratory equipment/ tools, safety hazards and precautions.

Unit	Topic	No. of Periods
Unit 1: Microscopy		
1.1	Introduction to Microscopy: Definition – Resolving Power, Limit of Resolution and Magnification.	**3**

1.2	Types of Microscopes (Basic Principle and Applications): Light Microscope and Electron Microscope	**10**
Unit 2: Chromatography & Blotting		
2.1	Chromatography: 1.2.1 Chromatography**:** Basic Principle 1.2.2 Types of Chromatography (Principle and Applications): Paper Chromatography, Ion Exchange, HPLC & Gas Chromatography	**10**
2.2	Blotting: 2.2.1: Concept of Blotting 2.2.2: Types of Blotting (Principle and Applications): Southern, Northern & Western Blotting.	**10**
Unit 3: Electrophoresis		
3.1	Electrophoresis: 3.1.1: Concept of Electrophoresis 3.2.2: Gel Electrophoresis: Principle and Applications	**10**
3.2	ELISA: Types, Principle and Applications	**4**
Unit 4: Spectroscopy		
4.1	4.1.1: Basic Concept and Principle of Spectroscopy 4.1.2: Electromagnetic Radiation	**3**
4.2	Types of Spectroscopy: 4.2.1: Absorption Spectroscopy 4.2.2: UV-Visible Spectroscopy 4.2.3: Infra-Red Absorption Spectroscopy	**10**
		Total Lectures/Hours/Periods = 60

Books Recommended:

1. Cooper, G. M. and Hausman, R. E. 2009. The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D. C.; Sinauer Associates, MA.
2. Karp, G, 2010. Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Willey & Sons. Inc.
3. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VIII

Advance Major-1 (AMJ-1): Molecular Biology and Biotechnology
Credit – 4 **Lectures – 60 Hours**
Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]
Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop an understanding of the fundamental molecular tools and their applications of DNA modification and cloning.
- Develop future course of their career development in higher education and research with a sound base.
- Apply their knowledge with problem solving approach to recommend strategies of genetic engineering for possible applications in Biotechnology and allied industry.

Unit	Topic	No. of Periods
Unit 1: DNA Replication and Gene Expression		
1.1	DNA Replication 1.1.1: Central Dogma 1.1.2: Replication of DNA in Prokaryotes	**06**
1.2	Gene Expression 1.2.1: Concept of Genetic Code 1.2.2: Mechanism of Transcription in Prokaryotes	**10**

	1.2.3: Mechanism of Translation in Prokaryotes.	
Unit 2: Operon Concept and Gene Regulation		
2.1	Concept of Operons (Positive and Negative: Inducible & Repressible)	**06**
2.2	Concept of *Lac* Operon, *Trp* Operon	**04**
Unit 3: DNA Damage and Repair		
3.1	DNA Damage 3.1.1: DNA damage by Mutagens 3.1.2: Types of DNA Damage	**08**
3.2	DNA Repair 3.2.1: Base Excision Repair 3.2.2: Nucleotide Excision Repair 3.2.3: Double Stranded Break Repair 3.2.4: Thymine Dimer Repair	**10**
Unit 4: Biotechnology		
4.1	Cloning Vectors and Enzymes 4.1.1: Enzymology; Restriction Enzyme; Endonuclease; DNA Polymerase; Ligase 4.1.2: Cloning Vectors: Plasmid and Cosmid	**07**
4.2	Cloned Animal: Concept and creation of Dolly	**03**
4.3	Transgenic animals: basic concept	**03**
4.4	DNA Fingerprinting	**03**
		Total Lectures/Hours/Periods = 60

Books Recommended:

1. B.D. Singh – A Textbook of Biotechnology
2. Alberts *et al*: Molecular Biology of the Cell (2008, Garland)
3. Karp: Cell and Molecular Biology (2008, John Wiley)
4. Lodish *et al*: Molecular Cell Biology (2008, Freeman)
5. Brown, T.A. (2001) Gene Cloning and DNA Analysis: An Introduction
6. Watson, J.D. (2006) Recombinant DNA (3rd edition) Cold Spring Harbour Laboratory Press.

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VIII

Advance Major-2 (AMJ-2): Wildlife and Biodiversity Conservation & Sustainable Development

Credit – 4 **Lectures – 60 Hours**

Full Marks = 100 [End Semester = **75**] + [Internal Examination = **25** (Written Examination = **20** + Class Performance & Attendance = **05**)]

Pass Marks = [End Semester = **30**] [Internal Examination = **10**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be very short answer type consisting of **five questions** of **1 mark** each in the form of MCQ/Fill in the blanks/ True or False etc.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **6 subjective/descriptive** questions* out of which the examinees are required to answer **any 4** carrying **15 marks** each.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand wildlife and Biodiversity, encompassing the theoretical knowledge, practical applications, and its importance for environment and society.
- Learn the wildlife and biodiversity analysis and estimation of their habitat for understanding their population and distribution in various types of ecosystem and forests.
- Understanding theoretical and practical knowledge on various traditional and modern tools and techniques used in identification and population estimation of wildlife.
- Understand the measures for conservation of wildlife and biodiversity.
- Understand the sustainable development and its relevance in present time, various SDG Goals.
- Understand the various organization, institution and NGOs working in the field of wildlife conservation

Unit	Topic	No. of Periods
Unit 1: Introduction to Wildlife		

1.1	Definition, value and importance of wildlife; Cause and Impact of Wildlife Depletion, Major wildlife's of India & their distribution; Biogeographic Zones of India	**7**
1.2	faecal analysis of ungulates and carnivores, Hair identification, Pug Mark, Scat & Pellet	**5**
1.3	Wildlife Census Methods, Use of GIS and Remote Sensing in wildlife	**4**
Unit 2: Biodiversity & its Components		
2.1	Introduction and Types of Biodiversity	**2**
2.2	Alpha, Beta and Gamma Diversity	**3**
2.3	Biodiversity Hotspot; Flagship species; Keystone species	**3**
Unit 3: Conservation of Wildlife and Biodiversity		
3.1	Ethics of Wildlife and Biodiversity Conservation	**6**
3.2	In-situ Conservation- National Park, Wildlife Sanctuary, Biosphere Reserve, Tiger Reserve in India & Project Elephant	**5**
3.3	Ex-Situ Conservation- Zoological Garden, Gene Bank & Cryopreservation	**4**
3.4	Human-Wildlife Conflicts & its management, Reintroduction of wildlife	**3**
3.5	Ecotourism/Wildlife tourism, Organization working on wildlife conservation- MAB Programme, Red data Book, IUCN & WWF	**4**
Unit 4: Sustainable Development		
4.2	Definition, Scope and Relevance of Sustainable Development	**6**
4.3	Sustainable Development Goals (SDGs), SDGs on Climate Action, Life below water and Life on Land	**6**
4.5	Ways to achieve sustainable developments	**2**
		Total Lectures/Hours/Periods = 60

Books Recommended

1. Techniques for Wildlife Census in India: A Field Manual by W A Rdgers
2. Wildlife Ecology, Conservation, and Management by A. R. E. Sinclair and G. J. Caughley
3. Conservation biology in theory and practice by G. J. Caughley
4. The Conservation Handbook: Research, Management and Policy by W.J. Sutherland
5. Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory by · Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008).

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Year Undergraduate Programme
Department of Zoology
NEP UG Syllabus
Semester VIII (Practical)

Advance Major-3 (AMJ-3): Practical Based on AMJ-1 (Molecular Biology and Biotechnology) and AMJ-2 (Wildlife and Biodiversity Conservation & Sustainable Development)

Credit – 4 **Lectures – 120 Hours**

Full Marks = 100 [End Semester = **100**] [There is no internal examination in this paper]

Pass Marks = [End Semester = **40**] **Time: 5 Hours**

Practical	**Marks Distribution**
1. Identify and Comment upon transgenic animals/cloned animals.	**5x2 = 10**
2. Principle, method and application of electrophoresis/centrifugation/ spectrophotometer/ chromatography/Blotting	**2x10 = 20**
3. Identification and comments of wild fauna on the basis of pugmark/Dung/Pellet etc.	**2.5×4 = 10**
4. Spotting (Identify and Comment)	**3x10 = 30**
a. Wild animals (photographs) (3)	
b. Bird's nest or Antlers (2)	
c. Bio-instruments (photographs) (3)	
d. Photographs of maize specimens/photographs of transposition (2)	
5. Class record	**10**
6. Viva voce	**10**
7. Project/Model/Field Visit	**10**
	Total = 100 Marks

Suggested Practical:

Molecular biology & Biotechnology

1. Study of transposition through Maize specimens/Photographs
2. Study of cloned animals through photographs.
3. Study of transgenic animals through photographs
4. Principle, method and application of electrophoresis/centrifugation/ spectrophotometer/ chromatography/Blotting

Wildlife & Biodiversity Conservation and Sustainable Development

1. Identification of Flora, Mammalian Fauna, Avian Fauna, Herpeto-Fauna through field visit & photographs.
2. Demonstration of Basic Equipment needed in Wildlife Studies (Binoculars, Global Positioning System (GPS) and various types of Cameras and Lenses).
3. Familiarization and Study of Animal Evidences in the Field and Identification of Animals through Pug Marks, Hoof Marks, Scats, Pellet Groups, Nest, Antlers Etc.
4. Quantitative estimation for Flora and Fauna using different field technique
5. Project report based on the visit to natural history museum/National Park/Biodiversity Park/Wildlife Sanctuary.

Part-III

Syllabus for
Minor from Discipline (Zoology)

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Discipline
Subject: Zoology
Semester I/II

Minor-1A (MN-1A): Animal Classification & Diversity and Cell Biology
Credit – 4 (3+1), Theory=3, Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Practical = 25]
Theory **[**End Semester = **60**] + [Internal Examination = **15** (Written Examination = **10** + Class Performance & Attendance = **05**)]
Pass Marks = Theory [End Semester = **24**] [Internal Examination = **6**]

Instructions:

- In all **8 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of short answer type carrying **5 marks** each.
- **Group B** will contain **descriptive** type **five questions*** of **15 marks** each, out of which **any three** to be answer.

  ***Question no. 8** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus

Learning Outcomes

After successfully completing this course, the students will be able to:

- Develop understanding on the diversity of life with regard to Protists, non-chordates and chordates.
- Group animals on the basis of their morphological characteristics/ structures.
- Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
- Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
- Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
- Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis thus enabling them to understand the anomalies in cancer.
- Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

Units	Topics	No. of Periods
Unit 1: Classification & Diversity of Non-Chordates		

1.1	**General characters and classification (up to classes) of the following phyla:** Protozoa, Porifera, Coelenterate, Platyhelminthes, Annelida, Mollusca, Arthropoda, Echinodermata & Hemichordate with examples	**5**
1.2	**Non-Chordates Form & function** 1.2.1: Protozoa: Pathogenicity, treatment & prevention of diseases caused by *Entamoeba histolytica* & *Leishmania donovani.* 1.2.2: **Porifera**: Canal System of sycon 1.2.3: **Coelenterata**: Life Cycle of *obelia* & Metagenesis 1.2.4: **Aschelminthes**: *Ascaris* - life cycle & their pathogenicity 1.2.5: **Annelida**: *Pheretima* - Excretory system 1.2.6: **Arthropoda**: *Palaemon* - Respiratory System 1.2.7: **Mollusca**: *Pila* - Respiratory system 1.2.8: **Echinodermata**: *Asterias* - Water vascular System	**10**
Unit 2: Classification & Diversity of Chordates		
2.1	General characters and classification of living chordates of the following Classes upto Mammalia	**5**
2.2	**Chordate forms & Function** 2.2.1: **Pisces**: Respiratory & Accessory Respiratory organs 2.2.2: **Reptilia**: Biting mechanism of snake, Poison gland, Venom 2.2.3: **Aves**: Flight Adaptation in Birds 2.2.4: **Mammals**: Characters, distribution and affinities of Prototheria	**6**
Unit 3: Cell Biology		
3.1	Study of structure & function of Plasma Membrane	**2**
3.2	Study of cell Organelle - Mitochondria, Ribosomes, Lysosomes	**3**
3.3	Ultra-structure of Chromosomes	**2**
Unit 4: Cell Cycle & Cell Signaling		
4.1	Cell Cycle, Cell Division - Mitosis and Meiosis.	**6**
4.2	Cell Signaling: Signaling Molecules and their Receptors	**6**
		Total Lectures/Hours/Periods = 45

Minor-1A Practical

Minor-1A Practical (MN-1A-P): Animal Classification & Diversity and Cell Biology

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Slide Preparation (Mounting)	**04**
2. Study on the stages of Mitosis through slides	**04**
3. Spotting	**2x4 = 08**
a. Museum Specimen (3)	
b. Slides (Eukaryotic & Prokaryotic Celts) (1)	
4. Class record	**04**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

Animal Classification and Diversity:

1. Mounting: Spicules of Porifera, Obelia colony, Daphnia, Trachea and salivary gland of Coackroach
2. Museum Specimens (Non-Chordates): *Sycon, Euspongia, Aurelia, Gorgonia, Metridium, Tubipora, Pennatula, Tapeworm, Fasciola, Ascaris, Pheretima, Hirudinaria, Neris, Pila, Unio, Sepia, Octopus*, Hermit Crab, Prawn, *Asterias*, Sea urchin, Brittle star
3. Museum Specimens (Chordates): *Scoliodon, Torpedo, Labeo rohita, Cirrhinus mrigala, Hippocampus, Exocetus, Clarias batrachus, Anabas, Necturus, Ambystoma, Axolotle larva, Alytes, Hyla, Bufo (Toad), Rana tigerina, Tortoise, Ca/ates, Draco, Chameleon, Naja naja, Bungerus, Crocodylus, Python, Columba livia, Psittacula* (Parrot), *Bubo* (Owl), *Alcedo* (Kingfisher), Ostrich model. Duck-bill Platypus, Spiny Anteater, *Pteropus*, *Manis* (Pangolin), *Funnambulus, Hystrix, Rattus.*

Cell biology

1. Study of the permanent slides of Mitosis Cell division
2. Study on slides of Prokaryotic and Eukaryotic cells: Bacteria, Amoeba, Paramecium, Euglena.

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Discipline
Subject: Zoology
Semester III/IV

Minor-1B (MN-1B): Genetics, Ecology and Evolution
Credit – 4 (3+1), Theory=3. Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Practical = 25]
Theory [End Semester = **60**] + [Internal Examination = **15** (Written Examination = **10** + Class Performance & Attendance = **05**)]
Pass Marks = Theory [End Semester = **24**] [Internal Examination = **6**]

Instructions:

- In all **8 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type **five questions*** of **15 marks** each, out of which **any three** are to answer.
  ***Question no. 8** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand how DNA encodes genetic information and the function of mRNA and tRNA
- Apply the principles of Mendelian inheritance.
- Understand the cause and effect of alterations in chromosome number and structure.
- Discuss and analyze the epigenetic modifications and imprinting and its role in diseases.
- Get new avenues of joining research in related areas such as genetic engineering of cells, cloning, genetic disorders, human fertility programme, genotoxicity etc.
- Know the evolutionary and functional basis of animal ecology.
- Analyze a biological problem, derive testable hypotheses and then design experiments and put the tests into practice
- Understand what makes the scientific study of animal ecology a crucial and exciting endeavor.
- Acquire an in-depth knowledge on the diversity and relationships in animal world.

Units	Topics	No. of Periods
Unit 1: Genetics: Principle of Genetics		

1.1	Mendel's Law of Inheritance	**10**
1.2	Linkage and Crossing Over	
1.3	Autosomal and Sex-linked Inheritance	
1.4	DNA: Structure & function	
Unit 2: Concept of Gene Expression		
2.1	Semi conservative DNA Replication in prokaryotes	**10**
2.2	Transcription in Prokaryotes	
2.3	Translation in Prokaryotes	
Unit 3: Ecology		
3.1	**General Concept:** 3.1.1: Ecosystem 3.1.2: Food Chain & food Web &Ecological Pyramids 3.1.3: Energy Flow	**10**
3.2	**Population & Communities** 3.2.1: Ecological Succession	**2**
3.3	**Environmental Pollution:** 3.3.1: Pollution Sources 3.3.2: Impacts of Environmental Pollution - Air & Water 3.3.3: Green House Gases: Causes and Effects	**6**
Unit 4: Evolution		
4.1	Theory of organic evolution	**7**
4.2	Lamarckism's theory of inheritance of acquired characters	
4.3	Darwin's theory of natural selection	
		Total Lectures/Hours/Periods = 45

Minor-1B Practical

Minor-1B Practical (MN-1B-P): Genetics, Ecology and Evolution

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	Marks Distribution
1. Pedigree Analysis	05
2. Ecological Experiment	05
3. Homologous/ Analogous organ/Fossil/Extinct Models	05
4. Class record	05
5. Viva voce	05
	Total = 25 Marks

Suggested Practical:

Genetics

1. Study of Sex-linked characters: Hemophilia and Colour blindness through Pedigree Analysis

Ecology

1. Determination of pH in soil and water sample
2. Estimation of free carbon dioxide
3. Food chain/food web/ecological pyramids through models

Evolution

1. Study of homologous and analogous organs
2. Study of fossils/extinct models: Dinosaurs, Archeopteryx

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Discipline
Subject: Zoology
Semester V/VI

Minor-1C (MN-1C): Biochemistry, Physiology & Endocrinology
Credit – 4 (3+1), Theory=3, Practical=1 **Lectures – 60 Hours**
Full Marks = 100 [Theory = 75 + Practical = 25]
Theory [End Semester = **60**] + [Internal Examination = **15** (Written Examination = **10** + Class Performance & Attendance = **05**)]
Pass Marks = Theory [End Semester = **24**] [Internal Examination = **6**]

Instructions:

- In all **8 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type **five questions*** of **15 marks** each, out of which **any three** are to answer.
  ***Question no. 8** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand about the importance and scope of biochemistry.
- Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
- Understand the structure and function of immunoglobulins.
- Understand the concept of enzyme, its mechanism of action and regulation.
- Understand the physiology at cellular and system levels.
- Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
- Understand how mammalian body gets nutrition from different biomolecules.
- Understand the process of digestion and excretion.
- Develop critical understanding how a single-celled fertilized egg becomes an embryo and then a fully formed adult by going through three important processes of cell division, cell differentiation and morphogenesis.

Units	Topics	No. of Periods
Unit 1: Biochemistry		
1.1	**Structure and Classification of Biomolecules** 1.1.1: Protein 1.1.2: Carbohydrates 1.1.3: Lipids	**15**
1.2	**Metabolism** 1.2.1: Glycolysis 1.2.2: Kreb's Cycle	
Unit 2: Physiology		
2.1	Blood composition, Blood Coagulation	**15**
2.2	Respiration: Transport of gases (O_2 & CO_2)	
	Digestion of food: Protein, Carbohydrate and Lipid	
	Excretion: Nephron & Urine formation	
	Nerve: Structure and Types of Neurons; Synapse	
Unit 3: Reproductive Biology and Endocrinology		
3.1	Testis and ovary: Structure and Function	**15**
3.2	Thyroid gland	
3.3	Pituitary gland	
		Total Lectures/Hours/Periods = 45

Minor-1C Practical

Minor-1C Practical (MN-1C-P): Biochemistry, Physiology an Endocrinology

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Biochemistry Experiment	**05**
2. Physiology Experiment	**05**
3. Permanent slides of Histology/Endocrine Glands	**05**
4. Class record	**05**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

Biochemistry

1. Biochemical Test for Protein, Carbohydrate (starch & glucose) and Lipid
2. Study of Haemin crystal

Physiology and Endocrinology

1. Record of the blood pressure in normal and after exercise
2. Study of permanent slides: Kidney, liver, stomach & Blood cell types
3. Study of permanent slides: Thyroid and Pituitary glands

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Discipline
Subject: Zoology
Semester VII/VIII

Minor-1D (MN-1D): Developmental Biology, Animal Behaviour and Economic Zoology
Credit – 4 (3+1), Theory=3, Practical-1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Practical = 25]
Theory [End Semester = **60**] + [Internal Examination = **15** (Written Examination = **10** + Class Performance & Attendance = **05**)]
Pass Marks = Theory [End Semester = **24**] [Internal Examination = **6**]

Instructions:

- In all **8 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type **five questions*** of **15 marks** each, out of which **any three** are to answer.
  ***Question no. 8** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Acquire knowledge about embryonic development of animal.
- Develop concepts to understand important aspects of applied zoology.
- Know about life history of honey bee and its role in honey production.
- Understand the economic status and importance of honey production in India.
- Know life history of silk moth and its role in silk-production
- Understand the economic status and importance of silk-production in India.
- Develop concepts and skills to understand important aspects of animal behaviour.
- Learn innate behaviour of animal and its roles in survival.
- Learn acquired behaviour of animal and its roles in survival.
- Understand various pattern of animal behaviour.

Units	Topics	No. of Periods
Unit 1: Developmental Biology		
1.1	Gametogenesis & Fertilization	**15**
1.2	Cleavage	

1.3	Placenta & their Function	
Unit 2: Animal Behaviour		
2.1	Innate/Instinct Behaviour	**15**
2.2	Acquired/Learnt Behaviour	
2.3	Patterns of Behaviour: Taxes, Reflexes, Orientation, Instinct, Habituation, Imprinting & Motivation	
Unit 3: Economic Zoology		
3.1	Apiculture - life history and economic importance	**15**
3.2	Sericulture - life history and economic importance	
3.3	Lac Culture: Lac Insect, economic importance	
	Total Lectures/Hours/Periods = 45	

Minor-1D Practical

Minor-1D Practical (MN-1D-P): Developmental Biology, Animal Behaviour and Economic Zoology

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	Marks Distribution
1. Experiment on Geotaxis/Phototaxis	04
2. Study of types of placenta through photographs	05
3. Spotting (3)	2×3 = 06
a. Developmental Biology(1)	
b. Animal Behaviour(1)	
c. Economic Zoology(1)	
4. Class record	05
5. Viva voce	05
	Total = 25 Marks

Suggested Practical:

Developmental Biology

1. Study of the permanent slides of various stages of chick embryo (WM): 18 hrs, 24 hrs, 36 hrs, 48 hrs, 72 hrs
2. Types of Placenta

Animal Behaviour

1. Study of Geo-Taxis, Photo-Taxis, Hygro-Taxis in Animals
2. Study of Bee Hive
3. Study of Caste of Honey Bees

Economic Zoology

1. Silk or Tasar Cocoon
2. Study of Infested Lac Stick, Cocoon, Honey Comb.

Part-IV

Syllabus for
Minor from Vocational (Zoology)

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Vocational
Subject: Zoology
Semester II

Minor-2A (MN-2A): Apiculture - Entrepreneurship in Bee-Keeping
Credit – 4 (3+1), Theory=3, Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Skill Test/Viva voce/Practical/Demonstration = 25]
Theory [End Semester = **75**] [No Internal Examination]
Pass Marks = Theory [End Semester = **30**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type, **six questions*** of **15 marks** each, out of which **any three** are to be answer.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Explain what are the prerequisite to get started in beekeeping
- Explain the varieties of honey bee and their significance
- Discuss the responsibilities of urban beekeepers
- Identify where to purchase equipment and demonstrate how to assemble it
- Name and identify major parts of the honey bee such as the stinger or mandibular parts
- Describe bee biology and anatomy from the perspective of managing bees
- Describe the imp●liance of wax and identify what to look for in comb during hive inspections

Units	Topics	No. of Periods
Unit 1: General Morphology, Types and Behaviour of Honey Bees.		
1.1	Major Types of Economically Important Honeybees, Stingless Honey bee,	**3**
1.2	General Morphology, Behaviour and Life Cycle	**2**

1.3	Social Organization in Honey bee: Polymorphism, Caste System and Division of Labour,	**4**
1.4	Introduction to bee flora, Some important Bee Flora and their General Characters	**3**
Unit 2: Introduction to Apiculture:		
2.1	History of beekeeping, beekeeping in India and World wide	**2**
2.2	Traditional Bee-keeping, Modern Bee-keeping, Urban Bee-keeping	**3**
2.3	Selection of Bee species, Setting up an Apiary. Rearing Equipment, Handling of Bees	**4**
2.4	Bee- keeping Equipment: Bee Box (Newton and Langstroth box), Tools and Artificial Diet	**4**
Unit 3: Diseases of Honey Bee and their Management		
3.1	Pests of Honey bees and their Management	**3**
3.2	Diseases of Honey bee: Viral, Bacterial, Fungal, and Protozoan causing diseases	**4**
3.3	Management and their Treatments.	**2**
Unit 4: Economics of Bee Keeping and their Products		
4.1	Honey Extraction Techniques, Physico-chemical Analysis of Honey, and Uses	**4**
4.2	Other Products of Apiculture Industry: Bee Wax, Pollens, Royal Jelly, Propolis and Bee Venom and its Uses.	**4**
4.3	Expenditure, Net Income, and Additional benefits. Honey Mission Program of KVIC	**3**
	Total Lectures/Hours/Periods = 45	

Books Recommended

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. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharam Singh and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.
6. Prost. P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
7. Sardar Singh. Beekeeping in India, Indian Council of Agricultural Research, New Delhi

Minor-2A (Skill Test/Viva voce/Practical/Demonstration)

Minor-2A Practical (MN-2A-P): Apiculture - Entrepreneurship in Bee-Keeping

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Identify and Comment on (Caste of Honey bee/ Honey comb)	**05**
2. Equipment used in Apiculture	**05**
3. Spotting (2)	**2.5x2 = 05**
a. Pest of Honey bee	
b. Products of Honey bee	
4. Class record and/or or Project Report	**05**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

Apiculture - Entrepreneurship in Bee-Keeping

1. Key to identify Cast of Honey Bee (Queen, Drone and Workers); Honey Comb.
2. Equipment used in Apiculture: Newton and Langstroth Box (Hive frames. Queen Excluder, Brood Chamber); Newton's Hive; Smoker; Honey Extractor; Drone trap and Pollen Trap.
3. Pests of honey bees
4. Field Work: Field visit to sight of Apiculture farm.

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Vocational
Subject: Zoology
Semester IV

Minor-2B (MN-2B): Aquaculture and Fishery
Credit – 4 (3+1), Theory=3, Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Skill Test/Viva voce/Practical/Demonstration = 25]
Theory [End Semester = **75**] [No Internal Examination]
Pass Marks = Theory [End Semester = **30**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type, **six questions*** of **15 marks** each, out of which **any three** are to be answer.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand aquaculture and fishery, encompassing the theoretical knowledge, practical applications, and its economic importance to society.
- Learn the small-scale fish farming and its commercial level of production in larger-scale including fish culture, pond management, harvesting, processing, packaging, transport, and storage, as well as the economic aspects of aquaculture and fishery.
- Understanding theoretical and practical knowledge on various traditional and modern tools and techniques used in aquaculture and fishery.
- Understand the Pearl oyster culture and Prawn farming, its varieties and economic importance of aquarium fishes to society, and its aesthetic values.
- Understand the aquarium fishes, its varieties and economic importance of aquarium fishes to society, and its aesthetic values.
- Know the current status of aquaculture and fishery in India and specifically in Jharkhand, including financial support mechanisms provided by governments and various NGOs for aquaculture initiatives.

Units	Topics	No. of Periods
Unit 1: Pisciculture		

1.1	General character of fishes, Fishing methods: Capture Fisheries, Monoculture, Polyculture, Integrated fish farming	**4**
1.2	Fish seed production technology, Different stages of seed: Spawn, Fry and Fingerlings	**3**
1.3	Preparation and Management of Nursery and Rearing ponds, Transport of fish seeds and brood fishes, Hatchery and its management	**4**
1.4	Fish Disease, its control and management: Causative agents, symptoms and control of some infectious diseases of fish	**2**
Unit 2: Fishing Crafts, Gears and Post-harvest Technology in Pisciculture		
2.1	Classification and description of different type of fishing crafts in India	**3**
2.2	Fishing gear: Classification of fishing gear, Nets, meshes, hook and ropes	**3**
2.3	Post Harvest Technology: Principles and Importance of fish preservation	**2**
2.4	Methods of fish preservation: Icing, Freezing, Cold storage, Drying, Salting. Smoking, Canning and Fish Pickling.	**3**
Unit 3: Pearl Oyster culture and Prawn/Shrimp farming		
3.1	Basic concept of pearl culture, Pearl-producing mollusks, Pearl culture techniques. Economic importance of pearls	**4**
3.2	Basics of Prawn/Shrimp farming: Culture practices of *Penaeus monodon, Pe11ae11s* indicus and *Metapenaeus dobsoni*	**3**
3.3	Pond preparation, stocking of Hatchery, Nursery, grow out ponds and harvesting of shrimp	**3**
Unit 4: Ornamental Fish Production and Aquarium Management		
4.1	Ornamental/Aquarium Fishes: Common Species, Introduction to aquarium,	**3**
4.2	Design and construction of aquaria, Aquarium accessories - Aerators, filters, lighting and heaters etc. Use of natural and artificial aquatic plants.	**3**
4.3	Aquarium Management: Setting up of aquarium - under gravel filter, pebbles, plants, drift wood and ornamental objects,	**3**
4.4	Commercial breeding and culture of ornamental fishes.	**2**
		Total Lectures/Hours/Periods = 45

Books Recommended

1. Jayaram K.C(2010). Fish Taxonomy. NPH
2. Jayaram K.C(2010). Fishes of the Indian region. NPH
3. Khanna S.S. (214). Introduction to Fishes. Silver Line
4. ICAR. 2006. Hand Book of Fisheries and Aquaculture. ICAR.
5. Jhingran VG & Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
6. Jhingran VG. 1991. Fish and Fisheries of India. Hindustan Publisher.

Minor-2B (Skill Test/Viva voce/Practical/Demonstration)

Minor-2B Practical (MN-2B-P): Aquaculture and Fishery
Credit – 1 **Lectures – 30 Hours**
Full Marks = 25 [End Semester = **25**] [No Internal Examination]
Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Identification and comment on freshwater fishes.(2)	**2.5×2=05**
2. Identification of different Fishing craft/Gears	**02**
3. Spotting (4)	**4x2 = 08**
a. Carp fish (1),	
b. Prawn/Shrimp (1)	
c. Pearl oyster (1)	
d. Ornamental fish (1)	
4. Class record and/or Project Report	**05**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

1. Identification and comments on freshwater fishes.
2. Field visit: Visit to nearby freshwater bodies, fish culture pond, Collection and identification of fishes.
3. Common freshwater fishes/Major carp: Rohu, Catla, Mrigal, Cat fishes,
4. Pearl Oyster species of India: *Pinctada vulgaris, Pinctada marigaritifera, Pinctada chemnitzi* etc.
5. Prawn/Shrimp species of India: *Penaeus monodon, Penaeus indicus, Metapenaeus dobsoni and Mucrobrachium rosenbergii*
6. Aquarium Fishes(ornamental fishes): Goldfish, Live bearers (Molly, Guppy), Gouramies, Barbs and Tetras, Angel fish etc
7. Study on various fishing crafts, fish gears, and modern technology uses in fish culture.
8. Project Report based on field visits and surveys of aquaculture pond and freshwater bodies.

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Vocational
Subject: Zoology
Semester VI

Minor-2C (MN-2C): Vermiculture and Vermicompost Technology
Credit – 4 (3+1), Theory=3. Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Skill Test/Viva voce/Practical/Demonstration = 25]
Theory [End Semester = **75**] [No Internal Examination]
Pass Marks = Theory [End Semester = **30**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type, **six questions*** of **15 marks** each, out of which **any three** are to be answer.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Understand vermiculture and vermicomposting, encompassing theoretical knowledge, practical applications, and economic considerations.
- Understand the role of vermiculture and vermicomposting in maintaining soil structure and their contribution to the four R's of Recycling (Reduce, Reuse, Recycle, Restore).
- Explain the matter and humus cycle, including the transformation process of organic matter facilitated by earthworm activity.
- Describe the ecology, anatomy, physiology, and reproductive characteristics of important vermicomposting Earthworms.
- Learn the small-scale earthworm farming and commercial aspects of larger-scale vermicomposting, including vermiculture, harvesting, processing, packaging, transport, and storage, as well as the economic aspects of vermiculture and vermicomposting.
- Understand the composition of vermicompost, and exploring its physicochemical features to evaluate its suitability for agricultural and waste management purposes.
- Know the current status of vermicomposting in India and Jharkhand, including financial support mechanisms provided by governments and NGOs for vermiculture initiatives.
- Assess the impact of pests and microbes on vermiculture operations, and implementing effective control measures to mitigate their impact and ensure productivity.

Units	Topics	No. of Periods
Unit 1: Introduction to Vermiculture and Vermicomposting		
1.1	Vermiculture: Definition, meaning, difference between vermiculture and vermicomposting, history, scope, economic importance, their value in maintenance of soil structure, role as four R's of Recycling - Reduce, Reuse, Recycle, Restore	**3**
1.2	Types of Earthworms: Epigeic, Endogeic and Anecic earthworms. phytophagous and geophagous earthworm.	**1**
1.3	Definition, Habitat and Ecology of Native and Exotic species of Vermicomposting Earthworms (Native Indian earthworms. *Perionyx excovatus*, *Perionyx ceylanensis*, European earthworms. *Eisenia fetida*, *Eisenia andrei*, South African earthworms. *Eudrilus eugeniae*); Selective features of earthworm species for vermicomposting.	**4**
1.4	The matter and humus cycle. Transformation process of organic matter.	**3**
Unit 2: Earthworm Biology		
2.1	*Eisenia fetida* and *Eudrilus eugineae*: Taxonomy, Anatomy, Physiology and Reproduction	**6**
2.2	Vital cycle of *Eisenia fetida* and *Eudrilus eugineae*: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).	**5**
Unit 3: Vermicompost Technology		
3.1	Principle of vermicomposting; Components of the vermicomposting System; Methods of vermicomposting (Low-cost floor beds and Tank system); Management during vermicomposting.	**3**
3.2	Small Scale Earthworm farming and composting for home gardens	**3**
3.3	Commercial larger scale vermicomposting: Earthworm farming (vermiculture), vermicomposting extraction (harvesting) and processing. Packaging, transport and storage of Vermicompost.	**6**
Unit 4: Economic Aspects of Vermiculture and Vermicomposting		
4.1	Vermicompost: Definition, composition and physicochemical features. Role of earthworm and vermicompost in agriculture and waste management. Vermiwash composition and its use in agriculture.	**4**
4.2	Status of Vermiculture and Vermicomposting in India and Jharkhand. Marketing of vermicomposting products and financial support by	**4**

	governments and NGOs for vermiculture.	
4.3	Influence of pests, microbes and other enemies on vermiculture, measures to control them.	**3**
		Total Lectures/Hours/Periods = 45

Books Recommended

1. Chauhan, A. (2012) Vermitechnology, Vermiculture, Vermicompost and Earthworms: Vermiculture, Vermicomposting, Vermitechnology and Mirobes, Lambert Academic Publishing, Germany.
2. Christy, M. V. (2008) Vermitechnology, 1st edition, MJP Publishers.
3. Dash, M.C., B.K. Senapati, P.C. Mishra (1980) "Verms and Vermicomposting" Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa.
4. Ismail, S.A. (1997). Vermicology - The Biology of Earthworms. OrientLongman,92 pages.
5. Kumar, A. (2005) "Verms and Vermitechnology", APH Publishing.
6. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney.
7. Lekshmy, M. S., Santhi R. (2012) "Vermitechnology", Sara Publications, New Delhi, India,
8. National Institute of Industrial Research, (2010) "The Complete Technology Book on Vermiculture and Vermicompost", National Institute of Industrial Research, Delhi-7, India.
9. Satchel, J.E. (1983) "Earthworm Ecology" Chapman Hall, London.

Minor-2C (Skill Test/Viva voce/Practical/Demonstration)

Minor-2C Practical (MN-2C-P): Vermiculture and Vermicompost Technology

Credit – 1 **Lectures – 30 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Comments on earthworm life cycle/Life stages	**05**
2. Identify different types of earthworms based on key	**05**
3. Spotting (common species for vermiculture, Vermi pests) (2)	**2.5x2 = 05**
4. Class record and/or Project Report	**05**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

Vermiculture and Vermicompost Technology

1. Key to identify different types of earthworms.
2. Field Work: Collection of native earthworms & their identification.
3. Study of Systematic position, habits, and habitat & External characters of *Eisenia fetida*.
4. Study of Life stages & development of *Eisenia fetida* and *Eudrilus eugeniae*.
5. Study of Vermiculture, Vermiwash & Vermicompost equipment and devices.
6. Harvesting, packaging, transport and storage of Vermicompost and separation of life stages
7. Study of verms diseases & enemies.
8. Project Report

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Minor from Vocational
Subject: Zoology
Semester VIII

Minor-2D (MN-2D): Agrochemical and Pest Management
Credit=4 (3+1), Theory=3, Practical=1 **Lectures – 45 Hours**
Full Marks = 100 [Theory = 75 + Skill Test/Viva voce/Practical/Demonstration = 25]
Theory [End Semester = **75**] [No Internal Examination]
Pass Marks = Theory [End Semester = **30**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type, **six questions*** of **15 marks** each, out of which **any three** are to be answer.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Learning Outcomes

After successfully completing this course, the students will be able to:

- Gain knowledge and expertise on the agrochemicals and their modes of action and their fates in the Agro-ecosystem.
- Have the knowledge of pesticides families and be able to differentiate among families based on their specific modes of activity.
- Aware of the laws and regulations governing the proper use of pesticides.
- Develop appropriate pesticide management strategies by evaluating specific pest type.
- Understand the factors involved in calibrating equipment for pesticide applications.
- Estimate the potential hazards to humans, wildlife, and the environment.

Units	Topics	No. of Periods
Unit 1: Fundamentals of Pest Management		
1.1	Definition of pest, Types of pests according to nature of damage.	**4**
1.2	Plant pests: Weeds, Bacteria, Fungi, Viruses, Nematodes, Molluscs, Arthropods, etc.	**3**
1.3	Integrated Pest Management	**4**

	1.4.1: Cultural 1.4.2: Biological 1.4.3: Chemical 1.4.4: Genetic control	
Unit 2: Agrochemicals nutrients for increasing the health of plants		
2.1	Manures: Types, composition and value, sources of manures	**1**
2.2	Compost: Different composting technologies, mechanical compost plant, vermicomposting	**3**
2.3	Green manures: oil cakes, sewage sludge-biogas plant slurry.	**1**
2.4	Chemical fertilizers: N- fertilizers: manufacturing of ammonium sulphate, urea. P-fertilizers: processing rock phosphate, bone meal preparation K- fertilizers: potassium chloride, potassium sulphate	**4**
2.5	Biofertilizers: *Rhizobium*, *Azatobactor*, *Azolla*, *Blue Green Algae*, VAM.	**2**
Unit 3: Agrochemicals for pest management		
3.1	Conventional chemical/pesticides based on target species: Acaricides, Fungicides, Rodenticides, Nematicides, Molluscicides.	**4**
3.2	Fumigants and Repellents: Organophosphates, Carbamates. Structure, chemical name, physical and chemical properties; Mode of action, Toxicity	**4**
3.3	Application of pesticides, devices used; dose estimation for field application.	**3**
Unit 4: Botanicals and other biopesticides		
4.1	Basics of potential pesticidal plants, plant extract and its role in pest control.	**4**
4.2	Growth inhibitors or physiological antagonists, chemo-sterilant; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones.	**4**
4.3	Chitin synthesis inhibitors, Moulting inhibitors	**2**
4.4	BT methodology, genetically modified and transgenic plants.	**2**
		Total Lectures/Hours/Periods = 45

Books Recommended

1. Pradhan. S. (1969). *Insect Pests of Crops*. National Book Trust, India Book House.

2. Hill, D.S. (1983) *Agricultural insect pests of the tropics and their control*- Cambridge Univ. Press.
3. Atwal, A.S. (1993) *Agricultural pests of India and South East Asia*. Kalyani Pub., New Delhi.
4. Dent, D. (2000) *Insect pest management* (2nd edition)) CAB International.
5. Roberts F. Norris, Edward P. Caswell-Chen and Marcos Kogan, *Concepts of Integrated Pest Management*, Prentice Hall of India.
6. De Bach, P. (1964) *Biological Control of insect Pests and Weeds*, Chapman & Hall, New York.
7. Koul, O. and Dhaliwal, G.S. (2003) *Phytochemical Bio-pesticides*, Harwood Academic Publishers, Amsterdam.
8. Dennis, S. Hill. (2005) *Agricultural Insect Pests of the tropics and their management*, Cambridge University press.
9. Pedigo, L.P. (2002) *Entomology and Pest management*, Prentice Hall, N. Delhi.

Minor-2D (Skill Test/Viva voce/Practical/Demonstration)

Minor-2D Practical (MN-2D-P): Agrochemical and Pest Management

Credit – 2 **Lectures – 60 Hours**

Full Marks = 25 [End Semester = **25**] [No Internal Examination]

Pass Marks = [End Semester = **10**] **Time: 3 Hours**

Practical	**Marks Distribution**
1. Collection, preservation and identification of animal pests	**05**
2. Study of pest of paddy/sugarcane/Vegetable	**05**
3. Spotting (2)	**2.5x2 = 05**
4. Class record and/or Project Report	**05**
5. Viva voce	**05**
	Total = 25 Marks

Suggested Practical:

1. Collection Preservation and identification of animal pest.
2. Study of pest of paddy (*Scirpophaga incertulas*, *Leptocorisa acuta*), sugarcane (*Ceratovacuna lanigera*, *Pyrilla perpusilla*) and vegetables (*Bemisia tabaci*, *Spodoptera litura*).
3. Study of instruments used in Pest Management: Sprayer, Net, Sticky trap, Fogging instrument
4. Preparation of extract from Neem and *Lantana camara* and its application as biopesticide.
5. Trip to any agricultural field of your locality.

Part-V

Syllabus for
Multi-Disciplinary Course (MDC)

Binod Bihari Mahto Koyalanchal University, Dhanbad
FYUGP-NEP 2020
Multi-disciplinary Course (MDC)
Subject: Zoology
Semester I/II/III

MDC: Zoology **Credit – 3**
Lectures – 45 Hours

Full Marks = **75** [End Semester = **75**] [No Internal Examination and No Practical]
Pass Marks = [End Semester = **30**]

Instructions:

- In all **9 questions** to be set there shall be two groups – **Group A and Group B**.
- **Group A** is compulsory which shall contain **three** questions.
- **Question no. 1** will be **very short answer type/Objective** types consisting of **five questions** of **1 mark** each.
- **Question no. 2 & 3** will be of **short answer type** carrying **5 marks** each.
- **Group B** will contain **descriptive** type, **six questions*** of **15 marks** each, out of which **any three** are to be answer.
  ***Question no. 9** will be short answer type. There will be **four options** of which **any two** to be answer each carrying equal marks covering the whole syllabus.

Units	Topics	No. of Periods
Unit 1: Diversity in the Living World		
1.1	**Living World: Taxonomic Categories** 1.1.1: What is living? 1.1.2: Diversity in the living world 1.1.3: Taxonomic Categories 1.1.4: Taxonomic Aids	**2**
1.2	**Biological Classification** 1.2.1: Kingdom Monera 1.2.2: Kingdom Protista 1.2.3: Kingdom Fungi 1.2.4: Kingdom Plantae 1.2.5: Kingdom Animalia	**2**
1.3	**Animal Kingdom** 1.3.1: Basis of Classification 1.3.2: Classification of Animals	**1**
Unit 2: Cell Biology		
2.1	Cell: Structure & Function	**1**

	2.1.1: Cell Theory 2.1.2: Prokaryotic Cell 2.1.3: Eukaryotic Cell	
2.2	**Biomolecules**: 2.2.1: Biomacromolecules: Proteins, Carbohydrates, Lipids, Nucleic Acids	**3**
2.3	Cell Cycle & Cell Division	**2**
Unit 3: Human Physiology		
3.1	**Digestion & Absorption** 3.1.1: Alimentary Canal & Digestive Glands 3.1.2: Digestion of Food	**2**
3.2	**Respiration & Transport of Gases** 3.2.1: Respiratory Organs 3.2.2: Mechanism of Breathing 3.2.3: Exchange of Gases 3.2.4: Transport of Gases 3.2.5: Regulation of Respiration	**3**
3.3	**Body Fluids & Circulation** 3.3.1: Blood 3.3.2: Lymph 3.3.3: Circulatory Pathways 3.3.4: Double Circulation 3.3.5: Regulation of Cardiac Activity	**2**
3.4	**Excretory System:** 3.4.1: Human Excretory System 3.4.2: Urine Formation 3.4.3: Function of the Tubules	**3**
3.5	**Nervous System** 3.5.1: Human Neural System 3.5.2: Neuron 3.5.3: Central Nervous System	**3**
3.6	**Reproductive System** 3.6.1: Types of Reproduction 3.6.2: Male Reproductive System 3.6.3: Female Reproductive System 3.6.4: Gametogenesis 3.6.5: Menstrual Cycle 3.6.6: Fertilization, Implantation & Parturition	**5**
Unit 4: Genetics & Evolution		
4.1	**Principles of Inheritance and Variation**	**6**

	4.1.1: Mendel's Law of Inheritance 4.1.2: Sex Determination 4.1.3: Mutation 4.1.4: Genetic Disorders	
4.2	**Molecular Basis of Inheritance** 4.2.1: The DNA 4.2.2: RNA World 4.2.3: Replication 4.2.4: Transcription 4.2.5: Genetic Code 4.2.6: Translation	**6**
4.3	**Evolution: Theories & Sources of Evolution** 4.3.1: Lamarckism 4.3.2: Neo- Lamarckism 4.3.3: Darwinism 4.3.4: Neo-Darwinism	**4**
4.4	**Sources of Variations:** 4.4.1 : Mutation 4.4.2 : Recombination	
		Total Lectures/Hours/Periods = 45

Part-VI

Appendix

Appendix-I: Format for Question Paper

Jharkhand, NEP Regulations for FYUGP. 2022 onwards

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATIONS

Question format for **10 Marks**:

Subject/ Code

F.M. =10 Time=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 Time=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Note: These formats may be modified or designed uniformly for a common type of courses.

Jharkhand, NEP Regulations for FYUGP, 2022 onwards

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATIONS

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time**=2Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks:**

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B.**
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks:**

Subject/ Code

F.M. = 100 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B.**
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.

MEMBERS OF BOARD OF STUDIES OF UNDER GRADUATE (FYUGP)-NEP 2020 SYLLABUS OF BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY

Effective from session 2023 onwards and Session 2022 Semester III onwards.

Signature

1. Chairman: Dr. Kalpana Prasad
(Head, Dept. of Life Sciences)
Binod Bihari Mahto Koyalanchal University, Dhanbad

Recommended
18/10/2024

Remarks:

2. Members: Dr. S. K. Sinha
(DSW)
Binod Bihari Mahto Koyalanchal University, Dhanbad

Remarks:

3. Members: Dr. Navita Gupta
(Associate Professor, Dept. of Life Sciences)
Binod Bihari Mahto Koyalanchal University, Dhanbad

Approved and Recommended

Remarks:

4. Members: Dr. Rupam Mallik
(Assistant Professor, Dept. of Life Sciences)
Binod Bihari Mahto Koyalanchal University, Dhanbad

Recommended
16/10/24

Remarks:

5. Members: Dr. Sarita Murmu
(Assistant Professor, Dept. of Life Sciences)
Binod Bihari Mahto Koyalanchal University, Dhanbad

Recommended
18/10/24

Remarks:

6. External Expert: Prof. M. M. Chaturvedi
Former Head, University Department of Zoology,
Delhi University, Delhi

Remarks: