

Revised syllabus based on NEP 2020 and on the inputs from the Board of Studies

UNIVERSITY OF LUCKNOW

BACHELOR IN ZOOLOGY

*For B.Sc. Sem I, II & III
only*



PROGRAMME BROCHURE

(Proposed to be implemented from July 2025)

Head, Department of Zoology

[Signature]
26.08.25

TSNagar
26.08.25

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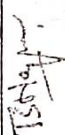
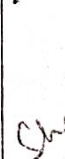
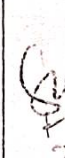
Mishra
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Shalini Malik
26/8/2025

Outline of NEP 4-year undergraduate syllabus: Department of Zoology, University of Lucknow

Year	Semester	Major A (Subject 1) @4 credits (Zoology)	Major B(Subject 2) @4 credits (Another subject from any faculty)	Minor (Subject 3) @ 2 credits (another department)	CC/ VC @ 2 credits	Total Credits	Degree
Year 1	Sem I	P1 (Theory) Diversity and Biology of Non-Chordata	P1	Q1 Diversity of Non-Chordata	Curricular course 1 (CC1)	20	CERTIFICATE
		P2 (Practical) Practical based on theory	P2				
	Sem II	P3 (Theory) Ecology and Environmental Biology	P3	Q2 Ecology and Environmental Biology	Vocational course 1 (VC1)	20	
		P4 (Theory) Biosystematics and Evolutionary Biology	P4				
Year 2	Sem III	P5 (Theory) Diversity and Biology of Chordata	P5	Q3 Diversity and Biology of Chordata	Curricular course 2 (CC2)	20	DIPLOMA
		P6 (Practical) Practical based on theory	P6				
	Sem IV	P7 (Theory) Animal Physiology	P7	Q4 Animal Physiology	Vocational course 2 (VC2)	20	
		P8 (Theory) Animal Behaviour and Chronobiology	P8				
Year 3	Sem V	P9 (Theory) Cell Biology and Genetics	P9	Internship/ Term paper/ Minor project @ 4 credits		20	GRADUATION DEGREE
		P10 (Practical) Practical based on theory	P10				
	Sem VI	P11 (Theory) Molecular Biology and Biochemistry	P11			20	
		P12 (Theory) Developmental Biology and Immunology	P12				
Year 4	Sem VII	P13A (Theory- Optional) Wildlife				20	GRADUATION HONOURS WITH RESEARCH
		P13B (Theory- Optional) Toxicology					
		P14 (Theory) Biotechnology and Bioinformatics					
		P15 (Theory) Bioinstrumentation and Biostatistics					
		P16 (Theory) Economic Zoology					
		P17 (Practical) Practical based on theory					
		P18A/B/C/D /E/F(Optional)					
	Sem VIII	P19 (Theory) Research Methodology	Major Research Project/ Dissertation (12 credits)			20	
		P20 Term paper					
Rashtra Gaurav (Compulsory Non credited)							
Total Credits							160


 Rashtra Gaurav
 26/8/2025

 Shalini Malik
 26/8/2025

 P2
 26/8/2025
 1

Semester I

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26/8/25 MB
Shahie Malik 26/8/25

Course Code- P1 (Major Paper)
Diversity and Biology of Non-Chordata

Total Credits: 04

Teaching Hours: 60

Course objectives

- To create in the student an appreciation of non-chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationships amongst non-chordate groups

Unit I

Phylum Protozoa

General characteristics and classification up to order level

Type study of *Paramecium caudatum*

Life cycle and pathogenicity of *Plasmodium vivax* and *Leishmania donovani*

5

RK

Phylum Porifera

General characteristics and classification up to order level

Type study of *Sycon*

Canal system

Skeleton in sponges

5

SM

Phylum Cnidaria

General characteristics and classification up to order level

Type study of *Obelia geniculata*

Corals and coral reefs

5

AMK

Unit II

Phylum Platyhelminthes

General characteristics and classification up to order level

Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*

Parasitic adaptations

7

AT

Phylum Nematoda

General characteristics and classification up to order level

Life cycle and pathogenicity of *Wuchereria bancrofti*

3

Phylum Annelida

General characteristics and classification up to order level

Type study of *Nereis virens*

Coelom

PS 5

Unit III

Phylum Arthropoda

General characteristics and classification up to order level

Type study of *Palaemon malcolmsonii*

Type study of Grasshopper (*Schistocerca*)

8

GM

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Phylum Mollusca

General characteristics and classification up to order level

Type study of *Pila globosa*

Pearl formation in bivalves

/AR⁷

Unit IV

Phylum Echinodermata

General characteristics and classification up to order level

Type study of *Asterias rubens*

/HH⁸

Phylum Hemichordata

General characteristics and classification up to order level

Type study of *Balanoglossus clavigerus*

Affinities

/NR⁷ (TY)

Course learning Outcomes:

At the completion of the course, the student will be able to:

- understand and appreciate the diversity of life concerning non-chordate animals.
- describe the general characters of non-chordate animals.
- identify and classify non-chordate animals based on their form and structure and classification.
- understand the life cycle and control of various representatives of non-chordate animals.
- explain the evolutionary relationship amongst different non-chordate groups.

Suggested Reading:

1. Ruppert, EE, Fox R.S., Barnes R.D. (2004) *Invertebrate Zoology*, 7th Edition. Cengage Learning
2. Thomas Jeffrey Parker, William A. Haswell (2016). *Parker & Haswell's A Textbook of Zoology Volume 1*. WENTWORTH Press
3. Brusca (2016). *Invertebrates*. Sinauer
4. Pechenik Jan (2014). *Biology of the invertebrates*. McGraw Hill
5. Barnes R. S. K., Calow P. P., Olive P. J. W., Golding D. W., Spicer J. I. (2009). *The Invertebrates: A Synthesis*. Wiley Blackwell
6. Kotpal R.L. (2018) *Modern Text Book of Zoology: Invertebrates*. Rastogi Publications
7. Nigam H.C. (2013) *Biology of non-chordates*. Vishal Publishing Co

Assignments(anyone)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature

Mhange
15/07/25

Arshad

15/7/25

P. Singh
15/07/25

Ch. Ch.

15.07.25

15/07/2025

Shah Malik
15/07/2025

Akhanzei
15.07.2025

Wishy

B. Sc. Semester I
(Detail Practical Syllabus)

Course Code- P2

Practical 1: Diversity and Biology of Non-Chordata

Course outcome:

The student at the completion of the course will be able to:

- demonstrate comprehensive identification abilities of non-chordates diversity
- understand the taxonomic position and body organization of invertebrates
- make temporary and permanent preparations
- demonstrate various phenomenon

Protozoa:

- (a) Examination of pond water for different kinds of protozoans, with emphasis on *Amoeba*, *Arcella*, *Euglena*, *Paramecium*, *Vorticella*
- (b) Study of prepared slides: *Amoeba*, *Euglena*, *Vorticella*, *Noctiluca*, *Monocystis*, *Arcella*, *Paramecium*, *Opalina*, *Nyctotherus*, *Balantidium*, *Polystomella*, *Trypanosoma*, *Plasmodium*, *Leishmania*.

Porifera:

- (a) *Sycon*: Spicules (temporary preparation).
Transverse and longitudinal sections (prepared slides).
- (b) Gemmule of *Spongilla* (permanent preparation).
- (c) Study of prepared slides/specimens: *Euplectella*, *Spongilla*, *Euspongia*, *Sycon*

Cnidaria:

- (a) *Obelia*: Colony (prepared slide), Medusa (prepared slide).
- (b) *Aurelia*: General morphology, Tentaculocyst (prepared slide).
Prepared slides and models of life-history stages (Scyphistoma, Strobila, Ephyra).
- (c) Study of prepared slides/specimens: *Hydra*, *Physalia*, *Corallium*, *Fungia*, *Mudrepora*, *Pennatula*, *Metridium*

Platyhelminthes:

- (a) *Fasciola*: Whole mount (W.M.) Transverse sections (T.S.) of oral sucker and ventral sucker
(Prepared slides)
Larval forms (prepared slides).
- (b) *Taenia*: Mature and gravid proglottids
- (c) Study of prepared slides/specimens: *Planaria*, *Polystomum*, *Paramphistomum*, *Echinococcus*, *Dipylidium*, *Cysticercus* (Bladder worm).

Nemathelminthes:

- (a) *Ascaris*: External characters of male and female (Specimen).
Transverse section (T.S.) of male and female (prepared slides).
- (b) *Ascaris lumbricoides*, *Enterobius vermicularis*, *Ancylostoma duodenale* (prepared slides).

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Annelida:

- (a) *Nereis*: T.S. body through parapodium of *Nereis* and *Heteronereis* (Prepared slides).
- (b) *Pheretima*: T.S. through Gizzard and Typhlosolar region (Prepared slides).
- (c) *Hirudinaria* (Leech): T.S. through crop region (prepared slide)
- (d) Permanent preparation of parapodium of *Nereis* and septal nephridia of *Pheretima*; temporary preparation of setae in situ of *Pheretima*

Arthropoda:

- (a) *Palaemon*: Appendages (Display)
Dissection of Central Nervous System; Take out of hastate plate; Glycerine preparation of statocyst.
- (b) *Anopheles* and *Culex*: Mouth parts of male and female.
- (c) *Musca*: Glycerine preparation of proboscis.
- (d) *Daphnia*, *Cyclops*, *Balanus*, *Eupagurus*, *Scylla*, *Sacculina* (on crab)
Larval forms (Nauplius, Zoea),
Study of prepared slides/specimens: *Lepisma*, *Schistocerca*, *Odontotermes*, *Apis*,
Xenopsylla, *Thyroglutus*, *Scolopendra*, *Lycosa*, *Ixodes*, *Limulus*, *Papilio demoleus*.

Mollusca:

- (a) *Lamellidens*: Permanent preparations of gill lamella;
- (b) Transverse section through middle region of body (prepared slides).
Glochidium (larva) (prepared slide).
- (c) *Pila*: Dissection.
- (d) Study of prepared slides/specimens: *Chiton*, *Teredo*, *Turbinella*, *Doris*, *Aplysia*, *Dentalium*,
Nautilus, *Sepia*, *Pinctada margaritifera*

Echinodermata:

- (a) *Pentaceros*: Pedicellaria (prepared slide).
Transverse section of arm (prepared slide).
- (b) Study of prepared slides/specimens: *Asterias*, *Echinus*, *Ophiothrix*, *Holothuria*, *Antedon*,
Pentaceros

Chundri *Ash. h.* *Akanangis* *Wishu*

Semester II

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26/8/25

Charlie Nunk
26/8/2025



Course Code- P3
Ecology and Environmental Biology

Total Credits: 04

Teaching Hours:60

Course objectives

- To develop in the student an understanding of ecosystem structure and function
- To understand community interactions and succession.
- To develop in the student an understanding of environmental structure and function
- To develop in the student an understanding of global environmental issues, policies and practices.
- To learn about the factors polluting the environment, their impacts and control measures
- To learn about environmental management

Unit I

Concepts of Ecosystem

- Amk { Ecology: Definition, ecological hierarchy
Ecosystem: concept, types and structural components
Ecosystem functions: Energy flow and Biogeochemical cycles
Trophic levels, Food chain and Food web
Population: characteristics, growth and regulation

(15)
1
3
4
2
5

Unit II

Ecological Features

- AK { Inter specific interactions
Ecological succession
Ecological niche
r- and k- strategies
Ecological adaptations (aquatic, volant, arboreal, cursorial, fossorial and desert)

(15)
3
3
2
2
5

Unit III

Environmental pollution

- mk { Definition, consequences, management strategies.
Cause/source, consequences, preventive measures, and management of air, water, soil, radiation, noise and light pollution.
Environmental problems:
The Green house effect: Cause, consequences, preventive measures.
Ozone depletion: Cause, consequences, preventive measures.
Acid rain: Cause, consequences, preventive measures.
Environmental Footprints

(15)
1
7
2
2
2
1

Unit IV

Environmental Management Strategies

- HH { Environmental awareness, including resource conservation and sanitation.
Environmental legislation: The Environment Protection Act (1986), The National Green Tribunal Act (2010).
United Nations Environment Programme (UNEP).

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2

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P2

Recent Conventions	2
Environmental Monitoring: Methods, components and significance	4
Waste management: Sanitary landfill, Composting, Incineration and pyrolysis.	4

Course learning outcomes:

At the completion of the course, the student will be able to:

- Understand the basic concept of ecology, structure and function of ecosystem and its management.
- Understand, interpret and explain how interactions between organisms and their environments drive the dynamics of individuals, populations, communities, and ecosystems.
- Apply the scientific method and techniques to describe, monitor and manage environmental pollutions.
- Develop critical thinking for shaping strategies (scientific, social, and legal) for environmental protection and conservation of biodiversity and sustainable development.
- Understand the characteristics of population and its dynamics and illustrate how population data can be analyzed using statistics, graphs, life tables, and survivorship curves.

Suggested Reading:

1. Odum E.P. (2005) *Fundamentals of Ecology*. Cengage Learning India Private Limited
2. Smith Thomas M. Smith Robert Leo (2014) *Elements of Ecology*. Pearson Education
3. Krebs, Charles J. 2009. *Ecology: the experimental analysis of distribution and abundance*. Pearson.
4. Sharma P.D. (2018). *Fundamentals of Ecology*. Rastogi Publications.
5. Sharma P.D. (2018). *Environmental Biology and Toxicology*. Rastogi Publications.
6. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. *Environmental & Pollution Science*. Elsevier Academic Press.
7. Gupta, KR (2006). *Environmental Legislation in India*. Atlantic Publishers and Distributors.
8. Purohit, S.S. & Ranjan, R. (2007). *Ecology, Environment & Pollution*. Agrobios Publications.
9. Thangavel, P. & Sridevi, G. (2015). *Environmental Sustainability: Role of Green Technologies*, Springer Publications.
10. Wooley, T. & Kimmins, S. (2002). *Green Building Handbook* (Vol. 1 & 2). Spon Press
11. Darlington, P.J., (1957). *The Zoogeography: The Geographical Distribution of Animals*. Wiley Publication.
12. Caughley, G., and Sinclair, A.R.E. (1994). *Wildlife Ecology and Management*. Blackwell Science.

Assignments (anyone)

1. Project (500 words) / presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Survey of local ecosystems and submission of report.

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Course Code- P4
Biosystematics and Evolutionary Biology

Total Credits: 04

Teaching Hours: 60

Course objectives

To develop:

- understanding of animal taxonomy and systematic and their application
- molecular basis of animal taxonomy.
- basic knowledge of evolutionary biology, both presenting the general principles of the discipline and exploring in detail theoretical problems and case studies.
- understanding of various theories of evolution comprising Lamarckism, Darwinism, and Neo-Darwinism
- comprehensive knowledge regarding various sources of variations and their role in evolution
- understanding of key concepts of Population Genetics in terms of Hardy-Weinberg Law, Genetic Drift and Types of Natural Selection.

Unit I

mg {	Introduction to biosystematics and taxonomy		(15)
	Definition, basic concepts, and importance of taxonomy and biosystematics	3	
	Types and operation of taxonomy	5	
	International Code of Zoological Nomenclature (ICZN)	3	
	Taxonomic (Linnean) hierarchy	4	

Unit II

AT {	Biological Classification and Taxonomic Procedures		(15)
	Theories of biological classification	3	
	Collection, preservation of specimens	4	
	Process of identification, Description	4	
	Molecular Techniques in Systematics	4	

Unit III

gm {	Evolutionary concepts		(15)
	Theories of evolution (Lamarckism, Darwinism, Modern synthetic theory)	3	
	Mechanism of evolution: mutation, genetic drift, gene flow, non-random mating, natural selection, molecular drive	5	
	Hardy-Weinberg law	2	
	Biological species concept, Mode of speciation (allopatric, parapatric and sympatric)	5	

Unit IV

TV {	Evidence of Evolution		(15)
	Paleobiological: Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods).	5	
	Anatomical: Vestigial organs; Homologous and Analogous organs	2	
	Taxonomic: Transitional forms/evolutionary intermediates; living fossils.	4	
	Evolutionary patterns (Divergent, Convergent & Parallel evolution)	4	

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Course learning outcomes

At the completion of the course, the student will be able to:

- the fundamental principles of systematic,
- how to classify animals according to their characters, and
- what are the theories which have to followed to study the classification
- understand the concept, process and patterns of evolution.
- acquire knowledge and reasoning skills useful to interpret biological phenomena in the light of evolution.

Suggested Reading:

1. Alfred, J.R.B and Ramakrishna. 2004. Collection, Preservation and Identification of Animals. Zoological Survey of India Publications, Calcutta.
2. Anderson T.A.2001. Invertebrate Zoology (2edn). Oxford University Press, New
3. Kapoor V.C. 1991. Theory and Practice of Animal Taxonomy. Oxford and IBH Publishing Co., Pvt. Ltd. New Delhi.
4. Young J.Z. 1950. Life of Vertebrates. Clarendon Press, Oxford, UK.
5. Winston J.E.2000. Describing species: Practical Taxonomic Procedures for Biologists. Columbia University Press, Columbia, USA.
6. Simpson G.G. Principle of animal taxonomy. Oxford IBH Publishing company.
7. Mayer E. Elements of Taxonomy. Oxford IBH Publishing company.
8. Minnelli A. (1993). Biological Systematics. Chapman & Hall.
1. Futuyma, Douglas J. and Kirkpatrick Mark. Evolution (4th Edition) Sinauer
2. Veer Bala Rastogi (2017) Organic Evolution. Med Tech
3. Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger Pub. Co.
4. Hall B.K. and Hallgrímsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.
5. Dawkins, Richard. "The selfish gene: with a new introduction by the author." UK: Oxford University Press.
6. Dawkins, R. (1996). The blind watchmaker: Why the evidence of evolution reveals a universe without design. WW Norton & Company.
7. Darwin, Charles (2003). The Origin of Species: 150th Anniversary Edition
8. Huxley Julian. Evolution: The Modern Synthesis. Harper and Brothers
9. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

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P2

Semester III

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P2

Charlie Mink
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Course Code- P5

Diversity and Biology of Chordata

Total Credits: 04

Teaching Hours: 60

Course objectives

- To create in the student an appreciation of chordate diversity
- To develop in the student an understanding of structural and functional diversity
- To develop in the student the understanding of evolutionary relationship amongst chordates

Unit I

Phylum Chordata

General characteristics and outline classification up to subclass level
Origin of chordata

3

Sub-phylum Urochordata

General characters and classification up to order level
Type study of *Herdmania*
Affinities and systematic position

6

Sub-phylum Cephalochordata

General characters and classification up to order level
Type study of *Branchiostoma*
Affinities and systematic position

6

Unit II

Agnatha

General characters and classification up to order level

1

Pisces

General characters and classification up to subclass level
Type study of *Scoliodon sorrakowah*
Accessory respiratory organs
Migration

9

Amphibia

General characters and classification up to order level
Parental care
Neoteny/ Paedogenesis

5

Unit III

Reptilia

General characters and classification up to order level
Affinities of *Sphenodon punctatus*
Venomous & non-venomous snakes of India and their biting mechanism

5

Dinosaurs

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P2

Aves

5

General characters and classification up to order level

AS Archaeopteryx – a connecting link

Types of feathers

Flight adaptations

Migration

Mammalia

5

AS General characters and classification up to order level

Dentition

Affinities of Prototheria

Adaptive radiation with reference to locomotory appendages

Unit IV

Comparative functional anatomy of vertebrates

15

AK2 Integument, digestive system, circulatory system, urinogenital system, nervous system and sense organs

KS2

AS3

ML3

AR2

AS3

Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand and appreciate the diversity of life with respect to chordate animals.
2. describe the general characters of chordate animals.
3. identify and classify chordate animals on the basis of their form and structure and classification.
4. explain evolutionary relationships amongst different chordate groups.
5. obtain an overview of economically important vertebrates.

Suggested Reading:

1. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
2. Kenneth V. Kardong (2015). Vertebrates: Comparative Anatomy, Function, Evolution. McGraw Hill
3. Thomas Jeffrey Parker, William A. Haswell (2016) Parker & Haswell's A Textbook of Zoology Volume 2. WENTWORTH Press
4. Eroschenko, Victor P. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins
5. Kotpal R.L. (2018) Modern Text Book of Zoology: Vertebrates. Rastogi Publications
6. Nigam H.C. (2017) Biology of Chordates. Vishal Publishing Co

Assignments (Any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions
6. Study based report of animals in nature
7. Outreach activities promoting dissolution of superstitions associated with animals
8. Photography, identification and listing of local fauna

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26/8/2025
P2

Practical Syllabus

Semester III

Course Code- P6

MM: 100

Practical: Chordates, Animal Physiology, Animal Behaviour and Chronobiology

1. Type study (Specimens & Prepared Slides) of Chordata
 - **Protochordata:** Study of prepared slides and specimens
 - **Cyclostomata:** Study of prepared slides and specimens
 - **Pisces:** Study of prepared slides and specimens
 - **Amphibia:** Study of prepared slides and specimens
 - **Reptilia:** Study of prepared slides and specimens
 - Study of carapace and plastron
 - **Aves:** Study of prepared slides and specimens
 - ~~Beak modifications~~, feathers
 - **Mammalia** Study of prepared slides and specimens
2. Study of Mammalian histology from prepared slides
3. Study of Reptilian endoskeleton (C~~varanus~~)
4. Permanent preparation of Cycloid Scales
5. Dissections-
 - a. Afferent branchial system in *Wallago attu*
 - b. Efferent branchial system in *Wallago attu*
 - c. Cranial Nerves (V, VII, IX and X) in *Wallago attu*
6. Slide preparation of Haemin Crystals
7. ~~Permanent stained preparation of striated muscle of Frog~~
8. Study of Instruments: Haemoglobinometer, Haemocytometer
9. Analysis of active and rest durations in the perch hopping behavior of the bird from the data provided.
10. Recording and study of human (self) sleep-wake and feeding time over a given period

(Revised syllabus based on NEP 2020 and on the inputs from the Board of Studies and
Departmental Committee)

UNIVERSITY OF LUCKNOW

BACHELOR OF SCIENCE

For B.Sc. Sem IV & V
only

$$26 \times 3 = \begin{array}{r} 78 \\ 78 \\ \hline \end{array}$$

$$60 \mid \begin{array}{r} 156 \\ \hline \end{array}$$



SYLLABUS FOR ZOOLOGY

(Proposed to be implemented from July 2024)

B. Singh
03.04.2024

Head, Department of Zoology
3 April 2024

M. Banerjee
03/04/2024

P. Singh

Malik Malik

1-178

M. Singh

H. Singh

A. Singh
03/04/24

Outline of NEP 4-year undergraduate syllabus: Department of Zoology, University of Lucknow

Outline of NEP 4-year undergraduate syllabus: Department of Zoology, University of Lucknow						
Year	Semester	Major A (Subject 1) @ 4 credits (Zoology)	Major B (Subject 2) @ 4 credits (Another subject from any faculty)	Minor (Subject 3) @ 2 credits (another department)	CC/ VC @ 2 credits	Total Credits
Year 1	Sem I	P1 (Theory) Diversity and Biology of Non-Chordata	P1	Q1 Diversity of Non-Chordata	Curricular course 1 (CC1)	20
		P2 (Theory) Biosystematics and Evolutionary Biology	P2			
	Sem II	P3 (Theory) Ecology and Environmental Biology	P3	Q2 Ecology and Environmental Biology	Vocational course 1 (VC1)	20
		P4 (Practical) Practical based on theory	P4			
Year 2	Sem III	P5 (Theory) Diversity and Biology of Chordata	P5	Q3 Diversity and Biology of Chordata	Curricular course 2 (CC2)	20
		P6 (Theory) Animal Behaviour and Chronobiology	P6			
	Sem IV	P7 (Theory) Animal Physiology	P7	Q4 Animal Physiology	Vocational course 2 (VC2)	20
		P8 (Practical) Practical based on theory	P8			
Year 3	Sem V	P9 (Theory) Cell Biology and Genetics	P9	Internship/ Term paper/ Minor project @ 4 credits		20
		P10 (Theory) Developmental Biology and Immunology	P10			
	Sem VI	P11 (Theory) Molecular Biology and Biochemistry	P11	Minor project @ 4 credits		20
		P12 (Practical) Practical based on theory	P12			
Year 4	Sem VII	P13A (Theory- Optional) Wildlife				4
		P13B (Theory- Optional) Toxicology				
		P14 (Theory) Biotechnology and Bioinformatics				
		P15 (Theory) Bioinstrumentation and Biostatistics				
	Sem VIII	P16 (Theory) Economic Zoology	Major Research Project/ Dissertation (12 credits)	20		
		P17 (Practical) Practical based on theory				
		P18A/B/C/D/E (Optional) Specialization				
		P19 (Theory) Research Methodology				
P20 Term paper						
Rashtra Gaurav (Compulsory Non credited)						
Total Credits						160

Chandrabali

Dr. P. S. Singh

03/04/24

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Semester IV

(60)

Course Code- P7
Animal Physiology

Total Credits: 04

Teaching Hours: 60

Course objectives

- To develop in the student an understanding of functioning of an organisms' body
- To develop in the student an understanding of the various homeostatic systems of the body
- To develop in the student an understanding of regulation of function in the body

Unit I

Digestion

8

SS Physiology of digestion and absorption of protein, carbohydrates and lipid
Role of Gastrointestinal hormones in digestion

Respiration

7

HH Respiratory Pigments, Oxygen dissociation curves, and Bohr's Effect
Respiratory volumes and capacities
Transport of oxygen and carbon dioxide in blood

Unit II

Circulation

8

MK Composition and constituents of blood
Blood groups and Rh factor
Factors and mechanisms of blood coagulation
Cardiac cycle

Excretion

7

AR Structure of nephron
Urine formation
Osmoregulation

Unit III

Nerve Physiology

8

AMK Structure of neuron
Conduction of nerve impulse
Synapse and Synaptic transmission
Neurotransmitters

Muscles

7

Types of muscles
Mechanism of contraction of skeletal muscles

Unit IV

Endocrine glands

8

Structure and function of endocrine glands: pituitary, pineal, thyroid, parathyroid, pancreas, adrenal and gonads.

Reproduction

7

RK Physiology of reproduction, puberty and menopause

19

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Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand various functional components of the body
2. understand the mechanism underlying maintenance of homeostasis of the body
3. have an enhanced knowledge and appreciation of mammalian physiology;
4. understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems;
5. understand how these separate systems interact to yield integrated physiological responses to challenges such as exercise, fasting and ascent to high altitude, and how they can sometimes fail;

Suggested Reading:

1. Christopher D. Moyes, Patricia M. Schulte(2016). Principles of Animal Physiology. 3rd Edition, Pearson.
2. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions
7. Outreach activities promoting awareness of physiological and immunological diseases and disorders.
8. Surveys on health indices, disease spread in family, neighbourhood, communities.

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Semester V

Course Code- P9
Cell Biology & Genetics

Total Credits: 04

Teaching Hours: 60

Course objectives

- To understand the structure and function of organelles in a cell
- To understand the DNA structure & types, chromatin structure and organization
- To understand the process of cell division and growth
- To understand the basics of heredity

Unit I

Structure and Function of Cell Organelles

Plasma membrane, Cell-cell interaction: cell adhesion molecules, cellular junctions
Endomembrane system: protein targeting and sorting
Cytoskeleton: microtubules, microfilaments, intermediate filaments
Mitochondria, Peroxisome, and ribosome

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Unit II

Nucleus and Chromatin Structure

Structure and function of the nucleus in eukaryotes
Chemical structure and base composition of DNA and RNA
Chromatin organization, Structure of chromosomes
Cell cycle, Cell Division and cell cycle regulation

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Unit-III

Genetics I

Basic principles of heredity: Mendel's laws of Inheritance
Complete and Incomplete Dominance
Linkage and Crossing over
Sex Determination; Sex-linked inheritance and Dosage compensation
Sex-Influenced and Sex-Limited traits

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Unit IV

Genetics II

Multiple Alleles, Gene-gene interaction
Cytoplasmic Inheritance, Genetic Maternal Effects; Genomic Imprinting.
Interaction between Genes and Environment
Inheritance of continuous, meristic, and threshold characters

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Course learning outcomes:

The student after the course will be able to:

1. Understand the structure and function of all the cell organelles.
2. Know about the chromatin structure and its location.
3. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
4. Understand the basic laws of inheritance.

Suggested Reading:

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Pierce B. Genetics. Freeman (2004).

Assignments (any one)

1. Project (500 words)/ presentation based on the above course content
2. Analytical MCQ based questions
3. Biological Crosswords
4. Charts
5. 500 words answer to analytical questions

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Semester - VI

P12

Course Code- P10
Developmental Biology and Immunology

Total Credits: 04**Teaching Hours: 60****Course objectives**

The objective of this course is to provide insight on:

- The key events related to early embryogenesis including fertilization, cleavage, compaction, implantation, gastrulation and formation of body plan.
- how the single cell formed at fertilization forms an embryo and then a fully formed adult organism.
- integration of genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development, and.
- To develop basic understanding about Immunity, its organization and their mechanisms.
- To understand in detail the basic immune mechanism related to different Immunological diseases & disorders.
- To create and develop the ideology about different vaccines, immune treatment mechanisms, autoimmunity and hypersensitivity.

Unit I**Early embryonic development**

Gametogenesis (spermatogenesis and oogenesis)

Fertilization (external and internal)

Egg: structure and types

Morphogenesis and morphogens

Cleavage

Blastulation

Fate Maps

Gastrulation

Stem cells

Cell lineage

Unit II**Late embryonic development**

Chick embryo development upto primitive streak formation

Embryonic induction and organizers

Extra embryonic membranes.

Placenta: types and physiology

Modes and mechanisms of regeneration

Unit III**Overview of the immune system**

Immunity: concept and types

Cells and organs of immune systems

Immunoglobulins: types and structure of different classes

Antigen and antibodies and their interactions

Autoimmunity

Unit IV**Immunological mechanisms and applications**

Major Histocompatibility Complex

Cytokines: properties and functions

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Hybridoma technology
Monoclonal antibodies

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Course learning outcomes:

At the completion of the course, the student will be able to:

1. understand how the single cell formed at fertilization forms an embryo and then a full adult organism
2. a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features,
3. how a cell behaves in response to an autonomous determinant or an external signal, and
4. an in depth understanding about Immune System & its elaborate mechanisms.

Suggested Reading:

1. Gilbert, Scott F. and Barresi, Michael J. F. Developmental Biology. Eleventh Edition. By. Sunderland (Massachusetts): Sinauer Associates
2. Carlson BM. (1988). Patten's Foundations of Embryology. 5th ed. New York: McGraw-Hill.
3. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby (2007) Kuby Immunology. W H Freeman
4. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. (2017). Roitt's Essential Immunology, 13th Edition. Wiley Blackwell
5. Nandini Shetty (2005) Immunology Introductory Textbook. New Age International.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical question
7. Outreach activities promoting awareness of developmental disorders
8. Projects observing metamorphosis in insects and amphibians

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Internship/ Term Paper/ Minor Project

Total Credits: 4

Course objectives

- To allow the students to explore the realm of research that is being performed within the department.
- To strengthen the understanding of the fundamentals through effective application of theoretical concepts.
- To help the students develop writing and communication skills.
- Provide opportunity to gain real-world experience in their chosen fields.
- To organize their thoughts, develop their ideas, and present their findings in a clear and concise manner.

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**Department of Zoology
University of Lucknow
Lucknow**

For B.Sc
Sem VI
only



**Syllabus for UG (Zoology)
(National Education Policy – 2020)**

**Academic Session 2021-22
&
onwards**

Outline of NEP 4-year undergraduate syllabus: Department of Zoology, University of Lucknow

Year	Semester	Paper	Paper Type	Major Subject 1 (Zoology) @4 credits	Major Subject 2 (Another subject from any faculty) @4 credits	Minor 1 @4 credits (from another department)	@4 credits
CERTIFICATE COURSE IN ANIMAL DIVERSITY							
Year 1	Sem 1	P1	Compulsory (Theory)	Diversity and Biology of Non-Chordata		Diversity of Non-Chordata	Curricular course 1
		P2	Compulsory (Practical)	Theory based practical			
	Sem 2	P3	Compulsory (Theory)	Diversity and Biology of Chordata		Diversity of Chordata	Vocational course 1
		P4	Compulsory (Practical)	Theory based practical			
DIPLOMA IN APPLIED ZOOLOGY AND ANIMAL CONSERVATION							
Year 2	Sem 3	P5	Compulsory (Theory)	Environmental Biology and Wildlife		Environmental Biology and Wildlife	Curricular course 2
		P6	Compulsory (Practical)	Theory based practical			
	Sem 4	P7	Compulsory (Theory)	Applied Zoology		Applied Zoology	Vocational course 2
		P8	Compulsory (Practical)	Theory based practical			
BACHELOR IN SCIENCE							
Year 3	Sem 5	P9	Compulsory (Theory)	Animal Physiology and Biochemistry			Internship/ Term paper
		P10	Compulsory (Practical)	Theory based practical			
		P11X	Optional (Theory)	Biosystematics			
		P11Y	Optional (Theory)	Evolutionary Biology			
	Sem 6	P12	Compulsory (Theory)	Cytogenetics and Molecular Biology			Minor project
		P13	Compulsory (Practical)	Theory based practical			
		P14X	Optional (Theory)	Toxicology			
		P14Y	Optional (Theory)	Biotechnology			
HONOURS IN ZOOLOGY							
Year 4	Sem 7	P15	Compulsory (Theory)	Developmental Biology and Immunology			Research Methodology
		P16	Compulsory (Theory)	Animal Behaviour and Chronobiology			
		P17	Compulsory (Practical)	Theory based practical			
		P18X	Optional (Theory)	Endocrinology			
		P18Y	Optional (Theory)	Entomology			
		P19X	Optional (Theory)	Fisheries			
		P19Y	Optional (Theory)	Parasitology			
		Sem 8	P20	Compulsory			
	Major Project (24 credits)						

Semester VI

P12: Cytogenetics and Molecular Biology

Total Credit: 04

Teaching Hours: 60

Course objectives

- To understand the structure and function of organelles in a cell
- To learn about cellular transport and protein trafficking
- To understand the arrangement of Genes and their interaction
- To understand extra nuclear inheritance, linkage & crossing over
- To understand the DNA structure & types, chromatin structure and organization
- The course will provide an insight into the life processes at the subcellular and molecular levels
- Other important aspects include DNA and molecular genetics including gene cloning, sequencing and gene mapping in addition to the powerful techniques that revolutionized the pharmaceutical, health and agricultural industries

Unit I

PS

Structure and function of cell and cell organelles (Plasma membrane, Mitochondria, Nucleus, Endoplasmic reticulum, Golgi Complex, ribosome and lysosomes) 15

Unit II

NR

Chromosome: types (polytene and lampbrush), organisation of chromatin. Heterochromatin and euchromatin 15
Cell division (Mitosis and Meiosis), mitotic spindle and mitotic apparatus, chromosome movement
Cell Cycle

Unit III

DR

Mendel's law of inheritance and its extension (Incomplete dominance, Codominance, multiple alleles, sex-linked traits) 15
Recombination, linkage
Sex determination
Mutation: Chromosomal mutations (deletion, duplication, inversion, translocation, aneuploidy and polyploidy), Gene mutation and mutagenesis
Pedigree analysis
Hereditary diseases of men

Unit IV

MG MG

Nucleic Acids: structure, replication, central dogma, genetic code
Protein synthesis (Transcription, Translation)
RNA processing
Gene regulation

15

Course Outcomes:

At the completion of the course, the student will be able to:

- understand the structure and function of the cell organelles and the process of cell division.
- understand the structure of gene, Mendelian principles and learn how the information contained within them gets transferred from one generation to another.
- have conceptual understanding of molecular processes viz. DNA to trait.
- develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.

- understanding of the processes of central dogma viz. transcription, translation etc. underlying survival and propagation of life at molecular level.
- Apply their knowledge in problem solving and future course of their career development in higher education and research.

Suggested Reading

1. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). *The Cell: A Molecular Approach*. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
5. Brown, T.A. Genomes 4. 4th Edition. Garland Science
6. Krebs et al. Lewin's GENES XII, Twelfth Edition. Jones and Bartlett Learning.

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Practical Syllabus Semester VI

Course Code- P13

Practical I: Cytogenetics and Molecular Biology

Course outcome:

The student at the completion of the course will be able to:

- Understand structure of biomolecules
- Understand inheritance of traits and pedigree analysis
- Understand tools and techniques of biological importance

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of permanent slides of meiosis
3. Staining of cheek epithelial cells using methylene blue
4. Study of Polytene chromosomes from *Chironomus* / *Drosophila* larvae
5. Study and interpretation of electron micrographs/ photograph showing
6. DNA replication
7. Transcription
8. Split genes
9. Preparation of models of nitrogenous bases, nucleosides and nucleotides
10. Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe, widow's peak and tongue rolling.
11. Probability assessment of above traits for future generations.
12. Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimples in chin, hypertrichosis, colour blindness.
13. Experiments demonstrating genetic laws and their exceptions
14. Pedigree analysis

P14x: Toxicology

Total Credits: 04

Teaching Hours: 60

Course objectives

- To provide theoretical and applied knowledge on the effects of chemical substances on human health.
- To introduce the students with the toxicological analysis and the signs and symptoms of important toxic syndromes.
- To learn and apply toxicity tests for terrestrial and aquatic animals
- To develop an understanding of xenobiotics, their mode of action and damage caused
- To explain specific responses of Toxicity

Unit I ?

Exposure of toxicants

Different routes/methods of exposure, frequency & duration of exposure

Human exposure

Dose-response relationship

Selective toxicity

concept, significance

Basic mechanisms of selective toxicity

2

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(5)

Toxicity Tests

Bioassay

Acute toxicity tests for terrestrial and aquatic animals

Chronic toxicity tests

Concept of maximum acceptable toxicant concentration (MATC) and safe concentration

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(10)

Factors affecting toxicity

Factors related to the chemical exposure

Surrounding medium and the organisms

1

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Unit II

Toxic effects of Xenobiotics

Local and systemic effects

Immediate and delayed effects

Reversible and irreversible effects

Biochemical and physiological effects of xenobiotics

Nanotoxicology

1

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(7)

Bioaccumulation of Xenobiotics

Concept of bioconcentration, bioaccumulation and biomagnifications;

Bioconcentration factor

Process of bioaccumulation in the biological system

2

1

Biotransformation of Xenobiotics

Concept of biotransformation and metabolism

Sites of biotransformation

Biotransformation enzymes and general biotransformation reactions

Factors affecting biotransformation

Antidotal therapy

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(9)

Unit III

Toxic effects:

- Digestive system
- Circulatory system
- Respiratory system
- Excretory system
- Reproductive system
- Endocrine system
- Nervous system

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Unit IV

- Mutagenicity
- Teratogenicity
- Carcinogenicity
- Toxicogenomics
- Safety evaluation of xenobiotics
- Regulatory Toxicity

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Course Outcomes:

At the completion of the course, the student will be able to:

- examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics data
- use clinical and laboratory findings in the treatment of acute toxic exposures
- understand the xenobiotics, their categories and effects on organisms
- understand mechanisms of systemic and organ toxicity induced by xenobiotics; and learn how to analyze and interpret complex data sets in toxicological research

Suggested Reading

1. Sharma PD (2018). Environmental Biology and Toxicology. Raastogi Publications
2. Klaassen, C. & Watkins, J. (2005) Casarett & Doull's Essentials of Toxicology, 3rd edition. Lange Publications
3. Ernest Hodgson (2010) A Textbook of Modern Toxicology. Wiley
4. Beddows, C. (2017) Comprehensive Toxicology. Elsevier

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions

Course objectives

- To demonstrate the innovative utilization of manipulating enzymes, various cloning and expression vectors and analysis of genomic sequences.
- To provide an insight into the direct manipulation of DNA to alter the characteristics of an organism in a particular way.
- To learn techniques like PCR, DNA fingerprinting and cell culture.
- To interpret the applications of genetic engineering in biotechnological research.

Introduction**Unit I**

NR MG

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Concept and scope of biotechnology

Recombinant DNA technology

Cloning Vectors (Plasmid, Cosmid, Lambda bacteriophage)

Restriction enzyme

Construction of genomic and cDNA libraries

Unit II

RK

15

Molecular gene techniques

Transformation techniques (calcium chloride method and electroporation)

PCR, RFLP, RAPD, AFLP, and DNA fingerprinting

DNA microarray

DNA sequencing

Southern, northern, western blotting

Unit III

PS

15

Culture Techniques and Applications

Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)

Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

Unit IV

MG

15

Genetically Modified Organisms

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection.

Applications of transgenic animals: Production of pharmaceuticals, donor organs, knock out mice.

Human Genome Project

Course Outcomes:

At the completion of the course, the student will be able to:

- understand principles of animal culture, DNA fingerprinting, etc.
- learn and exhibit transformation techniques, embryo transfer technology, etc.
- get insight in applications or recombinant DNA technology in agriculture, production of therapeutic proteins
- use biotechnology in finding cure of animal diseases
- understand how transgenic animals can be useful for improving the welfare of humans and animals
- understand the ethical implications of animal biotechnology

Suggested Readings

1. Brown, T. A. (2010). Gene cloning and DNA analysis: An introduction. Hoboken: Wiley-Blackwell
2. Primrose, Sandy B. and Twyman Richard (2016). Principles of Gene Manipulation and Genomics, 8th Edition. Wiley-Blackwell
3. Biotechnology Fundamentals (2020). Edited by Firdos Alam Khan, 3rd Edition. Taylor and Francis
4. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. 4th Edition. ASM press, Washington, USA.
5. Click B.R. and Pasternak J.J. (1998). Molecular Biotechnology. ASM Press, Washington.
6. Wu W., Welsh M.J., Kaufman P.B. and Zhang H.H. (1997). Methods in Gene Biotechnology. CRC Press, New York

Assignments (any one)

1. Project (500 words) highlighting recent advancements.
2. Presentation highlighting recent advancements.
3. Analytical MCQ based questions
4. Biological Crosswords
5. Charts
6. 500 words answer to analytical questions