BINOD BIHARI MAHTO KOYALANCHAL UNIVERISTY, DHANBAD

FYUGP NEP 2020
UNDER GRAUDATION COURSE ZOOLOGY SYLLABUS
(Up to Semester-IV Only)

Effective from Session 2023 and Session 2022 Semester-III Onwards.

Index:

Members of BOARD OF STUDIES:

- **Dr. Kalpana Prasad (Head, Life Sciences Department)**
- **Dr. S.K. Sinha (DSW, BBMKU Dhanbad)**
- **Dr. Navita Gupta (Associate Professor, Life Science Department)**
- **Dr. Rupam Mallik (Assistant Professor, Life Science Department)**
- **Dr. Sarita Murmu (Assistant Professor, Life Science Department)**
- **Prof. M.M. Chaturvedi (External Expert) Former Head, University Department of Zoology, Delhi University Delhi.**

S.N.	Sem	Paper	Credits	Name of the Paper
1.	I	MJ-1: Theory	4	Systemic & Diversity of Non - Chordates
2.	II	MJ-2: Theory	4	Systemic & Diversity of Chordates
		MJ-3: Practical-I	4	Practical based on MJ 1 & 2
3.	III	MJ-4: Theory	4	Cell Biology & Microbiology
		MJ-5: Practical-II	4	Practical based on MJ 4
4.	IV	MJ-6: Theory	4	Biochemistry & Genetics
		MJ-7: Theory	4	Mammalian Physiology & Endocrinology
		MJ-8: Practical-III	4	Practical based on MJ 6 & 7
5.	V	MJ-9: Theory	4	Evolution & Population Genetics
		MJ-10: Theory	4	Immunology
		MJ-11: Practical-IV	4	Practical based on MJ 9 & 10
6.	VI	MJ-12: Theory	4	Human Reproductive system & Developmental Biology
		MJ-13: Theory	4	Ecology & Toxicology
		MJ-14: Theory	4	Wildlife Conservation and Management
		MJ-15: Practical-V	4	Practical based on MJ 12, 13 & 14
7.	VII	MJ-16: Theory	4	Animal Behaviour & Economic Zoology
		MJ-17: Theory	4	Applied Medical Zoology (with reference to Human Diseases)
		MJ-18: Theory	4	Biostatistics & introductory Bioinformatics
		MJ-19: Practical-VI	4	Practical based on MJ 16, 17 & 18
8.	VIII	MJ-20: Theory	4	Molecular Biology & biotechnology
		AMJ - 1 Theory	4	Tools & Techniques
		AMJ - 2 Theory	4	Applied Zoology
		AMJ - 3 Practical	4	Practical based on AMJ 1 & 2
Total Credit -			92	

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-Chordate
Credit – 4 **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. There will be four options of which any two to be answer carrying equal marks covering the whole syllabus.

Learning Outcomes:

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

- 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	TOTAL NO. OF LECTURES
1.	1.1: Acoelomate and Coelomate 1.2: Protostomes and Deuterostomes 1.3: Bilateria and Radiata **1.4:** Onychophora and Hemichordates	**04**
2.	**Protozoa:** **2.1**. General Features and Life history of Paramecium, Plasmodium and Leishmania **2.2**: Nutrition **2.3**: Reproduction	**08**
3.	**Porifera:** **3.1** Canal System in Sponges **3.2** Skeleton	**05**
4.	**Coelenterata:** **4.1** Structure, Life Cycle & Metagenesis in Obelia	**05**
	4.2 Polymorphism in Syphonophora	**02**
	4.3 Coral reefs and their formation	**01**
5.	**Platyhelminthes:** **5.1** General features and life history of *Fasciola and Taenia* and their pathogenicity **5.2** Parasitic adaptation	**06**
6.	**Nemathelminths:** **6.1** General features **6.2** Life history and parasitic adaptations in ***Ascaris*** *and Wuchereria*	**04**
7.	**Annelida:** **7.1** General features and life history of Earthworm **7.2** Coelom and metamerism	**07**
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***	**08**
9.	**Mollusca:** **9.1** General features and life history of Pila **9.2** Respiration **9.3** Locomotion	**05**

	9.4 Torsion and Detorsion in Gastropods	
10.	**Echinodermata:** **10.1** General features and life history of Asterias **10.2** Larval forms of Echinodermata **10.3**Water Vascular System	**05**
		Total = 60 Hours

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.I.(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)

Semester II

Major – 2 (MJ - 2) Systematics and Diversity of Chordates **Credit – 4**
FM= 100 [75+25] **Lectures – 60 Hours**
[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. There will be four options of which any two to be answer carrying equal marks covering the whole syllabus.

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

1.	**Protochordates:** 1.1: Origin of Chordates; General features of chordates	**08**
	1.2: Life history of Herdmania; Filter-feeding in Branchiostoma	
2.	**Pisces:** **2.1:** Basic organization and Diversity of Fishes; Dipnoi	**10**
	2.2: Structure of Gills and Respiration; Accessory Respiratory Organs in Teleosts	

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.	**06**
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	**08**
5.	**Aves:** **5.1:** Flight Adaptations in Birds **5.2:** Mechanism of Flight	**06**
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 = 60 Hours

Books Recommended:

Chordates:

1. Miller & Harley: Zoology (6thed. 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

- Swayam (MHRD) Portal ·
- Animal Diversity https://swayam.gov.in/courses/5686-animal-diversity
- Advances in Animal Diversity, Systematics and Evolution https://swayam.gov.in/courses/5300-zoology

ePGPathshala (MHRD)Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35

Semester II, Practical

Major – 3 (MJ - 3) P (Practical) Systematics and Diversity of Life- Protists to Chordates
Credit – 4 **Lectures – 120 Hours**

FM= 100 |End Semester = 100] (There will be no internal examination in this paper)

Practical Marks	Distribution	
1. Dissection:	10 X 2	
(one from Non -Chordate and one from Chordates)		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

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-Billed 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 class. 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.

Semester III

Major – 4 (MJ - 4) Cell Biology & Basics of Microbiology
Credit – 4 **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. There will be four options of which any two to be answer 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 signaling 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.

Unit	Topic	No. of periods
Unit 1: Prokaryotic and Eukaryotic Cells.		
1.1	General structure of prokaryotes, bacteria, Archaea and eukaryotes.	**02**
1.2	**Ultrastructure and Functions:** **1.2.1:** Endoplasmic Reticulum	**08**
	1.2.2: Ribosome	
	1.2.3: Golgi Apparatus	
	1.2.4: Lysosome,	

1.3	**Mitochondria:** Origin, Structure, Composition and Function.	04
1.4	**Nucleus:** Size, Shape, Structure and Functions	04
Unit 2: Cell Membrane and Transport Mechanism		
2.1	**Plasma Membrane:** **2.1.1:** Origin	06
	2.1.2: Structure	
	2.1.3: Composition	
	2.1.4: Function	
	2.1.5: Fluid Mosaic Model.	
2.2	**2.2.1:** Transport Across Membrane: Diffusion and Osmosis.	03
	2.2.2: Active and Passive Transport, Endocytosis and Exocytosis	03
Unit 3: Cell Cycle, Cell Signaling		
3.1	**3.1.1:** Cell Cycle, Cell Division- Mitosis and Meiosis.	04
	3.1.2: Cell Divisions Check Points and Their Regulation. Role Of Growth Factors	04
3.2	Programmed Cell Death (Apoptosis).	04
3.3	Cell Regulation and Cell Signaling: Signaling Molecules and their Receptors.	04
Unit 4: Basics of Microbiology		
4.1	Prokaryotic cell: Structure and characteristics: 4.1.1: Eubacteria 4.1.2: Cyanobacteria 4.1.3: Archaebacteria	04
4.2	Virus: Structure Characteristics and Life Cycle: 4.2.1: DNA Viruses 4.2.2: RNA Viruses	06

4.3	Bacteriophage: 4.3.1: Structure & Characteristics 4.3.2: Lytic & Lysogenic Cycle	**04**
		Total = 60 Hours

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**

Major – 5 (MJ - 5) PRACTICAL BASED ON CELL BIOLOGY AND MICROBIOLOGY

Credit – 4 **Lectures – 120 Hours**

FM= 100

[End Semester = 100] (There will be no internal examination in this paper) **Time: 5 Hours**

Suggested Practical:

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 a) Prokaryotes cells (Eubacteria, Cyanobacteria & Archaebacteria) b) Eukaryotic Cells (Unicellular Organisms)	5x2 =	10
4. Spotting: a) various stages of Meiosis/ Mitosis through permanent slides b) Structure of virus through photographs / Models	3x10 =	30
5. Class record		10
6. Viva Voce		10
7. Project & Model		10
		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

Semester IV

Major – 6 (MJ - 6) BIOCHEMISTRY & GENETICS **Credit – 4**

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. There will be four options of which any two to be answer 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

Unit 1: Biochemistry: Carbohydrates, Lipids and Proteins

1.1	**1.1.1**: Carbohydrates: Structure, Classification and Biological Importance.	**08**
1.2	**1.2.1:** Glycolysis,	
	1.2.2: Krebs cycle,	
1.3	**Lipids:** **1.3.1:** Structure and Biological significance.	

	Fatty acids- **1.3.2:** Types, Nomenclature (Saturated and Unsaturated) and Classification	**08**
1.4	**Amino acids –** **1.4.1:** Structure, Classification and Properties,	**02**
	Proteins: **1.4.2:** Confirmational structure, Composition and Biological significance	
1.5	**Enzymes:** **1.5.1:** Nomenclature and Classification	**08**
	1.5.2: General Properties	
	1.5.3: Specificity	
	1.5.4: Cofactors & Isozymes.	
	1.5.5: Mechanism of enzyme action	
Unit 2: Nucleic acids		
2.1	**Structure:** Bases, nucleosides and nucleotides.	**08**
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	
Unit	**Topic**	**No. of periods**
GENETICS		
Unit 3: Concept of Genes, Genomics and recombination and interaction of Genes		
3.1	**Classical and Modern concept of:** **3.1.1:** Gene (Cistron, Muton, Recon)	**01**
	3.1.2: Alleles	
3.2	**Classical Genetics:** **3.2.1:** Mendel's laws of inheritance	**08**
	3.2.2: Chromosomal basis of inheritance and its applications	
3.3	**Exceptions to Mendelian Inheritance:**	
	3.3.1: Incomplete dominance	
	3.3.2: Codominance	
	3.3.3: Multiple allelism & Lethal alleles	
	3.3.4: Epistasis - Recessive, Double recessive and Double Dominant.	
	3.3.5: Pleiotropy	
3.3	Linkage and crossing over	**02**

3.4	**Sex Chromosomes and sex-linkage:** **3.4.1:** XX/XO, XX/XY, ZZ/ZW **3.4.2:** Haploidy/Diploidy Types **3.4.3:** Gene Dosage Compensation **3.4.4:** Epigenetics	**04**
3.5	**Chromosomal Aberrations:** **3.5.1:** Structural Alterations of Chromosomes **3.5.2:** numerical Alterations of Chromosomes, **Genetic Disorders:** **3.5.3:** Chromosomal Aneuploidy (Down, Turner And Klinefelter Syndromes), And **3.5.4:** Chromosome Translocation (Chronic Myeloid Leukemia) **3.5.5:** Deletion, Gene Mutation (Sickle Cell Anemia).	**06**
3.6	**Autosomal & Sex-Linked Inheritance:** **3.6.1:** Autosomal Dominant and Autosomal recessive, **3.6.2:** X-linked Dominant, and X-linked recessive. **3.6.3:** Haplodiploidy, Genic Balance Theory, Intersex & Gynandromorphs.	**04**
3.7	Role of environmental factors- Crocodile	
3.8	Analysis of Pedigree Chart	**01**
		Total = 60 hours

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)

Major – 7 (MJ - 7) Mammalian Physiology & Endocrinology

Credit – 4 **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. There will be four options of which any two to be answer 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 hemoglobin 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.

Unit	Topic	No. of periods
Unit 1: Mammalian Physiology: Digestion & Excretion Reproduction		
1.1	**Nutrition:** 1.1.1: Concept of BMR	**02**
	1.1.2: Concept of Balanced Diet	
1.2	**Physiology of Digestion & Absorption:** **1.2.1:** Carbohydrates	**05**
	1.2.2: Proteins	
	1.2.3: Fats	

1.3	**Physiology of Excretion:** **1.3.1:** Anatomy of Kidney	03
	1.3.2: Physiology of Urine Formation	
1.4	**Reproductive Physiology:** **1.4.1:** Histo-Physiology of Testis	03
	1.4.2: Histo-Physiology of Ovary	
Unit 2: Respiration, Circulation & Nervous System		
2.1	**Body Fluids:** **2.1.1:** Composition & Function of Lymph	08
	2.1.2: Composition & Function of Blood	
	2.1.3: Blood Clotting Factors	
	2.1.4: Blood Clotting Mechanism	
2.2	**Respiration:** **2.2.1:** Mechanism & Regulation of Breathing	04
2.3	**Transport of Gases:** **2.3.1:** Transport of Oxygen	04
	2.3.2: Oxygen Dissociation Curve	
	2.3.3: Transport of Carbon Dioxide	
	2.3.4: Carbon Dioxide Dissociation Curve	
2.4	**Nerve Physiology:** **2.4.1:** Structure & Types of Neuron	04
2.5	**Origin of Action Potential and its Propagation** **2.5.1:** Myelinated & Non – Myelinated Nerve Fibers	04
	2.5.2: Saltatory Conduction	
2.6	**Synapse:** **2.6.1:** Types of Synapse and Synaptic Transmission	02
Unit 3: Endocrinology: Hormones & Endocrine Glands		
3.1	**Hormones:** **3.1.1:** Hormones, Properties & Classification of Hormones	04
	3.1.2: Nature and Mechanism of Hormones	
3.2	**Endocrine Glands:** **3.2.1:** Structure & Histo-Physiology of Thyroid	08
	3.2.2: Structure & Histo-Physiology of Pituitary	
	3.2.3: Structure & Histo-Physiology of Adrenal	
	3.2.4: Structure & Histo-Physiology of Endocrine Pancreas	
3.3:	**Gastrointestinal Hormones:** **3.3.1: Gastrin**	04
	3.3.2: Cholecystokinin	

	3.3.3: Secretin	
	3.3.4: Motilin	
Unit 4: Disease Associated with Hormonal Abnormality		
4.1	**4.1.1:** Cretinism, Goiter & Myxedema	**05**
	4.1.2: Gigantism, Dwarfism & Acromegaly	
	4.1.3: Diabetes Insipidus Vs Diabetes Mellitus	
	4.1.4: Addison's Disease & Grave Disease	

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

Practical

Semester IV

Major – 8 (Practical Based on MJ – 6 & 7) **Credit – 4**

F.M. = 100 [End Semester = 100] (There will be no internal examination in this paper) **Lectures – 120 Hours**

Practical		Marks Distribution
1.	**Physiological Experiment:**	**10+5 = 15**
2.	**Biochemistry**	**15**
3.	**Genotype analysis through Pedigree chart/ Ishihara test/ Structural of chromosomal aberrations**	**10**
4.	**Demonstration of Barr Body in buccal epithelium**	**10**
5.	**Spotting:** **10x03 =**	**30**
	a) **Permanent slides (Mammalian Physiology) (05)**	
	b) **Permanent slides (Endocrinology) (05)**	
6.	**Class record**	**10**
7.	**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: Stomach, lung, liver, kidney, intestine

Endocrinology

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

Biochemistry:

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

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
Subject: Zoology
FYUGP _NEP2020(from session 2023 onwards)
UG Syllabus
Minor from Discipline Paper
Semester I

Minor – 1A (MN – 1A) Animal Classification & Diversity and Cell Biology
Credit – 4 **Lectures – 60 Hours**
FM= 100 [Theory = 75 + Practical = 25]
Theory = [End Semester = 60 + Internal Examination = 15 (Written Examination =10 +class Performance & Attendance = 05)]
Practical = [End Semester = 25]. There will be no internal examination in Practical .

Instructions:

- In all eight questions to be set there shall be two groups, i.e., A and B.
- Group A is compulsory which will contain three questions.
- Question no. 1 will be very short answer type / Objective type consisting of five questions of 1 mark each.
- Question no. 2 & 3 will be of short answer type of 5 marks each.
- Group B will contain descriptive type, five questions* of Fifteen 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 carrying equal marks covering the whole syllabus

Learning Outcomes:

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

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

Unit	Topic	Total no. of Lectures
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	**10**
1.2	**Non-Chordates Form & function** **1.2.1:** Protozoa: Pathogenecity, treatment & prevention of diseases caused by *Entamoeba histolytica & Lesishmenia donovani*	**10**
	1.2.2: Porifera: Canal System *of sycon*	
	1.2.3: Coelenterata: Life Cycle of *obelia* & Metagenesis	
	1.2.4: Aschelminthes: *Ascaries- life cycle* & their pathogenecity	
	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	
Unit 2: Classification & Diversity of Chordates		
2.1	General characters and classification of living chordates of the following Classes up to Mammalia	**10**
2.2	Chordate forms & Function **2.2.1:** Pisces: Respiratory & Accessory Respiratory organs	**10**
	2.2.2: Reptilia: Biting mechanism of snake, Poison gland , Types of Venom	
	2.2.3: Aves: Flight Adaptation in Birds	
	2.2.4: Mammals: Characters, distribution and affinities of Prototheria	

Unit 3: Cell Biology		
3.1	Study of structure & function of Plasma membrane	**5**
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.	**5**
4.2	Cell Signaling: Signaling Molecules and their Receptors	**5**

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Years Undergraduate Programm
Subject: Zoology
NEP UG Syllabus
Semester I
Paper: Minor

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

Credit-2 Practical Lecture-60 Hours
Full Marks= 25(End Semester)- No Internal Examination

Sl. No	Practical	Marks Distribution
1	Slide Preparation (Mounting)	04
2	Study on the stages of Mitosis through slides	04
3	Spotting	08
a.	Museum Specimen (3)	
b.	Slides (Eukaryotic & Prokaryotic Cells) (1)	
4	Class record	04
5	Viva voce	05
	Total	**25**

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, Gogonia, 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, Torpeda, Labeo rohita, Cirrhinus mrigala, Hippocampus, Exocetus, Clarias batrachus, Anabas, Necturus, Ambystoma, Axolotle larva, Alytes, Hyla, Bufo* (Toad), *Rana tigerina, Tortoise, Calotes, Draco, Chemeleon, 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, Ameoba, Paramecium, Euglina

Department of Zoology

NEP UG Syllabus

Minor Paper

Semester III

Minor – 1B (MN – 1B) Genetics, Ecology and Evolution

Credit – 4 **Lectures – 60 Hours**

FM= 100 [Theory = 75 + Practical = 25]

Theory = [End Semester = 60 + Internal Examination = 15 (Written Examination =10 + Class Performance & Attendance = 05)]

Instructions:

- There will be two groups of questions. **Group A** is compulsory which will contain **three questions**.
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **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 carrying equal marks covering the whole syllabus.

Learning Outcomes:

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

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

Unit	Topic	Total no. of Lectures
Unit 1: Genetics: Principle of Genetics		
1.1	Mendel's Law of Inheritance	
1.2	Linkage and Crossing Over	
1.2.1	Autosomal and Sex-linked Inheritance	

1.3	DNA: Structure & function	**10**
Unit 2: Concept of gene expression		
2.1	Semi conservative DNA Replication in prokaryotes	**15**
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	**05**
3.3	**Environmental Pollution:** **3.3.1:** Pollution Sources **3.3.2:** Impact of Environmental Pollution-Air & Water **3.3.3:** Green House Gases: Causes and Effects	**10**
Unit 4: Evolution		
4.1	Theory of Organic Evolution	**10**
4.2	Lamarckism's theory of Inheritance of Acquired characters	
4.3	Darwin's theory of Natural Selection	

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Years Undergraduate Programm
Subject: Zoology
NEP UG Syllabus
Semester III
Paper: Minor

Minor-2 (Practical) (MN-1B-P) Genetics, Ecology and Evolution

Credit-2 Practical Lecture-60 Hours

Full Marks= 25(End Semester. There will be no internal examination.

Sl. No	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**

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

Department of Zoology
NEP UG Syllabus
Minor Paper
Semester V

Minor – 1C (MN – 1C) Biochemistry, Physiology & Developmental Biology
Credit – 4 **Lectures – 60 Hours**
FM= 100 [Theory = 75 + Practical = 25]
Theory = [End Semester = 60 + Internal Examination = 15 (Written Examination =10 + Class Performance & Attendance = 05)]

Instructions:

- In all eight questions to be set there shall be two groups, i.e., A and B. There will be two groups of questions.
- **Group A** is compulsory which will contain **three questions.**
- **Question no. 1** will be **very short answer type** consisting of **five questions of 1 mark each.**
- **Question no. 2 & 3** will be of **short answer type** of **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 carrying equal marks covering the whole syllabus.

Learning Outcomes:

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

1. Understand about the importance and scope of biochemistry.
2. Understand the structure and biological significance of carbohydrates, amino acids, proteins, lipids and nucleic acids.
3. Understand the structure and function of immunoglobulins.
4. Understand the concept of enzyme, its mechanism of action and regulation.
5. Understand the physiology at cellular and system levels.
6. Understand the mechanism and regulation of breathing, oxygen consumption and determination of respiratory quotient.
7. Understand how mammalian body gets nutrition from different biomolecules.
8. Understand the process of digestion and excretion.
9. 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.

Unit	Topic	Total no. of Lectures
Unit 1: Biochemistry		
1.1	**Structure and Classification of Biomolecules** **1.1.1:** Protein	**20**
	1.1.2: Carbohydrates	
	1.1.3: Lipids	
1.2	**Metabolism** **1.2.1:** Glycolysis	
	1.2.2: Kreb's Cycle	
Unit 2: Physiology		
2.1	Blood composition, Blood Coagulation	**20**
2.2	Respiration: Transport of gases (O_2 & CO_2)	
2.3	Digestion of food: Protein, carbohydrate and lipid	
2.4	Excretion: Nephron & Urine formation	
Unit 3: Developmental biology		
3.1	Fertilization	**20**
3.2	Cleavage	
3.3	Placenta & their Function	

Binod Bihari Mahto Koyalanchal University, Dhanbad
Four Years Undergraduate Programm
Subject: Zoology
NEP UG Syllabus
Semester V
Paper: Minor

Minor-3 (Practical) (MN-1C-P) Biochemistry, Physiology and Development Biology

Credit-2 Practical Lecture-30 Hours

Full Marks= 25(End Semester. There will be no internal examination.

Sl. No	Practical	Marks Distribution
1	Biochemistry Experiment	05
2	Physiology Experiment	05
3	Permanent slides of Chick Embryo/Histology	08
4	Class record	03
5	Viva voce	04
	Total	**25**

Suggested Practical

Biochemistry

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

Physiology

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

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

Binod Bihari Mahto Koyalanchal University, Dhanbad

Department of Zoology NEP UG Syllabus

Multidisciplinary Course (MDC)

For Semesters 1/2/3: Zoology

Credit – Theory 3 Lectures = 45 Hours

FM= 75 [End Semester Examination = 75, No Internal Examination and no practical]

Instructions:

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

***Question no.9 will be short answer type. There will be four options of which any two to be answer carrying equal marks covering the whole syllabus.**

Unit	Topic	Total No. ofLectures
Unit 1: Diversity in the Living World		**60**
1.1	**Living World: Taxonomic Categories** **1.1.1:** What is living?	**02**
	1.1.2: Diversity in the living world	
	1.1.3: Taxonomic Categories	
	1.1.4: Taxonomic Aids	
1.2	**Biological Classification** **1.2.1:** Kingdom Monera	**02**
	1.2.2: Kingdom Protista	
	1.2.3: Kingdom Fungi	
	1.2.4: Kingdom Plantae	
	1.2.5: Kingdom Animalia	
	1.2.6: Viruses, Viroids & Lichens	
1.3	**Animal Kingdom** **1.3.1:** Basis of Classification	

	1.3.2: Classification of Animals	**02**
Unit 2: Cell Biology		
2.1	**Cell: Structure & Function** **2.1.1:** Cell Theory	**02**
	2.1.2: Prokaryotic Cell	
	2.1.3: Eukaryotic Cell	
2.2	**Biomolecules:** 2.2.1: Biomacromolecules: Proteins, Carbohydrates, Lipids, Nucleic Acids, Enzymes	**04**
2.3	**Cell Cycle & Cell Division**	**02**
Unit 3: Human Physiology		
3.1	**Digestion & Absorption** **3.1.1:** Alimentary Canal & Digestive Glands	**04**
	3.1.2: Digestion of Food	
	3.1.3: Absorption	
	3.1.4: Associated Disorders	
3.2	**Respiration & Transport of Gases** **3.2.1:** Respiratory Organs	**04**
	3.2.2: Mechanism of Breathing	
	3.2.3: Exchange of Gases	
	3.2.4: Transport of Gases	
	3.2.5: Regulation of Respiration	
	3.2.6: Associated Disorders	
3.3	**Body Fluids & Circulation** **3.3.1: Blood**	**02**
	3.3.2: Lymph	

	3.3.3: Circulatory Pathways	
	3.3.4: Double Circulation	
	3.3.5: Regulation of Cardiac Activity	
	3.3.6: Associated Disorders	
3.4	**Excretory System:** **3.4.1:** Human Excretory System	**04**
	3.4.2: Urine Formation	
	3.4.3: Function of the Tubules	
	3.4.4: Counter Current Mechanism	
	3.4.5: Regulation of Kidney Function & Micturition	
	3.4.6: Associated Disorders	
3.5	**Nervous System** **3.5.1:** Human Neural System	**06**
	3.5.2: Neuron	
	3.5.3: Central Nervous System	
	3.5.4: Sensory Reception & Processing	
3.6	**Reproductive System** **3.6.1:** Types of Reproduction	**06**
	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	
Unit 4: Genetics & Evolution		
4.1	**Principles of Inheritance and Variation** **4.1.1:** Mendel's Law of Inheritance	**06**
	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	**04**
	4.2.2: RNA World	
	4.2.3: Replication	
	4.2.4: Transcription	
	4.2.5: Genetic Code	
	4.2.6: Translation	
4.3	Evolution: Theories & Sources of Evolution • Lamarckism • Neo- Lamarckism • Darwininsm • Neo-Darwinism	**04**
4.4	**Sources of Variations:** **2.2.1:** Mutation **2.2.2:** Recombination	
4.5	Reproductive Isolation & Its Role in Evolution	**02**
4.6	**Evolutionary Forces:** • **Hardy – Weinberg Law of Equilibrium**	**02**
4.7	**Genetic Drift** **3.2.1:** Bottle- Neck Phenomenon **3.2.2:** Founder's Principle	**02**