

S.S. JAIN SUBODH PG COLLEGE, JAIPUR



DEPARTMENT OF ZOOLOGY (Three -Year Undergraduate Programme)

**SYLLABUS
B.Sc. Bio (Subject: Zoology)
(Semester Scheme)
Choice-Based Credit System (CBCS)
[As Per the National Education Policy (NEP) – 2020]**

**B.Sc.(Bio)Semester I-VI
Subject: Zoology**

B.Sc.Biology(Subject: Zoology)

CourseStructureunderC.B.C.S.AndNEP-2020

B.Sc.Biology (S u b j e c t : Z o o l o g y)

ExaminationSchemeforEoSEforSemesterI

Type of Examination	CourseCodeandNomenclature	Duration of Examination		MaximumMarks		MinimumMarks	
Theory	ZOO-T-101 – Diversity & Biology of Non-Chordates	CIA	1Hrs	CIA	30	CIA	12Marks
		EoSE	3Hrs	EoSE	70	EoS E	28Marks
Practical	ZOO-P-101–PracticalII	CIA	1Hrs	CIA	20	CIA	8Marks
		EoSE	2Hrs	EoSE	30	EoS E	12Marks

ExaminationSchemeforEoSEforSemesterI&II

Semester	CourseCode	CourseTitle	Credit	Marks	External EoSE	Internal (CIA)
SEM- I	ZOO-51T-101	Paper -I Diversity & Biology of Non-Chordates	4	100	70	30
	ZOO-51P-101	Practical	2	50	30	20
SEM- II	ZOO-51T-102	Paper- II Diversity of Chordates & Developmental Biology of Vertebrates	4	100	70	30
	ZOO-51P-102	Practical	2	50	30	20

ExaminationScheme

- 1credit=25marksforexamination/evaluation
2. For Regular Students, there will be a Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Eachcourse in Semester Grade Point Average (SGPA) has two components- Continuous assessment (30% weightage) and End of end-semesterexamination (EoSE) (70% weightage).
3. ForRegularStudents,75%AttendanceismandatoryforappearingintheEoSE.
4. To appear in the EoSE examination of a course/ subject, a regular student must appear in the mid-semester examination.

Detailed Syllabus
Diversity & Biology of Non-Chordates
Practicals based on Diversity & Biology of Non-Chordates
I Semester-Zoology

Semester	Course Code	Title of the Course/Paper			NHEQF Level	Credits
I		Diversity & Biology of Non-Chordates Practicals based on Diversity & Biology of Non-Chordates			5	6
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
5	Major	4	2	6	No	60 lectures including diagnostic and informative assessments during lecture hours, and 30 Hours of Practical training/demonstration
List of Programme Codes in which Offered as Minor Discipline		Biotechnology Botany Chemistry Microbiology Psychology				
Prerequisites		XIIPass				
Objectives of the Course:		- The main purpose of introducing this course is to teach the students the Morpho-taxonomy, and evolutionary relationships among and between non-chordates and chordates along with creating awareness and concern towards the importance of animal diversity for human survival and its socioeconomic significance. - In addition to this, the course is aimed at nurturing skills of conducting scientific inquiry and experimentation in the field of animal diversity to acquire knowledge of fundamental concepts and theories of animal diversity.				

14

Detailed Syllabus
ZOO- 51T-101: Diversity & Biology of Non -Chordates

UNIT-I

Principles of taxonomy:

6 Hrs

- International code of nomenclature;
- Concept of the five-kingdom system;
- Basis of classification: symmetry, coelom, segmentation, embryogeny
- Levels of organization
- Invertebrate versus vertebrate (comparison)

Protozoa:

6 Hrs

- General characteristics and classification up to classes
- Paramecium: Habit, Habitat, Morphology, locomotion, nutrition, and reproduction
- Economic importance of protozoa

Porifera:

4 Hrs

- General characteristics and Classification up to classes;
- Canal system in Porifera

UNIT-II

Coelenterata (Cnidaria):

6 Hrs

- General characteristics and Classification up to classes;
- Obelia: Habit, Habitat, Morphology, reproduction, and life cycle, Metagenesis

Platyhelminthes and Nemathelminthes:

8 Hrs

- General characteristics and Classification up to classes
- Fasciola: Structure and life cycle
- Ascaris: Structure and life cycle

UNIT-III

Annelida:

7 Hrs

- General characteristics and Classification up to classes;
- Nereis (Nereis): Habit, Habitat, Morphology, organ systems: locomotion, digestive, excretory, nervous, reproductive and life cycle

Arthropoda:

7 Hrs

- General characteristics and Classification up to classes;
- Prawn: Habit, Habitat, Morphology, organ systems: digestive, circulatory, excretory, nervous, and reproductive

UNIT-IV

Mollusca:

7 Hrs

General characteristics and Classification up to classes;

Pila: Habit, Habitat, Morphology, organ systems: locomotion, digestive, circulatory, excretory, reproductive

Echinodermata:

7 Hrs

- General characteristics and Classification up to classes;
- Asterias: Habit, Habitat, Morphology, organ system: water vascular system, digestive, Circulatory, reproductive, and life cycle

Hemichordata:

3 Hrs

- Affinities with Chordata and Echinodermata
- Biology of Balanoglossus

Suggested Books and References:

1. Invertebrate Zoology. VII Edition, Barnes, R.D. (2006) Cengage Learning, India.
2. The Invertebrates: A New Synthesis. III Edition, Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J. (2002) Blackwell Science
3. Invertebrate Zoology. Jordan E.L., Verma P.S. (2022): S. Chand and Company Limited.
4. Invertebrate Structure and Functions. II Edition Barrington, E.J.W. (2012), EWP Publishers
5. Invertebrate Zoology: A Functional Evolutionary Approach. VII Edition, Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003) Cengage Learning, India
6. Biology of the Invertebrates. VII Edition, Pechenik, J.A. (2015) Mraw-Hill Education
7. जैवविविधता Mali, P.C., Singh, M., Kumari, V. and Digarwal, G.L. (2023) (Animal Diversity-B.Sc I Semester). Neelkanth Publishers (P) Ltd.

Suggested E-resources:

1. Kachhwaha, Nand Kaushik, P (2019): Freely online available gaming websiteinnovativezoology.com to study vertebrate and invertebrate classification.

Course Learning Outcome:

Upon completion of the course, students will have knowledge of:

- Morpho-taxonomy and structural organization of non-chordata and chordata groups.
- Diversity of non-chordata and chordata groups.
- Evolutionary relationships and phylogeny of non-chordates and chordates through functional and structural similarities.
- Economic importance of non-chordates and chordates and their significance in the ecosystem.

Practical Syllabus Semester I

Based on Diversity & Biology of Non- Chordates

1. Microscopy

- i. Organization and working of Optical Microscope: Dissecting and compound microscopes.
- ii. General methods of microscopic slide preparations: Narcotization; fixing and preservation; washing; staining; destaining; dehydration; clearing and mounting.

2. General idea of composition, preparation, and use of:

- i. Fixatives: Formalin, Bouin's fluid.
- ii. Stains: Aceto-carmine, Aceto-orcin, Haematoxylin, Eosin.
- iii. Common reagents: Normal saline, Acid water, Acid alcohol and Mayer's albumin.

3. Study of Microscopic Slides and Museum Specimens:

- i. Protozoa: *Euglena*, *Amoeba*, *Plasmodium*, *Paramecium* (W.M.), binary fission, conjugation)
- ii. Porifera: *Leucosolenia*, *Euplectella*, *Spongilla*, *Sycon*
- iii. Coelenterata: *Millipora*, *Physalia*, *Aurelia*, *Velella*, *Sea anemone*, *Gorgonia*, Stone corals.
- iv. Platyhelminthes: *Taenia* (WM), *Cysticercus* larva, *Fasciola* (WM), *Miracidium*, Sporocyst, Redia, *Cercaria* and *Metacercaria* Larvae of *Fasciola*.
- v. Aschelminthes: *Ascaris*, *Dracunculus*, *Wuchereria*
- vi. Annelida: *Nereis* (*Nereis*), *Aphrodite*, *Pontobdella*, *Arenicola*, *Glossiphonia*, *Hirudinaria*.
- vii. Onychophora: *Peripatus*
- viii. Arthropoda: *Limulus*, Scorpion, Centipede, Millipede, *Lepas*, Crab, *Mantis*, *Pediculus*, Termite, *Cyclops*, *Daphnia*, crustacean larvae (Nauplius, Zoea, Mysis, Megalopa)
- ix. Mollusca: *Chiton*, *Aplysia*, *Dentalium*, *Cypraea*, *Mytilus*, *Loligo*, *Octopus*, *Nautilus*. Glochidium larva
- x. Echinodermata: *Asterias*, *Antedon*, *Ophiotrix*, *Echinus*, *Holothuria*

4. Anatomy:

- i. Pila: External features and nervous system.
- ii. Prawn: External features, appendages, alimentary canal, and nervous system.

5. Study of the following through Permanent Slide Preparation:

- i. *Euglena*, *Paramecium*,
- ii. Sponge spicules, Gemmule,
- iii. *Obelia* colony,
- iv. Statocyst and hastate plate of prawn,
- v. Osphradium and gill lamella of *Pila*

6. Education tour and report preparation on the study of local invertebrate fauna

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercise	Regular Students	Ex. Students
1.	Major exercise	3	3
2.	Minor exercise	2	2
3.	Permanent slide preparation	3	3
3.	Identification and comments on Spots (1 to 6)	12	12
4.	Viva Voce	5	10
5.	Class Record	5	
	Total	30	30

Note:

*Internal marks for regular students only.

1. Anatomy: Study of systems of the prescribed types with the help of dissection. Detailed charts/Dissection softwares/virtual tools/models can also be utilized to study anatomy.
2. With reference to microscopic slides, in case of non-availability, the exercises should be substituted with diagrams photographs.
3. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

Syllabus

Diversity of Chordates & Developmental Biology of Vertebrates

II-Semester-Zoology

Semester	Course Code	Title of the Course/Paper			NHE QF Level	Credits
II	ZOO-mT	Diversity of Chordates & Developmental Biology of Vertebrates Practicals based on Diversity of Chordates & Developmental Biology of Vertebrates			5	6
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
5	Major	4	2	6	No	60 lectures, including diagnostic and informative assessments during lecture hours, and 30 Hours of Practical training/demonstration.
List of Program Codes in which Offered as Minor Discipline		B.Sc. Chemistry: UG0804 B.Sc. Botany: UG0805				
Prerequisites		B.Sc. I Semester (Bio Group)				
Objectives of the Course:		• The course offers a complete understanding about diversity and classification of Chordate animals. • It educates the students regarding general and specific characteristics of chordates. Thorough understanding of their affinities and evolutionary aspects of chordates will be developed in students. • The course will also provide a glimpse of the scope and historical background of developmental biology to the students. • It will impart knowledge regarding basic concepts of differentiation, morphogenesis, and pattern formation, and insight into stem cells and cloning. • Understanding of essential events of developmental biology will be imparted through proper explanation of gametogenesis, stages of embryonic development, and foetal formation.				

Detailed Syllabus

Diversity of Chordates & Developmental Biology of Vertebrates

Unit-I

Lower Chordates and Vertebrates:

- General characteristics and classification of Chordata up to orders; 2 Hrs
- **Urochordata:** Study of Biology of *Herdmania* 6 Hrs
- **Cephalochordata:** Study of Biology of *Branchiostoma* (Amphioxus) 4 Hrs
- **Cyclostomata (Agnatha):** Study of *Petromyzon* and Ammocoete Larva 3 Hrs
- **Pisces:** Types of fins and scales, Parental care and migration in fishes 4 Hrs
-

Unit-II

Amphibia: 4 Hrs

- General characteristics and classification up to orders;
- Neoteny
- Parental care in Amphibians.

4 Hrs

Reptilia:

- General characteristics and classification up to order;
- Identification of poisonous and non-poisonous snakes, Biting Mechanism

Aves: 5 Hrs

- General characteristics and classification up to orders;
- Flight adaptations and Migration in birds. 4 Hrs

Mammals:

- General characteristics and classification up to sub-classes;
- Dentition in Mammals;
- Adaptive radiation in mammals. 4 Hrs
-

Unit-III

Introduction to Developmental Biology:

- Scope and History of Developmental Biology; 1 Hrs

Gametogenesis:

- Spermatogenesis
- Oogenesis;

Fertilization: 3 Hrs

Early Embryonic Development 10 Hrs

- Cleavage: planes and patterns of cleavage.
- Blastulation and Morulation.
- Gastrulation: Types of morphogenetic movements; Fate of germ layers
- Early embryonic development of frog (upto Gastrulation) and chick (upto 96 hrs).

Parthenogenesis	2 Hrs
Metamorphosis and its hormonal regulation in frogs;	4 Hrs
Types and functions of extraembryonic membranes in chick development	2 Hrs
Types, formation, and functions of placenta in mammals, Implantation	3 Hrs
Teratology and Developmental Disorders.	2 Hrs

Suggested Books and References:

1. Biology. Campbell & Reece (2005), Pearson Education, (Singapore) Pvt. Ltd.
2. Chordate Zoology. Jordan E.L., Verma P. S. (2022) S. Chand and Company Limited.
3. Biology, 6th edition. Raven, P. H. and Johnson, G. B. (2004) Tata McGraw Hill Publications. New Delhi.
4. Analysis of Vertebrate Structure. Hilderbrand, M. and Gaslow G.E.. John Wiley and Sons
5. Principles of Developmental Biology (4th edition). Wolpert, L. & Tickle, C. (2011). Oxford University Press, ISBN 9780198792918
6. Patten's Foundations of Embryology. Carlson, Bruce M (1996). McGraw Hill, Inc. ISBN: 9780070634275
7. The Life of Vertebrates. III Edition. Young, J.Z. (2004) Oxford University Press.
8. Comparative Anatomy and Development Biology of Vertebrates (2024) Dr Jyotsna Jain, Dr Dev D. Patel, Dr Pallavi Kaushik and Dr Dau Lal Bohra. Text book for B.Sc. II Semester, Neelkanth Publishers (P) Ltd, Jaipur, India 2024 ISBN: 978-93-5736-733-2.
9. Developmental Biology. X Edition. Gilbert, S.F. (2014) Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts USA. ISBN : 9780878939787
10. An Introduction to Embryology. Balinsky, B.I. (2008). International Thomson Computer Press.

Suggested E-resources:

1. Meena G, 2020. Developmental Biology, Glossary, Ideal International Publication Pvt. Ltd.
<https://drive.google.com/file/d/1ebK1B6QHc6fJG6CXaGicmXTZlY6VkOxi/view?usp=drivesdk>

Course Learning Outcome:

Upon completion of this course, students will be able to:

- Know about the levels of organization among different groups of vertebrates.
- Understand how chordates evolved during the course of evolution through succession.
- Know the evolution of different concepts in developmental biology.
- Understand the process of gamete formation from stem cell population to mature ova and sperm.
- Comprehend the sequence of steps leading to the formation of gametes and development of embryo.
- Know the mechanisms underpinning cellular diversity and specificity in animals.
- Have the knowledge about the methods and tools related to developmental biology which help to understand different processes of embryogenesis.

Practical Syllabus Semester II

ZOO-52P-104- Practicals based on Diversity of Chordates & Developmental Biology of Vertebrates

1. Anatomy: Study of swim bladder and Cranial nerves in any edible fish
2. Study of microscopic slides and museum specimens:
 - i. **Protochordates:** *Herdmania, Ciona, Botryllus, Amphioxus, Doliolella, Oikopleura, Pyrosoma*, Tadpole larva of *Ascidia*
 - ii. **Agnatha:** *Petromyzon, Myxine, Ammocoete* larva.
 - iii. **Pisces:** *Zygaena (Sphyrna), Torpedo, Pristis, Chimaera; Acipenser, Amia* or *Lepidosteus, Labeo, Claria, Anguilla, Hippocampus, Exocoetetes, Elenias*, any flat-fish, *Syngnathus, Protopterus, Lepidosiren, Neoceratodus, Notopterus*.
 - iv. **Amphibia:** *Ichthyophis, Necturus, Proteus, Ambystoma, Salamander, Axolotl, Siren, Alytes, Hyla, Pipa, Rachophorus, etc.*
 - v. **Reptilia:** *Testudo, Chelone* and freshwater tortoise, *Sphenodon, Hemidactylus, Phrynosoma, Draco, Calotes*, Chameleon; *Eryx, Hydrophis, Krait, Naja, Viper, Bungarus, Crocodilus, Alligator*.
 - vi. **Aves:** *Pavocristatus* (peacock), *Choriotis* (Great Indian Bustard), *Columba*
 - vii. **Mammalia:** *Ornithorhynchus, Echidna, Tachyglossus, Didelphis, Kangaroo, Bat, Loris, Manis, Mongoose, Otter*
3. Study of the following through Permanent Slide preparations:
 - i. Oral hood of amphioxus, scales of fishes, hair of mammals
 - ii. Frog - Study of developmental stages through permanent slides (whole mounts and sections) — cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.
 - iii. Study of Chick Embryo: 18hrs, 21hrs, 24hrs, 33hrs, 48hrs, 72hrs and 96hrs of incubation.
4. Window making in chick egg to study the various incubation stages of the developing chick embryo
5. Study of extra-embryonic membranes in chick development.
6. Educational tour: Visit to Zoo/National Park/Sanctuary and submission of report.

Scheme of Practical Examination and Distribution of Marks

S.No	Practical Exercise	Regular Students	Ex./N.C. Students
1.	Major exercise	3	3
2.	Permanent slide preparation	2	2
3.	Developmental Biology	3	3
3.	Identification and comments on Spots (1 to 6)	12	12
4.	Viva Voce	5	10
5.	Class Record	5	
		30	30

Note:

***Internal marks for regular students only.**

1. Anatomy: Study of systems of the prescribed types with the help of dissection. Detailed charts/Dissection softwares/virtual tools/models can also be utilized to study anatomy.
2. With reference to microscopic slides, in case of non-availability, the exercises should be substituted with diagrams photographs.
3. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
4. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
5. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 or amendments made subsequently.

Syllabus

UG0802-ZOO-63T-201-Economic Zoology & Ethology UG0802 -ZOO-63P-202- Practicals based on Economic Zoology & Ethology

III SEMESTER -Zoology

Semester	Code of the Course	Title of the Course/Paper			NHEQF Level	Credits
III	ZOO-63T- 201 ZOO-63P- 202	- Economic Zoology & Ethology - Practical based on Economic Zoology & Ethology			6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
6	Major	4	2	6	Yes	Lectures: 60 lectures including diagnostic and informative assessments during lecture hours and 30 Hours of Practical training/demonstration.
List of Programme Codes in which Offered as Minor Discipline		B.Sc. Chemistry B.Sc. Botany				
Prerequisites		B.Sc(BioGroup)IISEM				
Objectives of the Course:		- Gain knowledge about silkworms rearing and their products; Bee keeping equipment and apiary management. - Acquaint knowledge on dairy animal management, the breeds, and diseases of cattle and learn the testing milk quality. - Acquaint knowledge about the culture techniques of fish, prawn and poultry. - Acquaint the knowledge about basic procedure and methodology of Vermiculture. Learn various concepts of lac cultivation. - Learn the various pests and diseases and their management strategies - Students can start their own business i.e. self- employments. and Get employment in different applied sectors. - To equip learners with a sound knowledge of how animals interact with one another and their environment. - To enable the learners to understand different behavioral patterns				

Detailed Syllabus
Semester III
ZOO-63T-201: Economic Zoology & Ethology
UNIT I

Sericulture: 4 Hrs

- Silkworm species, host plants, types of silk,
- Economic importance of silk,
- Moriculture: life cycle of mulberry silkworm, silk production,
- Processing of silk, associated enemies, diseases and their management.

Lac culture: 4 Hrs

- Life cycle of lac insect,
- General practices and management of lac cultivation, processing of lac,
- Composition, properties and products of lac, associated enemies, diseases and their management.

Apiculture: 4 Hrs

- Species of domesticated honey bee, life cycle of honeybees
- Indigenous and artificial bee hives, management of beekeeping,
- By-products, associated enemies, diseases and their management, apiculture and apiary in India.

Prawn culture: 3 Hrs

- Culturable species, prawn hatcheries, Culture practices
- Products and maintenance of culture, associated diseases and their management.

UNIT II

Vermiculture and Vermicomposting: 4 Hrs

- Suitable and non-suitable species, conventional and commercial vermiculture
- Small- and large-scale vermicomposting, harvesting, processing, problems related to vermicomposting

Pearl culture and industry: 3 Hrs

- Pearl-producing molluscs, pearl formation, harvesting, properties and composition of pearls.

Pisciculture: 4 Hrs

- Culturable species, edible fishes, seed production, hatcheries, feeding of fishes
- By-products of fish culture, associated diseases and their management.

Poultry keeping: 4 Hrs

Indigenous and exotic breeds of poultry, housing system of poultry

Common poultry management practices, associated diseases and their management.

UNIT III

Protozoan:

- Economic importance of Protozoa: Amoebic Dysentery, Malaria, African Sleeping Sickness 4 Hrs

Helminth:

- Outline of diseases caused by Platyhelminthes and Aschelminthes 4 Hrs

Arthropod-borne diseases:

- Tick-borne diseases, Mite infestation, Insect-borne diseases. 4 Hrs

Pest and their management:

- Agricultural pests, stored grain pests, household pests, Integrated pest management 5 Hrs

UNIT IV

Ethology:

31

- Introduction and history of Ethology
- Brain and behaviour, Limbic system, and Hypothalamus.

3 Hrs

Concepts of ethology:

- Fixed action pattern, sign stimulus, innate releasing mechanism, action-specific energy,
- Motivation, imprinting, and learning.

4 Hrs

Communication:

4 Hrs

- Auditory, tactile, visual, and chemical;
- Societies: Characteristics and advantage with special reference to honey bee and monkeys.

Biological clocks and animal behaviour:

4 Hrs

- Biological rhythms and biological clocks. Methods of studying animal behaviour (in situ and ex situ).

Suggested Books and References:

1. Economic Zoology, Biostatistics and Animal behaviour, S. Mathur, 2009, Deep and Deep Publications.
2. Economic Zoology, Shukla G.S. & Upadhyay V.B., 2017, Rastogi Publications.
3. Vermicomposting for sustainable agriculture, Gupta P.K., 2003, Agrobios India
4. A handbook of economic zoology, Ashan J. and Sinha S.P., 2010, S. Chand and Company
5. Perspectives in Indian Apiculture, Mishra R.C., 1999, Allied scientific publ. Bikaner India
6. A Textbook of Applied Entomology, Srivastava, K.P., 1988., Publ. Kalyani Publishers, New Delhi.
7. Animal Behavior: An Evolutionary Approach, Alcock J., 2013, Sinauer Associates.
8. Animal Societies and Evolution: Reading from Scientific America, 1981, Tophoff H.R., W.H. Freedman and C Ltd. Animal Behavior, Breed M.D. and Moore J., 2015, Academic Press.
9. Animal Behavior, Mathur R., 2010, Rastogi Publications.
10. The ecology & Evolution of Animal Behavior, Werlance R.A., 1979, Good Year Publishing Co., Inc.
11. Biological Rhythms, Kumar V., 2002, Narosa Publishing House, Delhi/ Springer-Verlag.

Suggested E-Resources: <https://vidyamitra.inflibnet.ac.in/content/index/6018e55f8007bec1c22166b0/ET>

1. <https://vidyamitra.inflibnet.ac.in/content/index/6018e69d8007be8bc42166af/ET>
2. <https://vidyamitra.inflibnet.ac.in/index.php/content/index/5fd9f1678007bef4453de567>
3. <https://vidyamitra.inflibnet.ac.in/index.php/content/index/6018dbb48007be63c12166ae>

Course Learning Outcome: Upon completion of the course, students will be able to:

- Understand the economic importance of non-chordates and chordates and their significance in the ecosystem.
- Comprehend the life cycle of specific parasites, the symptoms of the disease and its treatment and apply simple preventive measures for the same.
- Gain knowledge on animals useful to mankind and the means to make the most of it.
- Learn the modern techniques in various industries of beneficial animals.
- Pursuing entrepreneurship as careers
- Understand the main historical ideas that underpin animal behaviour theory.
- Critically review hypotheses to explain animal behaviour.
- Gain an insight into different types of animal behaviour and their role in biological adaptations.

**Practical Syllabus
Semester III**

UG0802-ZOO-63P-202-Practicals based on Economic Zoology & Ethology⁴¹

1. Study of Microscopic Slides/models/ photographs of the following: *Plasmodium*, *Giardia*, *Toxoplasma*, *Trypanosoma*, Bedbugs, mosquito (any), *Pediculus humanus capitis*, *Xenopsylla cheopis*, *Aphis*, *Tribolium*, *Tenia solium*, *Fasciola hepatica*, *Ascaris*, *Waucheria*,
2. Study of Museum Specimens/photographs/Models of following:
Silk moth species, earthworm species, Prawn, Pearl oyster, poisonous spiders, scorpion, ants, Centipede, earwig, types of honeybees, cockroach, crickets, grasshopper, edible fishes, fur, feathers, corals, cowrie
3. To study life cycle of silk worm and different types of silk yarns available in the market.
4. To study the qualitative analysis of honey.
5. To study the construction of vermicomposting bins and devices used for vermicomposting.
6. Study to differentiate between original and artificial pearls.
7. To study the food preference and response to light in any of the stored insect pest
8. To study the antennal grooming in cockroach.
9. Study of chemical communication behaviour in Ants/earthworm.
10. Educational tour: Visit to any sericulture research and training Institute/ Apiary/ Poultry farm/ Aquaculture and report submission (Candidates are expected to submit a detailed report of such visit)

Scheme of Practical Examination and Distribution of Marks

S.No	Practical Exercises	Regular Students	Ex./N.C. Students
1.	Exercise based on sericulture, apiculture, lac culture.	3	3
2.	Exercise based on vermiculture, pearl culture, aquaculture.	2	2
3.	Exercise based on ethology	3	3
4.	Identification and comments on Spots (1 to 8)	12	12
5.	Viva Voce	5	10
6.	Class Record and report	5	----
		20*+30=50	20*+30=50

Note:

*Internal marks for regular students only.

1. With reference to microscopic slides, in case of non-availability, the exercises should be substituted with diagrams / photograph
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

UG0802-ZOO-64T-203-CellBiology,Genetics&Biotechnology
UG0802 -ZOO-64P-204- Practicals based on Cell Biology,Genetics&Biotechnology
IVSemester-Zoology

Semester	Code of the Course	Title of the Course/Paper			NHEQF Level	Credits
IV	ZOO-64T-203 ZOO-64P-204	• Cell Biology, Genetics & Biotechnology • Practicals based on Cell Biology, Genetics & Biotechnology			6	6
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method
		Theory	Practical	Total		
6	Major	4	2	6	Yes	Lectures: 60 lectures including diagnostic and informative assessments during lecture hours and 30 Hours of Practical training/demonstration.
List of Programme Codes in which Offered as Minor Discipline		• B.Sc. Chemistry • B.Sc. Botany				
Prerequisites		B.Sc(BioGroup)II SEM				
Objectives of the Course:		• This course will provide with a deep knowledge of Cell Biology, Genetics and Biotechnology. • Understand the role of different cell organelles in the maintenance of life activities, the history and basic concepts of heredity, variations and gene interaction, the application of biotechnology in the fields of industry and agriculture. • In addition to this, the course is aimed at nurturing skills of conducting scientific inquiry and experimentation in the field of recent advancements, recent trends and technologies. • Students can start their own business i.e. self-employment and get employment in different applied sectors.				

40

Detailed syllabus
Semester IV
UG0802-ZOO-64T-203-Cell Biology, Genetics & Biotechnology

UNIT I

Introduction to cell:

3Hrs

- Morphology, size, shape, characteristics and structure of prokaryotic and eukaryotic animal cells
- Basic ideas of virus and cell theory.

Plasma membrane:

4Hrs

- Composition, Structure and functions of Plasma Membrane
- Fluid mosaic model
- Transport across the membrane: active and passive transport (diffusion and facilitated), osmosis.

Cell Organelles:

8Hrs

- Structure and functions of nucleus, mitochondria, endoplasmic reticulum, ribosome (prokaryotic and eukaryotic), Golgi complex, lysosome, microbodies and centrioles.
- Structure and functions of cilia, flagella

UNIT II

Cell Division:

4Hrs

- Mitosis
- Meiosis
- Cell Cycle

Prokaryotic chromosomes and eukaryotic chromosomes:

4Hrs

- Morphology, telomeres, primary and secondary constrictions, chromatids
- Giant chromosome types: Polytene and Lampbrush.

Chromosomal organization:

4 Hrs

- Euchromatin, heterochromatin
- Folded fiber model and Nucleosome concept.

Cell-Cell Junctions:

3 Hrs

- Structure and Functions- Tight junctions, Desmosomes, Gap junctions.

UNIT III

Mendel's law of Inheritance:

4 Hrs

- Principle of segregation, independent assortment, dominance
- Mendelian genetics in humans
- Variety of gene expression- modifiers, suppressors, pleiotropic gene, multiple allelism
- Genetic Interaction: epistasis, complementary gene, duplicate gene.

Linkage & Crossing over:

4 Hrs

- Linkage- Definition, coupling and repulsion hypothesis, linkage groups
- Crossing over- Mechanism and Theory
- Structure of chromosomes
- Extrachromosomal inheritance- mitochondrial and plastids

Mutation:

4 Hrs

- Definition, basic concept, types (spontaneous and induced);
- Mechanism of mutagenesis; base analogues, nitrous acid, hydroxyl amine, alkylating agent, Acridine dyes, U.V. light.

Genetic disorders:

3 Hrs

- Down's syndrome
- Turner's syndrome
- Klinefelter's syndromes
- Color blindness
- Hemophilia
- Phenylketonuria

40

UNITIV

Concept and scope of Animal Biotechnology:

3 Hrs

- Cloning methods (Cell, Animal and Gene cloning)
- Vectors- Plasmids, Cosmids, Lambda bacteriophages and Yeast artificial chromosomes (YAC)

Animal cell culture:

4Hrs

- Equipment and materials for animal cell culture
- Applications of cell culture techniques
- Recombinant DNA technology and its applications.

Transgenesis:

4Hrs

- Methods of Transgenesis
- Production of transgenic animals and their application in Biotechnology
- Stem cells: Types and their applications.

Dairy biotechnology:

3 Hrs

- Food, drink and dairy biotechnology (outline idea only)
- Fermented food production: dairy products, wine, beer, vinegar and food preservation.

1. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and James Darnell, J. Molecular Cell Biology, Freeman, 7th edition 2013.
2. Cell Biology, Genetics, Molecular biology, Evolution and Ecology (2022) P.S. Verma, V.K. Agarwal.
3. Cross A.E. and Nagle R.B. (2006). Cell Adhesion and Cytoskeletal Molecules in Metastasis. Vol. XII, Springer Publication.
4. Karp G. John. (2013). Cell and Molecular Biology. Concepts and Experiments. 7th Edition, Wiley & Sons Inc., New York.
5. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
6. Brown, T.A. (2015). Gene Cloning and DNA Analysis. 7th Edition, Academic Press, California, USA.
7. Gardner E.J. (2008). Principles of Genetics. VIII Edition, Simmons M.J. and Snustad D.P. Wiley, India.
8. Pierce B.A. (2008). Genetics-A Conceptual Approach. W.H. Freeman & Co., New York.
9. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
10. Biotechnology by U. Satyanarayan. (2010).
11. B.D. Singh. (2004). Biotechnology-Expanding Horizons. Kalyani Publishers, New Delhi. India.
12. Current Frontiers and Perspectives in Cell Biology (2012). Stevo Najman.
13. Cooper, G. M., and Hausman, R. E. (2013). The Cell: A Molecular Approach (6th Ed.). Washington: ASM; Sunderland.
14. Principles of Genetics by Gardner (2008) (8th Edition).
15. Genetics (2009) P.K. Gupta, Rastogi Publications.
16. Primrose S.B. and Twyman R.M.: Principles of Gene Manipulation and Genomics. John Wiley & Sons, 2013.

Suggested E-Resources:

1. The Cell: A Molecular Approach (2013) Geoffrey M. Cooper and Robert E. Hausman. Sixth Edition. Sinauer Associates.
2. Principles of Molecular Biology (2023) Veer Bala Rastogi. Second Edition. Medtech.
3. Genetics and Molecular Biology (Volume 1) Kohji Hasanuma. Encyclopedia of Life Support Systems. UNESCO-EOLSS.
4. <https://egyankosh.ac.in/handle/123456789/5504>

Course Learning Outcome: Upon completion of the course, students will be able to:

- Students will be able to explain the basic concepts of Cell Biology.
- Have an understanding of classical genetics.
- To impart knowledge and practical training in various techniques to develop research in commercial and scientific application.
- Learn about biotechnology and its concepts as well as various scopes in Biotechnology.

UG0802 -ZOO-64P-204- Practicals based on Cell Biology, Genetics&Biotechnology

Exercises in Cell Biology:

1. Principle and uses of Microscopy.
2. Squash preparation for the study of mitosis in the onion root tip, permanent slides of mitosis (all stages)
3. Squash preparation for the study of meiosis in grasshopper or cockroach testes, permanent slides of meiosis (all stages).
4. Study of giant chromosomes in salivary glands of *Chironomus* or *Drosophila* larva.
5. Preparation of blood smear and differential staining of blood cells.

Exercises in Genetics:

6. Life cycle of *Drosophila* and an idea about its culture.
7. Identification of male and female *Drosophila*.
8. Identification of wild and mutant (yellow body, ebony, vestigial wing and white eye).
9. Study of permanent prepared slides: Sex comb and salivary gland chromosomes.
10. Numerical exercises on Monohybrid and dihybrid cross.

Exercises in Biotechnology:

11. Study of Lab instruments: Centrifuge, Autoclave, pH meter.
12. Isolation of DNA from cheek cells.
13. Separation of DNA by Agarose gel electrophoresis.
14. Chromatography: Paper/TLC chromatography for separation of dyes/Amino acids.

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercises	Regular Students	Ex. Students
1.	Exercise in Cell Biology	3	3
2.	Exercise in Genetics	2	2
3.	Exercise in Biotechnology	3	3
4.	Identification and comments on Spots (1 to 6)	12	12
5.	Viva Voce	5	10
6.	Class Record and report	5	-----
		20*+30=50	20*+30=50

Notes:

*Internal marks for regular students only

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.

Outline of Syllabus
UG0802-ZOO-75T-301-Animal Physiology & Biochemistry
UG0802 -ZOO-75P-302- Practical based on Animal Physiology & Biochemistry

V Semester-Zoology

Semester	Code of the Course	Title of the Course/Paper			NHEQF Level	Credits
V	ZOO-75T-301 ZOO-75P-302	Animal Physiology & Biochemistry Practicals based on Animal Physiology & Biochemistry			7	6
Level of Course	Type of the Course	Credit Distribution			Course Delivery Method	
		Theory	Practical	Total		
7	MJR	4	2	6	Lectures: 60 lectures including diagnostic and informative assessments during lecture hours and 30 Hours of Practical training/demonstration.	
List of Programme Codes in which Offered as Minor Discipline		• B.Sc. Chemistry • B.Sc. Botany				
Prerequisites		IV Semester (B.Sc. Biogroup)				
Objectives of the Course:		The learning objectives of this course are as follows: • To achieve a thorough understanding of various aspects of physiological systems and their functioning in animals. To expand their knowledge with respect to functioning of various organ systems such as muscular, nervous, digestive, circulatory, respiratory, excretory, reproductive and endocrine in animals. • To instill the concept of hormonal regulation of physiology, metabolism and reproduction in animals. • To provide insightful knowledge on the structure and classification of carbohydrates, proteins, lipids and enzymes.				

Detailed Syllabus
Semester V
ZOO-75T-301-Animal Physiology & Biochemistry

Unit-I

Physiology of digestion:	5 Hrs
• Definition of digestion • Various types of digestive enzymes and their digestive action in the alimentary canal • Absorption and assimilation of the carbohydrates, proteins, and lipids.	
Physiology of respiration:	5 Hrs
• Definition of respiration; Mechanism of breathing • Exchange of gases: transportation of oxygen and carbon dioxide in blood; • Regulation of respiration; Respiratory pigments.	
Physiology of blood circulation:	5 Hrs
• Composition and functions of blood; Mechanism of blood clotting • Heartbeat, Cardiac cycle, Blood pressure • Body temperature regulation	

Unit-II

Physiology of excretion:	7 Hrs
• Kinds of nitrogenous excretory end products • Functional architecture of nephron; Mechanism of urine formation • Hormonal regulation of water and electrolyte balance (Homeostasis).	
Physiology of nerve impulse:	4 Hrs
• Functional architecture of a neuron • Origin and propagation of nerve impulse; Synaptic transmission, Reflex arc	
Physiology of muscle contraction:	4 Hrs
• Functional architecture of skeletal muscles • Chemical and biophysical events during contraction and relaxation of muscle fibers	

Unit-III

Physiology of reproduction:	5 Hrs
• Control and regulations of testis and ovarian functions; Female reproductive cycles • Implantation, parturition, and lactation in mammals	
Physiology of endocrine glands:	8 Hrs
• Type of endocrine glands and their secretions and functions: Pituitary, Adrenal, Thyroid, Pancreas	
Hormonal regulation	
• Mechanism of hormone action, feedback mechanism, hypothalamic control of pituitary function.	

Unit-IV

Carbohydrates:	6 Hrs
• Structure, classification and function of carbohydrates • Glycolysis, Krebs's cycle, and oxidative phosphorylation and gluconeogenesis	
Proteins:	5 Hrs
• Structure, classification and function of proteins • Deamination, transamination, decarboxylation, ornithine cycle • Enzymes: definition, classification, inhibition, and regulation of Enzymatic Kinetics	
Lipids:	5 Hrs
• Structure, classification and functions of lipids • Beta-oxidation • Brief account of biosynthesis of triglycerides.	

Suggested Books and References–

1. A Text Book of Medical Physiology (2017) Arthur C. Guyton MD, Eleventh ed., John E. Hall, Harcourt Asia Ltd.
2. Animal Physiology, Roger Eckert and Randal, 4th ed, Freeman Co, New York.
3. Text Book of Animal Physiology, Veer Bal Rastogi, Kedarnath Ramnath, Meerut.
4. Animal Physiology, Eckert R., Randall D.J., Burggren W., French K., 1997, Burggren WW & Co. Ltd.
5. Practical Zoology, Lal SS, 2014, Rastogi Publications.
6. Lehninger Principles of Biochemistry, Nelson DL and Cox MM, 2013, 6th edition W.H. Freeman.
7. Animal Physiology and Biochemistry, Sastry KV. 2nd edition Rastogi Publications.
8. Animal Physiology, Verma PS, Tyagi BS, Agarwal VK, 2004, 6th edition S. Chand & Co.
9. Biochemistry of Biomolecules, Ritu Kamal 2006, Paragon International Publishers
10. Biochemistry, Voet D and Voet JG, 2011, 4th edition, John Wiley & Sons, Inc.
11. Concepts of Biochemistry, Gupta S.N., Rastogi Publications Meerut.
12. Zoology for Degree Students, Agarwal VK, S Chand and Company New Delhi.
13. Principles of Anatomy and Physiology, Tortora, G.J. and Derrickson, B.H., 2009, XII Edition, John Wiley & Sons, Inc.

Suggested E-resources:

1. National Institute of Science Communication & Information Resources (NISCAIR) <http://nsdl.niscair.res.in/>
2. National digital library of India (NDL India) <http://ndl.iitkgp.ac.in/>
3. https://onlinecourses.swayam2.ac.in/cec19_bt02/preview
4. [https://onlinecourses.nptel.ac.in/noc20_bt42/preview\(AnimalPhysiology\)](https://onlinecourses.nptel.ac.in/noc20_bt42/preview(AnimalPhysiology))
5. Virtual Labs (<http://www.vlab.co.in>)
6. [http://www.ignouhelp.in/ignou-lse-05-study-material/AnimalPhysiology\(English Hindi\)http://rastogipublications.com/Rastogi-Publications-SUCHIPATRA-2022-23-Mail.pdf](http://www.ignouhelp.in/ignou-lse-05-study-material/AnimalPhysiology(EnglishHindi)http://rastogipublications.com/Rastogi-Publications-SUCHIPATRA-2022-23-Mail.pdf)
7. <http://rastogipublications.com/Rastogi-Publications-SUCHIPATRA-2022-23-Mail.pdf>
8. <https://www.schandpublishing.com/books/higher-education/sciences/zoology-degree-students-semester-/9789352534104>
9. <https://www.scribd.com/document/696830782/A-K-Jain-Physiology-Practical-Manual>

Course Learning Outcomes:

By studying this course, students will be able to

- Have an enhanced knowledge and appreciation of animal physiology.
- Recognize and identify principal tissue structures and functions.
- Better understand the functions of important physiological systems including the nervous system, muscular system, endocrine and reproductive system.
- Understand how these separate systems interact to yield integrated physiological responses to maintain homeostasis in the body along with feedback mechanisms.
- Develop a strong foundation for research & employability skills using the knowledge of biochemistry.
- Improve their perspective of health through deep study of physiology and biochemistry.

Practical Syllabus Semester V

UG0802-ZOO-75P-302-Practicals based on Animal Physiology & Biochemistry

Practical exercises of Animal Physiology

1. Counting of RBCs and WBCs using haemocytometer.
2. Estimation of hemoglobin by Sahli's haemometer.
3. Estimation of haematocrit value (PCV).
4. Preparation of blood smear to study different blood cell types using Wright's or Leishman stain.
5. Demonstration of enzyme activity (catalase) in the liver.
6. Study the effect of pH and temperature on salivary amylase activity.
7. Study of histological sections of various organs and major endocrine glands:
Stomach, intestine, lungs, spleen, liver, kidney, spinal cord, pituitary, parathyroid, thyroid, pancreas, adrenal gland, testis, and ovary.

Practical exercises of Animal Physiology

1. Detection of proteins in the animal tissue/food samples.
2. Detection of carbohydrates in the animal tissue/food samples.
3. Detection of lipids in the animal tissue/food samples.
4. Demonstration of separation of amino acids from a mixture using paper chromatography/TLC

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercises	Regular Students	Ex./N.C. Students
1.	Major exercise (Physiology)	3	3
2.	Minor exercise (Physiology)	2	2
3.	Minor exercise (Biochemistry)	3	3
4.	Identification and comments on Spots (1 to 6)	12	12
5.	Viva Voce	5	10
6.	Class Record and report	5	-----
		20*+30=50	20*+30=50

Note:

*Internal marks for regular students only.

1. With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photograph
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. Mounting material for permanent preparations would be as per the syllabus or as available through collection and culture methods.
4. Computer aided techniques should be adapted as per UGC guidelines.

Outline of Syllabus

UG0802-ZOO-76T-303-Microbiology, Immunology & Biostatistics

UG0802 -ZOO-76P-304- Practicals based on Microbiology, Immunology & Biostatistics

VI-Semester-Zoology

Semester	Code of the Course	Title of the Course/Paper			NHEQF Level	Credits
VI	ZOO-76T- 303 ZOO-76P- 304	Microbiology, Immunology & Biostatistics Practicals based on Microbiology, Immunology & Biostatistics			7	6
Level of Course	Type of the Course	Credit Distribution			Course Delivery Method	
		Theory	Practical	Total		
7	MJR	4	2	6	Lectures: 60 lectures including diagnostic and informative assessments during lecture hours and 30 Hours of Practical training/demonstration.	
List of Programme Codes in which Offered as Minor Discipline		B.Sc. Chemistry B.Sc. Botany				
Prerequisites		V Semester (B.Sc. Bio group)				

Objectives of the Course

- The objectives of studying a combined course in Microbiology, Immunology, and Biostatistics are to develop a foundational understanding of microorganisms, the immune system, and statistical methods.
- Students will acquire practical skills in microbiological and immunological techniques, including culturing, staining, and identifying microbes, as well as conducting immunoassays.
- The course aims to help students understand the interplay between microbiology, immunology, and biostatistics, applying statistical analysis to interpret experimental data in these fields.
- It enhances abilities in designing experiments, collecting and analyzing data, and drawing valid conclusions, thereby fostering research capabilities.
- The course prepares students for careers in biomedical research, clinical diagnostics, public health, and related fields by understanding the applications of these disciplines in health and disease.

Detailed Syllabus Semester VI

ZOO- 76T-303: Microbiology, Immunology & Biostatistics

Unit-I

History of Microbiology: 6Hrs

- Contributions of Anton van Leeuwenhoek, Louis Pasteur, Edward Jenner and Robert Koch.
- Basic structural and functional characteristics of Microbes- Bacteria, Fungus, Cyanobacteria, Rickettsiae, Chlamydiae, Mycoplasmas and Virus
- Structural organization of bacteria- flagella, capsule, cell wall, cell membrane, cytoplasm, chromosome

Techniques in Microbiology: 3Hrs

- Pure culture technique
- Growth conditions (temperature, pH, nutrients),
- Gram's staining, fungal staining

Bacterial diseases: 3Hrs

- Causative agent, brief pathology, treatment, prevention of -> Diphtheria, Meningitis, Tuberculosis, Botulism, Tetanus, Leprosy

Viral diseases: 3Hrs

- Causative agent, brief pathology, treatment, prevention of -> Influenza, Herpes, Measles, Chicken Pox, Small Pox, Rabies, Polio, AIDS, Covid-19

Unit-II

Components of immune system: 3Hrs

- Different types of cells and organs involved.

Antigens: 3Hrs

- Essential features of antigen
- Antigenic determinants, Immunological valence, adjuvants, haptens

Antibodies: 2Hrs

- Nature and Primary structure of immunoglobulins
- Types of immunoglobulins: IgG, IgM, IgA, IgD and IgE and their structure and functions

Antigen Antibody reactions: 2Hrs

- Precipitation and agglutination

Types of immunity: 3Hrs

- Active and passive immunity,
- Cell mediated immunity, humoral immunity, Auto immunity
- Basic idea of interferon, Complement system and MHC

Unit III

Application of microbes:

- Use of microbes in fermented foods, dairy and beverages: wine, beer, cheese, curd and vinegar **5 Hrs**
- Use of microbes in wastewater treatment, bioremediation (brief idea)

Types of vaccines: **6Hrs**

- Live attenuated, inactivated vaccine, DNA and recombinant vaccine
- Monoclonal antibodies production and application, Abzymes

Unit-IV

Introduction **4 Hrs**

- Biostatistics and its applications, variables and attributes, population vs sample, **3 Hrs**
- Arrangement of data, frequency distribution

Graphical representation of data: **4 Hrs**

- Line Diagram, Bar Diagram, Pie Chart, Histogram And Polygon

Measures of central tendency: **8Hrs**

- Arithmetic Mean, Median, Mode
- Standard deviation, standard error of mean

Suggested Books and References:

1. Fundamentals of microbiology by Edward Alcamo. Benjamin/Cummings publishing company, Inc.
2. Prescott's Microbiology by Joanne. M. Willey, Linda Sherwood, Christopher J. Woolverton, 2017. McGraw-Hill Education
3. Kindt, T.J., Goldsby, R.A., Osborne, B.A., & Kuby, J. (2007). *Kuby Immunology* (6th ed.). New York: W.H. Freeman and Company.
4. Owen, J.A., Punt, J., Stranford, S.A., & Jones, P.P. (2018). *Kuby Immunology* (8th ed.). New York: W.H. Freeman and Company.
5. Abbas, A.K. & Lichtman, A.H. (2001). *Basic Immunology: Functions and Disorders of Immune System*. US: W.B. Saunders.
6. Pagano, M., & Gauvreau, K. (2018). *Principles of Biostatistics* (2nd ed.). CRC Press.
7. Rosner, B. (2015). *Fundamentals of Biostatistics* (8th ed.). Cengage Learning.
8. Microbiology-concepts and applications (2023) Micheal Joseph Pelczar, Eddie Chin Sun Chan, Noel R. Krieg. McGraw-Hill Education
9. Delves, P.J., Martin, S.J., Burton, D.R., & Roitt, I.M. (2011). *Roitt's Essential Immunology* (12th ed.). New Jersey, USA: John Wiley & Sons Ltd.

Suggested E-resources:

1. Microbiology Society: Offers educational resources, including articles and practical resources for learning microbiology
2. OpenStax - Microbiology Textbook: A free, peer-reviewed textbook that covers a wide range of topics in microbiology.
3. MicrobeWiki: A student-edited resource that provides detailed information on various microorganisms.
4. Immunology Online Textbook: A comprehensive online textbook from NCBI that covers various aspects of immunology.
5. Janeway's Immunobiology: A highly regarded textbook available online that provides a deep dive into immunology.
6. Statistical Methods for the Analysis of Biomedical Data: An open-access book that focuses on statistical methods used in biostatistics.
7. OpenIntro Statistics: A free textbook that provides an introduction to statistics, including applications in biostatistics.

Course Learning Outcomes: After successful completion of the course, students will be able to:

- Understand the basic concepts and applications of Microbiology, and Immunology and Biostatistics.
- Explain the structure and function of microorganisms.
- Describe the role of microbes in the environment, industry, and human health.
- Explain the principles and applications of immunological techniques.
- Apply appropriate statistical methods to analyze biological data, interpret results accurately, and make informed decisions based on statistical evidence.
- Gain proficiency in using statistical software for data management, analysis, and visualization, enabling them to handle complex datasets effectively in biomedical research contexts.

Practical Syllabus Semester VI

ZOO-76P-304- Practical based on Microbiology, Immunology & Biostatistics Microbiology

Microbiology

1. Preparation and use of culture media for microbes (NA and PDA).
2. Culture of microbes (bacteria and fungi) from food (curd/spoiled food).
3. Gram's staining for bacteria.
4. Simple staining of bacteria.
5. Slide preparation and identification of any two fungi.

Immunology

6. Tests of blood grouping.
7. Widal test to identify any pathogen in blood.
8. Differential leucocyte count (DLC) in the blood sample.

Biostatistics

9. Representation of data by using bar diagram and pie charts.
10. Numerical based on biostatistical measurement: Mean, Mode and Median.
11. Numerical based on standard deviation, Student's T test and Chi square test.
12. Educational trip to any Microbiology Lab/Dairy/industry.

Scheme of Practical Examination and Distribution of Marks

S.No.	Practical Exercises	Regular Students	Ex. Students
1.	Major exercise (Microbiology)	3	12
2.	Minor exercise (Immunology)	2	6
3.	Minor Exercise (Biostatistics)	3	6
3.	Identification and comments on Spots (1 to 6)	12	16
4.	Viva Voce	5	10
5.	Class Record	5	-----
		20*+30=50	20*+30=50

Note: *Internal marks for regular students only.

1. In case of non-availability, the exercise can be substituted with diagrams/photographs.
2. Candidates must keep a record of all work done in the practical class and submit the same for inspection at the time of the practical examination.
3. Mounting materials for permanent preparation will be made available according to the course or through collection and preservation methods.
4. Computer-aided techniques should be adapted as per UGC guidelines.