COURSES OF STUDIES

FOR P.G. PROGRAM

ZOOLOGY

(UNDER SEMESTER SYSTEM)

(Effective from 2024-2025)

SCHOOL OF ZOOLOGY
GANGADHAR MEHER UNIVERSITY,
AMRUTA VIHAR, SAMBALPUR, ODISHA
PIN-768004

Vision and Mission

Vision

To create a highly conductive academic and research ambience for producing graduates with excellent theoretical knowledge and practical skills and to promote scientific temper and urge of community services among the postgraduates.

Mission

- **To provide a solid foundation of basic principles and processes in zoology to understand biological complexities including the interrelationships among humans, animals and the environment.**
- **To establish critical thinking, conceptual skills, strong practical knowledge, hands on in all the basic, advanced and applied techniques in the subjects.**
- **To develop an aptitude for research among the graduates making them professionally capable, well trained and creative individuals in the field of biological sciences.**

Program objective of PG program

The program objectives of M. Sc zoology should enable the students to
POB 1: develop to deep understanding of the key concepts at various levels of the biological organization.
POB-2: elucidate animal-animal, animal-plant and animal-microbes interactions and their consequence to humans, animals, and the environment.
POB-3: apply skills in performing scientific experiments and drawing logical interference.
POB-4: expose learners to frontiers and thrust areas of zoology
POB-5: acquire and develop self- confidence for better performance at various levels of life.
POB-6: become worthy professional/citizens of the nation in the field of Biology.

Program outcomes of PG program

After completing M. Sc zoology students will be able to
PO-1: recognize the scientific facts behind natural phenomenon in the biological world and analyze the relationship among plants, animals and microbes.
PO-2: relate the theory and practical knowledge to solve the biological problems of society.
PO-3: carryout internship programs and research projects to develop scientific facts and innovative ideas.
PO-4: become a successful professional in the industry. Government, academic, research and entrepreneurship.
PO-5: utilize the obtained scientific knowledge to create an ecofriendly environment.
Po-6: understand the application of biological sciences in Aquaculture, Apiculture, Pisciculture, Agriculture, Medicine and other applied zoology.

P. G. COURSE STRUCTURE OF THE DEPARTMENT OF ZOOLOGY AT A GLANCE 2024-2025

FIRST SEMESTER

Paper No.	Name of the Papers	Credit
ZOO – 101	Non Chordata	4
ZOO – 102	Molecular Cell Biology	4
ZOO – 103	Environmental Biology	4
ZOO – 104	Evolutionary Biology	4
ZOO – 105	Practical	4

SECOND SEMESTER

Paper No.	Name of the Papers	Credit
ZOO – 201	Chordata	4
ZOO – 202	Microbiology & Ethology	4
ZOO – 203	Developmental Biology	4
ZOO – 204	Cytogenetics	4
ZOO – 205	Practical	4
DSE PAPERS		
ZOO- 206	Applied Zoology	4

THIRD SEMESTER

Paper No.	Name of the Papers	Credit
ZOO – 301	Physiology – Life sustaining system	4
ZOO – 302	Physiology – Controlling & coordinating system	4
ZOO – 303	Biomolecules & Enzymology	4
ZOO – 304	Biochemistry of metabolic processes	4
ZOO – 305	Practical	4
IDSE Papers		
ZOO – 306	General Zoology	4

FOURTH SEMESTER

Paper No.	Name of the Papers	Credit
ZOO – 401	Molecular Biology & Immunology	4
ZOO – 402	Biotechnology	4
ZOO – 403	Biophysics, Biophysical Chemistry, Instrumentation	4
ZOO – 404	Biostatistics	4
ZOO – 405	Practical & Dissertation	4

PG FIRST SEMESTER

ZOO – 101

NONCHORDATA

FM: 30+70 (4 CH)

Prerequisites: Knowledge of origin of life, Animal Kingdom, Systematic, Taxonomy, Diversity of non-chordata and chordata.

Course Objectives-

(i) To know the special adaptive features & their role and action in non-chordates
(ii) To understand the social organization & behavioral aspects of non-chordates
(iii) To analyze their phylogenetic status & their significance

Unit-I

(A) PROTOZOA:
- (i) Nutrition, Locomotion & Reproduction in Protozoans.
- (ii) Parasitic Protozoans with special reference to human host.

(B) PORIFERA:
- (i) Origin of metazoa
- (ii) Canal system and reproduction in porifera
- (iii) Skeleton in sponges

Unit-II

(A) COELENTERATA:
- (i) Polymorphism in coelenterate
- (ii) Corals and coral reef formation
- (iii) Ctenophora and its affinities

(B) HELMINTHES:
- (i) Parasitism and parasitic adaptations in helminthes

(C) ANNELIDA:
- (i) Origin of coelom in annelida
- (ii) Metamerism and segmental organs in annelida
- (iii) Excretion in annelida

Unit-III

(A) ARTHROPODA:
- (i) Structural organization and phylogenetic status of Limulus
- (ii) Parasitic castration with reference to the life cycle of Sacculina
- (iii) Larval forms in Crustaceans
- (iv) Vision in arthropods
- (v) Social life in insects
- (vi) Beneficial insects – Silkmoth, Honeybee, Lac insect

(B) ONYCHOPHORA:
- (i) Structural organization and phylogenetic status of Peripatus

Unit-IV

(A) MOLLUSCA:
- (i) Respiration in Molluscs
- (ii) Foot in Molluscs
- (iii) Torsion and de-torsion in Gastropoda

(B) ECHINODERMATA:
- (i) Water vascular system of Echinoderms
- (ii) Larval forms in Echinoderms

(C) MINOR PHYLA:
- (i) Structure and affinities of Rotifera, Brachiopoda and Phoronida

Text Books: -

1. Modern Text Book of Zoology-Invertebrates- R.L. Kotpal- M/S Rastogi Publication, Meerut
2. Invertebrate Zoology- E.L. Jordan & P.S. Verma- M/S S. Chand & Company Ltd., New Delhi
3. Text Book of Zoology- Parker & Haswell- M/S ELBS Edition
4. Invertebrate Zoology- R.D. Barnes- M/S Thomson Press (India) Ltd.

Reference Books: -

1. Invertebrate Zoology- R.D. Barnes- M/S Thomson Press (India) Ltd.
2. Invertebrates- L.H. Hyman- M/S McGraw Hill Books, New Delhi
3. Invertebrate Zoology- T.C. Mojpuria- M/S Pradeep Publication, Jalandhar
4. Biology of Nonchordates- H.C. Nigam- M/S Vishal Publishing Co., Jalandhar
5. Life of Nonchordates-Part-I & II- H.C. Nigam- M/S Vishal Publishing Co., Jalandhar
6. Biology of Nonchordates-Part-I & II- Niranjan Routray & Sujata Mohanty- M/S Kalyani Publishers, New Delhi
7. Phylums of Invertebrates-(Protozoa to Minor Phyla)- R.L. Kotpal- M/S Rastogi Publication, Meerut

Course Outcomes:-

1. (L - I) - Identify/ Recognise the beneficial and harmful groups of NonChordates.
2. (L -2) -Explain/ Discuss the harmful effects of harmful groups and ecological & economical benefits of beneficial groups.
3. (L - 3) - Establish/ Show the interrelationships among the different groups of NonChordates and predict the pattern of evolution.
4. (L - 4) - Analyse/ Examine the development of special features in certain groups of NonChordates and the reason thereof.5.
5. (L - 5 & 6) - Develop a taxonomical hierarchy and construct the phylogenetic tree of NonChordates.

PG FIRST SEMESTER

ZOO – 102

MOLECULAR CELL BIOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Cell Concept, Cell Theory, Cellular Organisation and Cellular Functions.***

Course Objectives-

(i) To understand the basis structure, molecular organisation of cell and their parts
(ii) To learn about the principles & molecular pathways of various cellular processes
(iii) To acquire skills to perform scientific experiments in order to draw logical inferences

Unit-I	(i)	Chemical composition and Molecular organization of Cell membrane
	(ii)	Membrane modifications and junctions
	(iii)	Membrane transports
	(iv)	Cell adhesion
	(v)	Cell signaling
Unit-II	(i)	Molecular organization of various cell organelles – Endoplasmic Reticulum, Golgi complex, Mitochondria, Lysosome, Ribosomes
Unit-III	(i)	Cytoskeleton of the cell
	(ii)	Structural organization and function of nucleus and nucleolus
	(iii)	Ultra structure of chromosome
	(iv)	Chemical nature of chromosome
	(v)	Types of chromosome
Unit-IV	(i)	Cell cycle and its regulations
	(ii)	Behaviour of chromosome during cell division
	(iii)	Apoptosis
	(iv)	Cytology of Cancer

Text Books: -

1. Cell Biology- C.B. Bower- M/S Himalaya Publishing House, Mumbai
2. Introductory Cytology- V.B. Rastogi- M/S Rastogi Publication, Meerut
3. Text Book of Cell & Molecular Biology- Ajay Paul- M/S Books & Allied Publications, Kolkata
4. Cell & Molecular Biology- DeRobertis & DeRobertis- M/S EDP, ISE Publication

Reference Books: -

1. Cell & Molecular Biology- G. Karp- M/S John Wiley & Sons Inc., 5th Edition
2. The Cell-A Molecular Approach- G.M. Cooper & R.E. Hansman- M/S Sinauer Associates Inc.
3. Cell Biology & Cytogenetics- H.C. Nigam- M/S Vishal Publishing Co., Jalandhar
4. Cell & Molecular Biology- Lodis, Baltimore- M/S W.H. Freeman & Co. Ltd., New York
5. Animal Cell Biology- Ralph Becker- M/S Syrawood Publishing House
6. Simplified Courses in Cell Biology- V.K. Agarwal- M/S S. Chand & Company Ltd., New Delhi
7. Cell & Molecular Biology- P.K. Gupta- M/S Rastogi Publication, Meerut

Course Outcome:-

1. (L-1) Study of the basic structure of cell and cell organelles. Finding out the function of different cell organelles.

2. (L-2) understanding the cellular organization and the properties of different cell components involved in cell survival and propagation.
3. (L-3) To show how molecular organization is associated with respective function of the cell organelles. Further to see how the series of biophysical and biochemical reactions are helping the cell to survive and propagate.
4. (L-4) Examining the molecular pathways to perform processes such as cell division, cell signaling and transportation of molecules in and across cell.
5. (L-5 & L-6) Declaration of the role of different biomolecules in structural organization and functional aspects of the cell.

PG FIRST SEMESTER

ZOO – 103

ENVIRONMENTAL BIOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Environment: Concepts and Components, Study of Nature, Natural Resources and their management.***

Course Objectives-

(i) To develop a deep understanding about environment & its components
(ii) To expose the students to various ecological problems /hazards
(iii) To aware the students of biotic groups of environments and their characteristics features
(iv) To elucidate a well-developed & stable interaction between human, animals & environment

Unit-I	(i)	Biosphere and its components
	(ii)	Structural and functional nature of ecosystem (Productivity and energy flow in the ecosystem)
	(iii)	Ecological pyramids
	(iv)	Ecological factors – Light and Temperature
	(v)	Biogeochemical cycle – Oxygen, Carbon and Nitrogen
Unit-II	(i)	Biotic interactions
	(ii)	Characteristic of biotic community
	(iii)	Pedogenesis – Composition and formation of soil, soil profile
	(iv)	Ecosystem development (Ecological succession)
Unit-III	(i)	Population dynamics – Characteristic and growth of population, factors affecting population growth.
	(ii)	Environmental pollution – Air, Water and Noise pollution.
	(iii)	Biomagnifications and Bioremediations
	(iv)	Solid waste management
Unit-IV	(i)	Zoogeography – Various geographical regions with flora and fauna
	(ii)	Wild life Odisha and India
	(iii)	Wild life conservations including Wildlife Acts
	(iv)	Biodiversity – Nature, Distribution, Hotspots of Biodiversity
	(v)	Biodiversity conservation

Text Books: -

1. Fundamentals of Ecology- O.P. Odum- M/S Books/Cole, 5th Edition (2004)
2. Ecology & Environment- P.D. Sharma- M/S Rastogi Publication, Meerut
3. Ecology & Environmental Science- H.R. Singh & Neeraj kumar- M/S Vishal Publishing Co., Jalandhar
4. Environmental Biology- Verma & Agrawal- M/S S. Chand & Company Ltd., New Delhi

Reference Books: -

1. Perspectives in Ecology- Manideep Raj- M/S Kalyani Publishers, New Delhi
2. Animal Ecology- Rastogi & Jayraj- M/S Kedarnath Ramnath Publications
3. Ecology- M.P. Arora- M/S Himalaya Publishing House, New Delhi
4. Ecology & Environmental Biology- T.K. Saha- M/S Books & Allied Ltd.
5. Fundamentals of Environmental Biology- Biswarup Mukherjee- M/S Tata Mcgraw Hill Publishing Company Ltd.
6. Principles of Environmental Biology- P.K. Nair- M/S Himalaya Publishing House, New Delhi

7. General Ecology- H.D. Kumar- M/S Vikas Publishing House, New Delhi

Course Outcome:-

1. (L-1) Identification of components of Biosphere, Ecosystems, Biotic interaction, Geographical regions, Wild Life, Sources of Pollution.
2. (L-2)Discussion on energy flow, Soil Profile, Population Characteristics, Biomagnification and Bioremediation, Biodiversity Conservation.
3. (L-3) To establish relation between productivity and energy flow, Light and Temperature on animal and plant nutritions, Various Biotic interactions, Population growth.
4. (L-4)Analysis of Biogeochemical Cycles and their roles, Formation of Soil, Ecosystem Development, Factors affecting Population growth, Management of Solid Waste and other pollutants.
5. (L-5 & L-6) Develop the flow chart of Ecological Succession, Roadmap for Wild Life and Biodiversity Conservation, Preservation of Biosphere and Action Plan for Ecological Balance.

PG FIRST SEMESTER
ZOO - 104

EVOLUTIONARY BIOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Origin of Earth, History of Past Animals and their special features, Types and Causes of changes in Environment.***

Course Objectives-

(i) To facilitate a deep understanding about life, evolution of life, theories and process of evolution

(ii) To acquire knowledge on the special adaptive features developed in different groups during evolution

(iii) To establish relation between past & present groups of animals using fossil records & their evolutionary processes

Unit-I	(i)	Origin of life
	(ii)	Evidences in favour of evolution
	(iii)	Species concept and evolution above species level
	(iv)	Modes of speciation
Unit-II	(i)	Evolutionary theories – Lamarckism, Darwinism, Mutation Theory, Modern Synthetic Theory
	(ii)	Evolutionary processes – Isolation, Natural selection, Variation, Genetic drift
Unit-III	(i)	Adaptations – Cursorial, Desert, Deep Sea and Cave adaptation
	(ii)	Population genetics – Hardy Weinberg Principle, Gene frequency and its equilibrium, Influence of evolutionary forces on gene frequency
Unit-IV	(i)	Palaentology – Process of fossilization, Dating of fossils
	(ii)	Fossil records of evolution of Horse, Elephant and Man
	(iii)	Extinction – Mass extinction and its role in evolution

Text Books: -

1. Organic Evolution- V.B. Rastogi- M/S Kedarnath Ramnath, Meerut.
2. Evolution, Adaptation & Ethology- S.Chattopadhyaya- M/S Books & Allied Pvt. Ltd., Kolkata.
3. Organic Evolution- M.P. Arora & C. Kanta- M/S Himalaya Publishing House, Mumbai.
4. Strickberger's Evolution (Indian Edition)- Hall & Hallgrimsson- M/S Jones Bartlett India, 5th Edition (2013).

Reference Books: -

1. General Ecology- H.D. Kumar- M/S Vikas Publishing House, New Delhi
2. Evolution-III Edition- M. Ridley- M/S Blackwell Publishing
3. Evolution & Environmental Biology- H.C. Nigam- M/S Vishal Publishing Co., Jalandhar
4. Evolutionary Biology- Dr. B.S. Tomer & Singh- M/S Rastogi Publication, Meerut
5. Organic Evolution- Dr. Kavita- M/S Aitbs Publishers & Distributors
6. Palaentology : Evolution & Animal Distribution- Jain & Anantharaman- M/S Vishal Publishing Co., Jalandhar
7. Evolutionary Biology-Concepts & Thesis- Richard Arber- M/S Callisto Reference
8. Evolution- Stephen Baxter- M/S Orion Publishing Group, UK

Course Outcome:-

1. (L-1) Identifay/Recognise the basics of life, its origin and various theories related to origin of life, types of species and evidences of evolution.
2. (L-2) Understand different theories and process of evolution.

3. (L-3) Establish/Shows the interrelationship among different groups of animals through fossil records.
4. (L-4) Analysis/Examine the characters develops by different groups of animals for their adaptability in various ecological conditions and analyze the evolution of certain higher groups of vertebrate like horse and man. Examine the causes of extension.
5. (L-5 & L-6) Evaluate of various modes of speciation, role of mass extinction in evolution and influence evolutionary process in gene frequency. Construction of phylogenetic tree of certain vertebrates with the help of their fossil records.

PG FIRST SEMESTER

ZOO – 105 PRACTICAL

NONCHORDATA, MOLECULAR CELL BIOLOGY, ENVIRONMENTAL BIOLOGY, EVOLUTIONARY BIOLOGY

FM: 100 (4 CH)

Course Objectives-

(i) To expose & increase skills in performing scientific experiments

(ii) To provide opportunities to develop responsibility in conducting practical experiments

(iii) To facilitate & synchronize the theoretical knowledge with practical

1. Preparation of permanent stained slides (TS & WM).

   (Phylum Protozoa to Echinodermata)

2. Study of prepared slides (TS & WM)

   (Phylum Protozoa to Echinodermata)

3. Study of museum specimens

   (Phylum Protozoa to Echinodermata)

4. Stages of mitosis from prepared slides of plant materials (squashing of Onion Root tip) & from permanent slides.

5. Stages of meiosis from prepared slides of animal materials (squashing of grasshopper testis) & from permanent slides.

6. Study of microphotographs of different cell organelles.

7. Estimation of chlorides and sulphates of calcium for hardness of water.

8. To determine dissolved oxygen (DO2) of different samples of water by Winkler's method.

9. To determine free carbon dioxide (CO2) content of different samples of water.

10. To study physical characteristics of soil texture, colour, temperature, moisture, carbonate and nitrate content of soil.

11. Determination of population density in a natural community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.

12. Study of fossil evidences from models and pictures.

13. Demonstration of changing allele frequencies with and without selection.

14. Construction and interpretation of phylogenetic trees with bioinformatics tools.

15. Gram's staining techniques for study of prokaryotic cells.

16. Preparation of permanent slides of Barr body in human female blood cells / cheek cells.

PG SECOND SEMESTER

ZOO - 201

CHORDATA

(Prerequisites-Knowledge of the classification of Animal kingdom, taxonomy, Diversity of Chordates)

Course objectives-

(i)To understand the general organization and behavioral aspects of various chordates.
(ii)To elucidate the basic principle and mechanism of action of special adaptive features of chordates.
(iii)To establish the relationship between their phylogenetics status and comparative account

FM: 30+70 (4 CH)

Unit-I	(i)	Biology and evolutionary significance of Hemichordates, Cephalochordates and Urochordates
	(ii)	General organization, classification and affinities of Cyclostomata
	(iii)	Structural organization of Petromyzon and its comparison with Myxine
Unit-II	(i)	Classification of fishes
	(ii)	Biology and affinities of Dipnoi
	(iii)	Biology and Phylogenetic significance of Latimeria
	(iv)	Osmo regulation in fishes
	(v)	Swim bladder and lateral line system in fishes
	(vi)	Origin of Tetrapoda
	(vii)	Parental care in amphibia
	(viii)	Neotony in amphibia
Unit-III	(i)	Classification of Reptilia on the basis of skull
	(ii)	Structural organization and phylogenetic significance of Sphenodon
	(iii)	Biting mechanism in snake
	(iv)	Origin of birds
	(v)	Flight adaptation in birds
	(vi)	Perching mechanism in birds
	(vii)	Affinities of Prototheria
	(viii)	Affinities of Metatheria
Unit-IV	(i)	Comparative account of Integument, Jaw suspensorium, Appendicular and Axial skeleton, Heart, Aortic arches, Kidney and Brain

Text Books: -

1. Modern Text Book of Vertebrate Zoology- R.L. Kotpal- M/S Rastogi Publication, Meerut
2. Chordate Zoology- Jordan & Verma- M/S S. Chand & Company Ltd., New Delhi
3. Biology of Chordates- H.C. Nigam- M/S Vishal Publishing Co., Jalandhar
4. Biology of Animals-Vol.-II- Sinha, Ganguli, Adhikari- M/S New Central Book Agency, Kolkata

Reference Books: -

1. A Text Book of Chordates- Bhamrah, Juneja, Srivastava, Joshi- M/S Anmol Publications, Darya Ganj, New Delhi
2. Chordata & Comparative Anatomy- R.L. Kotpal- M/S Rastogi Publication, Meerut
3. Text Book of Zoology- Parker & Haswell- M/S ELBS Edition
4. The Life of Vertebrates, III Edition- J. Young- M/S Oxford University Press
5. Vertebrate Life- H. Pough- M/S Pearson International Publisher

6. Chordata I- M.P. Arora- M/S Himalaya Publishing House, New Delhi
7. The Geographical Distribution of Animals- P.J. Darlington- M/S R.E. Krieger Publishing Co.

Course Outcome:-

1. (L-1) Identification of different groups of Chordates.
2. (L-2) Discussion of the beneficial and harmful groups of Chordates and their ecological importance.
3. (L-3) Establish /Show the inter relationships among the different groups of Chordates and predict the pattern of Evolution.
4. (L-4) Analysis of the development of special features in certain groups of Chordates and the reason thereof.
5. (L-5 & L-6) Development of taxonomical hierarchy and construct the phylogenetic tree of Chordates.

PG SECOND SEMESTER
ZOO – 202

MICROBIOLOGY & ETHOLOGY

FM: 30+70 (4 CH)

Prerequisites- Classification of animal kingdom, microbial World, animal behaviour – concepts and characterizations

Course objectives

(i) To explore the microbial world and their types.
(ii)To gain knowledge on their beneficial and harmful efforts
(iii) To elucidate the various types of behavior and analysis behavioral pattern and their regulation

Unit-I	(i)	Classification of Microbes
	(ii)	General characteristics of Virus
	(iii)	Types of Viruses – Retrovirus, Adenovirus, Oncovirus
	(iv)	Life cycle of Bacteriophage
	(v)	General organization and classification of Protista and Fungi
	(vi)	Viral, Protozoan and Fungal infections
Unit-II	(i)	Structure and reproduction of Bacteria
	(ii)	Isolation culture and maintenance of Bacteria
	(iii)	Growth in Bacteria
	(iv)	Bacterial infections
	(v)	Role of Microbes in the field of agriculture, industry and environment
Unit-III	(i)	Ethlogical concepts
	(ii)	Orientation in animals
	(iii)	Classification and analysis of behaviour pattern
	(iv)	Physiological basis of behaviour
	(v)	Methods of behavioural studies
Unit-IV	(i)	Social behaviour – Schooling in fishes, flocking in birds and herding in mammals
	(ii)	Reproductive Behaviour - Courtship and mating behaviour
	(iii)	Migration of fishes and birds
	(iv)	Biological rhythms – Circadian clock, Circannual clock
	(v)	Regulation of biological rhythms

Text Books: -

1. Microbiology- P.D. Sharma- M/S Rastogi Publication, Meerut
2. General Microbiology- R.P. Singh- M/S Kalyani Publishers, New Delhi
3. A Text Book of Microbiology- Dubey & Maheswari- M/S S. Chand & Company Ltd., New Delhi
4. Animal Behaviour- Reena Mathur- M/S Rastogi Publication, Meerut
5. Animal Behaviour- V.K. Agrawal- M/S S. Chand & Company Ltd., New Delhi
6. Animal Behaviour- M.P. Arora- M/S Himalaya Publishing House, Mumbai

Reference Books: -

1. Microbiology- Prescott- M/S Mcgraw Hill Education, US
2. Microbiology- Pelczar- M/S Mcgraw Hill Education, US
3. Microbiology-Principles & Exploration- J.G. Black- M/S John Wiley & Sons
4. Essentials of Microbiology- Raphael Turner- M/S ED-TECH PRESS

5. Fundamentals of Microbiology & Immunology- A.K. Banerjee & N. Banerjee- M/S New Central Book Agency, Kolkata
6. Fundamentals of Animal Behaviour- Satguru Prasad- M/S Emkay Publications
7. A Text Book of Animal Behaviour- Harjindra Singh- M/S Anmol Publications Pvt. Ltd.
8. A Text Book of Animal Behaviour- Gundevia & Singh- M/S S. Chand & Company Ltd., New Delhi
9. Text Book of Animal Behaviour- K.S. Madhavan- M/S WAVE Books
10. Animal Behaviour- Praharaj, Mishra, Mohanty- M/S Kalyani Publishers, New Delhi
11 Text Book of Animal Behaviour- Fatik Baren Mandal- M/S PHI Learning

Course Outcome:-

1. (L-1) Identification of various types of viruses and viral infections, various types of bacteria and bacterial infection, classification of behavioral pattern, identification of various biological rhythms and different types of migration.
2. (L-2) Differentiation of microbes, viruses and bacteria. Differentiation of orientation, social behaviour, reproductive behaviours with examples.
3. (L-3) Methods of controlling viral, bacterial, protozoan and fungal infections. Methods of beahvioural studies, applications of cultural techniques.
4. (L-4) Analysis of the life cycle of bacteriophage, physiological basis of behaviour, regulatory mechanism of biological rhythms and behavioural patterns
5. (L-5 & L-6) Evaluation of the role of microbes in agriculture, industry and environment. Evaluation of the bacterial growth and prediction about the pattern of growth. Justification of the migratory behaviour fishes and birds. Establishment of the relationship between courtship and mating behaviour.

PG SECOND SEMESTER
ZOO – 203

DEVELOPMENTAL BIOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Origin of life, Phylogenetic History, Reproductive mechanism in various animals including human being, Endocrine System.***

Course Objectives –

(i)to understand the general oncogenic developmental history of various animal groups
(ii) to know about the various mechanism of developmental processes.
(iii) to correlate and solve various developmental issues with case study.

Unit-I	(i)	Early embryonic development – Gametogenesis, Fertilisation, Cleavage, Blastulation, Gastrulation
	(ii)	Fate maps, Fate of Germ Layers
	(iii)	Development of frog and chick up to the formation of three germ layers
Unit-II	(i)	Embryonic induction and organizer concepts
	(ii)	Neural induction
	(iii)	Organogenesis of eye, heart and brain
	(iv)	Formation of extra-embryonic membranes in birds and mammals
Unit-III	(i)	Implantation of embryo in humans
	(ii)	Placenta (Structure, types and functions of placenta)
	(iii)	Mechanism of Parturition and its hormonal regulation
	(iv)	Metamorphosis in amphibians and its hormonal regulations
	(v)	Regeneration – Modes of regeneration with examples
Unit-IV	(i)	Ageing – Concepts and models
	(ii)	Teratogenesis – Teratogenic agents and their effects on embryonic development
	(iii)	In vitro fertilization
	(iv)	Twins study
	(v)	Stem cell culture

Text Books: -

1. An introduction to Embryology- B.I. Balinsky- M/S Cengage Learning India, 5th Edition (2012)
2. Chordate Embryology (Developmental Biology)- Verma & Agrawal- M/S S. Chand & Company Ltd., New Delhi
3. Chordate Embryology- Rastogi & Jayarajam- M/S Kedarnath Ramnath Publication, Meerut
4. Elements of Developmental Biology (Chordate Embryology)- P.C. Jain- M/S Vishal Publishing Co., Jalandhar

Reference Books: -

1. Embryology- M.P. Arora- M/S Himalaya Publishing House Pvt. Ltd.
2. Embryology- Mathur & Mehta- M/S Anmol Publications Pvt. Ltd.
3. An Introduction to Embryology- A.K. Berry- M/S Emkay Publications
4. Simplified Courses on Embryology and Histology- V.K. Agrawal- M/S S. Chand & Company Pvt. Ltd.
5. Chordate Embryology- V.B. Rastogi- M/S Kedarnath Ramnath Publications, Meerut
6. Developmental Biology- Praharaj, Mishra, Mohanty- M/S Kalyani Publishers, New Delhi
7. A Text Book of Embryology (Developmental Biology)- N. Arumugam- M/S Saras Publications

Course Outcome:-

1. (L-1) Remembering about different types of gametes in different groups of animals, types of cleavage, types of gastrulation etc. in various groups of vertebrate.
2. (L-2) Understanding the process of gamete formation in different groups of animals and understand the process of fertilization, cleavage, gestation, placenta in various groups of vertebrate.
3. (L-3) Application of different new technic like invitro-fertilization, stem cell culture, in the development of different groups of vertebrate.
4. (L-4) Analysis/Examine the basic mechanism of embryonic induction, neural induction and formation of extra embryonic membrane in different higher group of animals like birds and mammals and origin of eyes, heart, brain in various groups of vertebrate.
5. (L-5 & L-6) Evaluating the cause of ageing of human beings and formation of twins in human being, teratogenic process, regeneration process and metamorphic changes in some specific groups of animals.

PG SECOND SEMESTER
ZOO - 204

CYTOGENETICS

FM: 30+70 (4 CH)

Prerequisites: ***Cell Concept, Cell Theory and Cellular Organisation, Gene Concept, Chemical nature of gene, Structure of Chromosome, Genetic Principles in relation to evolution.***

Course Objectives –

(i) To acquire the basic knowledge and principles of genetics and chromosomal changes/behaviors.
(ii) to apply the genetic principle to solve various problems related to genetic disorders.
(iii)to understand the various chromosomal mechanism and their application in human welfare.

Unit-I	(i)	Mendelian inheritance
	(ii)	Extension and phenotypic and genotypic modifications of Mendelian genetic analysis
	(iii)	Genetic interaction
	(iv)	Multiple alleles - blood group inheritance, Rh factor inheritance
	(v)	Polygenic inheritance
	(vi)	Cytoplasmic inheritance
Unit-II	(i)	Linkage and crossing over
	(ii)	Chromosome mapping
	(iii)	Sex determination and sex link inheritance, dosage compensation
	(iv)	Sex limited, sex influenced characters
	(v)	Holandric inheritance
Unit-III	(i)	Chromosomal changes – Gene mutations, Chromosomal mutations
	(ii)	Variation in genome and composition of chromosome, C-value paradox, Cot value
	(iii)	DNA repair mechanism
	(iv)	Chromosomal disorder in man
	(v)	Genetic mapping by molecular markers (RFLPS, RAPDS, VNTRS)
Unit-IV	(i)	Population and applied genetics – Behaviour of genes in population, Application of Hardy-Weinberg Law in population genetics
	(ii)	Pedigree analysis
	(iii)	Genetic counseling
	(iv)	Cytogenetic techniques – Insitu hybridization with DNA probes, FISH, Chromosome banding techniques.

Text Books: -

1. Genetics- Verma & Agrawal- M/S S. Chand & Company Ltd., New Delhi
2. Genetics-Vol.-I & Vol.-II- C.B. Bower- M/S Himalaya Publishing House, Mumbai
3. Genetics- P.K. Gupta- M/S Rastogi Publication, Meerut
4. Elements of Genetics- V.B. Rastogi- M/S Kedarnath Ramnath Publication, Meerut

Reference Books: -

1. Gene-VI, VII & XI- Benjamin Lewis- M/S Oxford Press
2. Principles of Genetics- E.J. Gardner- M/S John Wiley & Sons, 2006
3. Genetics- Stickberger- M/S MacMilan Publishing Company
4. Fundamentals of Genetics- B.D. Singh- M/S Kalyani Publishers, New Delhi
5. Fundamentals of Human Genetics- S. Mandal- M/S New Central Book Agency, Kolkata
6. Text Book of Genetics- Ajay Paul- M/S Books & Allied Publications, Kolkata
7. Cytogenetics- Dr. B.S. Singh & M.P. Singh- M/S Astral International Pvt. Ltd., New Delhi

Course Outcome:-

1. (L-1) Learning the basic structure of DNA, gene and Mendelian principles.
2. (L-2) Understanding the role of chromosomes in heredity. Study the pathway and processes of genetic propagation.
3. (L-3) Determining the possible set of phenotypes from a given set of Genome. Identification of phenotypes based on Genetic markers.
4. (L-4) Utilization of genetic data's to construct family tree and establishing genetic relationship.
5. (L-5 & L-6) Use of genetic tools to resolve civil and criminal issues. Pedigree analysis based on genetic Data.

PG SECOND SEMESTER
ZOO – 205 PRACTICAL

CHORDATA, MICROBIOLOGY, ETHOLOGY, DEVELOPMENTAL BIOLOGY, CYTOGENETICS

FM: 100 (4 CH)

Course Objectives-

(i) to provide expertise in hand skill in dissection and slide preparation.
(ii)to expose the students in order to correlate the theoretical knowledge with practical exposure.
(iii) To apply their understanding in applied biology and biomedical practices.

1. Dissection of afferent branchial arteries of Scoliodon.
2. Dissection of efferent branchial arteries of Scoliodon.
3. Dissection of cranial nerves of Scoliodon.
4. Mounting of scales feathers and Ampulla of Lorenzini.
5. Museum specimens of fishes, cyclostomes, amphibians, reptiles, birds and mammals.
6. Staining of lactobacillus.
7. Gram staining technique.
8. Study of permanent bacterial slides.
9. Experiment on negative and positive transfer of learning by mirror experiment.
10. Window preparation of chick embryos.
11. Study of permanent embryology slides.
12. Squashing of onion root tip and grasshopper testis.
13. Preparation of slides to demonstrate barr body.
14. Staining of heterochromatin by C-band technique.
15. Chromosomal preparations from bone marrow cells of Chick by airdry Giemsa Stain Technique.
16. Study of stages of mitosis, meiosis and banding patterns.

PG SECOND SEMESTER
ZOO – 206

APPLIED ZOOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Applied Zoology, Animal Taxonomy, Breeds of economic important animals (indigenous and exotic), Knowledge of Culture Process.***

Course Objective: -

i. To acquire knowledge on applied zoology and various groups of economically important animals.
ii. To gain knowledge on the life cycles of various economically important groups and their culture.
iii. To gain scientific skills on their farming and management.

Unit-I Fish culture technique – Monoculture, polyculture & monosex c ulture, Induced fish breeding, Integrated fish farming.
Prawn culture – Site selection, topography location, soil quality, water quality, farm construction, production system, harvesting and processing.
Pearl culture – morphology and anatomy of pearl oyster, process of pearl formation, pearl oyster farming, production of cultured pearls and pearl culture establishment.

Unit-II Fish product and byproducts – Liver oil, body oil, fish meal, fish flour, manure, guano, isinglass, fish fin and leather.
Marketing of fish and fish products.
Fish pathology – Etiology, treatment of common diseases of fishes.

Unit-III Poultry farming – Morphology and variety of fowls, classification of fowls based on their use, feeding and management of poultry farming, poultry diseases.
Dairy farming and its management.

Unit-IV Sericulture – Silkworm rearing operations, physical and commercial characters of cocoons, reeling operation, importance of by product of sericulture.
Apiculture – Bee hive, flora for apiculture, selection of bees for apiculture, modern methods of bee keeping, indigenous method and modern methods of extraction of honey, disease of honey bee and their controlling measures.

Text Books: -

1. Economic Zoology- Shukla & Upadhyaya- M/S Rastogi Publication, Meerut
2. A Text Book of Economic Zoology- Aminul Islam- M/S I.K. International Publishing House
3. An Introduction to Fishes- S.S. Khanna- M/S Silver Live Publications, Faridabad
4. Fish & Fisheries- Pandey & Shukla- M/S Rastogi Publication, Meerut
5. Commercial Poultry Farming & Diary Industries- Rajender Kumar Singh- M/S Random Publications, 2019

Reference Books: -

1. A Hand Book on Economic Zoology- J. Ahsan & S.P. Sinha- M/S S. Chand & Company Ltd., New Delhi
2. Economic Zoology- Arumugam & Co.- M/S Saras Publications
3. A Text Book of Fishery Science & Indian Fisheries- CBL Srivastava- M/S Kitab Mahal

4. Poultry Production and Management- Jagadish Prasad- M/S Kalyani Publishers, New Delhi
5. Advances in Aquaculture- Mishra & Nayak- M/S Narendra Publishing House, New Delhi
6. Economic Zoology- S. Chandhuri- M/S New Central Book Agency, Kolkata
7. A Text Book of Fish Biology & Fisheries- S.S. Khanna & H.R. Singh- M/S Narendra Publishing House, New Delhi

Course Outcome:-

1. (L-1) Learning of various types of farming technical. Like fish culture, prawn culture, pearl culture etc.
2. (L-2) Understand the detailed process of different farming like poultry farming, sericulture, IMC culture etc.
3. (L-3) Application of advanced scientific technology in farming sector for improving the productivity in various farming system.
4. (L-4) Analyzing the productivity, marketing strategy for improving the livelihood status of farmers.
5. (L-5 & L-6) Qualitative and Quantitative evaluation of the role of different farming system for improving the livelihood status of farmers.

PG THIRD SEMESTER
ZOO - 301

PHYSIOLOGY – LIFE SUSTAINING SYSTEM

FM: 30+70 (4 CH)

Prerequisites: ***Anatomy of human body, Comparative Physiology, Food, Nutrition, Adaptation in animals.***

Course objective: -

(i) To understand the various physiological processes and mechanisms of action.
(ii) To find out various disorders related to various physiological processes.
(iii) To establish relation between various physiological processes.

Unit-I
(i) Comparative physiology of Digestion – Feeding mechanism and regulation.
(ii) Histology and functions of gastrointestinal tracts and its associated glands of man.
(iii) Digestion of various foods.
(iv) Absorption of foods.
(v) Pole of gastrointestinal hormones on secretion of enzymes.
(vi) Gastrointestinal disorders.

Unit-II
(i) Respiratory organs and respiratory pigments in different phylogenetic groups.
(ii) Mechanism of respiration in man
(iii) Transport of gases – Oxygen & Carbon dioxide
(iv) Buffering action of blood.
(v) Control of respiration.
(vi) Respiratory disorders.

Unit-III
(i) Circulation of body fluids and their regulations.
(ii) Blood – Composition, functions, Blood groups, Structure and functions of hemoglobin.
(iii) Structure of heart of man, origin and conduction of cardiac impulse.
(iv) Cardiac cycle and its regulation.
(v) Blood pressure and its regulation.
(vi) Disorders of blood.

Unit-IV
(i) Patterns of nitrogenous excretion among different animal groups.
(ii) Structure of kidney of man.
(iii) Physiology of urine formation, Acid base balance.
(iv) Osmo regulation in different animal groups.
(v) Thermo regulation in poikilothermic and homoeothermic animals.

Text Books: -

1. Animal Physiology & Biochemistry- H.R. Singh & Neeraj Kumar- M/S Vishal Publishing Co., Jalandhar
2. Text Book of Medical Physiology- A.C. Guyton & J.E. Hall- M/S Elsevier-Health Sciences Division
3. Animal Physiology- M.P. Arora- M/S Himalaya Publishing House, Mumbai
4. Physiology :- Life Sustaining System- Manorama Patri- M/S Kalyani Publishers, New Delhi

Reference Books: -

1. Essentials of Animal Physiology- S.C. Rastogi- M/S New Age International Publications
2. Animal Physiology & Biochemistry- Alexis Bradley- M/S ED-TECH PRESS
3. Animal Physiology- Kavita Juneja- M/S Anmol Publications Pvt. Ltd.

4. Animal Physiology & Biochemistry- Agarwal, Srivastava, K. Kumar- M/S S. Chand & Company Pvt. Ltd.
5. A Text Book of Animal Physiology- A.K. Berry- M/S Emkay Publications
6. Animal Physiology- Verma, Tyagi, Agarwal- M/S S. Chand & Company Pvt. Ltd.
7. Text Book of Physiology-Vol.-I- A.K. Jain- M/S Avichal Publishing Co.

Course Outcome:-

1. (L-1) Learning various organs, systems & their associate glands in human being and also their importance for life sustaining.
2. (L-2) Understand the detailed mechanism of various systems like digestive, circulatory, respiratory, and excretory systems and their functions for sustaining of life in human beings.
3. (L-3) Application of digestion and absorption of different types of food and also the action of various systems occurs for sustaining the life smoothly in human.
4. (L-4) Analyzing different disorders in various systems in human beings.
5. (L-5 & L-6) Qualitative and Quantitative evaluation of the rate of digestion, rate of respiration, rate of circulation etc in human being.

PG THIRD SEMESTER

ZOO - 302

PHYSIOLOGY – CONTROLLING & COORDINATING SYSTEM

FM: 30+70 (4 CH)

Prerequisites: ***Anatomy of human body, Animal Behavior, Animal Adaptation, Endocrine System, Controlling Mechanism.***

Course objective: -

(i) To know about the coordinating system and controlling system of our body.
(ii) To understand the mechanism and modes of action of these processes and their related disorders.
(iii) To develop methodological skills to avoid, counteract and cure of various disorders.

Unit-I
- (i) Contractile elements in different groups of animals.
- (ii) Ultra structure of skeletal muscle.
- (iii) Molecular and chemical basis of muscle contraction.
- (iv) Structure of Neuron, conduction of nerve impulse across the myelinated and unmyelinated nerve fibre.
- (v) Neurotransmitters, Synaptic transmission.

Unit-II
- (i) Receptor physiology – Photoreceptor (eye), Phonoreceptor (ear).
- (ii) Communication among animals – Bioluminescence, Audio signals, pheromones.
- (iii) Chromatophores and of their functions.
- (iv) Concept of environmental stress, stress resistance, stress avoidance, stress tolerance.

Unit-III
- (i) Structure and functions of pituitary, thyroid, pineal, parathyroid, adrenal glands.
- (ii) Mechanism of hormonal actions.
- (iii) Signal transduction pathways utilized by steroidal and non-steroidal hormones.
- (iv) Hormonal disorders.

Unit-IV
- (i) Histology of male and female reproductive systems of human being.
- (ii) Puberty and its Hormonal regulations
- (iii) Menstrual cycle and its Hormonal regulations
- (iv) Hormonal regulation of reproduction (ovulation, implantation, pregnancy, parturition, lactation)
- (v) Methods of contraception.

Text Books: -

1. Human Physiology-Vol.-I & II- C.C. Chatterjee- M/S CBS Publishers & Distributors Pvt. Ltd. / M/S New Central Book Agency, Kolkata
2. Mammalian Endocrinology- B.N. Yadav- M/S Vishal Publishing Co., Jalandhar
3. Vander's Human Physiology- Widmaier, Raff & Stang- M/S McGraw Hill Education, 2013
4. Animal Physiology- Hill & Anderson- M/S Oxford Univ. Press Inc.

Reference Books: -

1. A Text Book of Animal Physiology & Biochemistry- Dr. V. Kashyap- M/S Kedarnath Ramnath Publications, Meerut
2. Text Book of Physiology-Vol.-II- A.K. Jain- M/S Avichal Publishing Co.
3. Animal Physiology (Controlling & Coordinating System)- D. Mishra & T. Mishra- M/S Mahaveer Publications

4. Physiology & Biochemistry- Surya Prakash Mishra- M/S Kalyani Publishers, New Delhi
5. General Endocrinology- C.D. Turner- M/S W.B. Saunders Company
6. A Text Book of Endocrinology- A.K. Berry- M/S Emkay Publications
7. Mammalian Endocrinology- Ashoka Kumar Boral- M/S New Central Book Agency, Kolkata
8. Vander's Human Physiology- Widmaier Raff, Strang- M/S McGraw Hill Education

Course Outcome:-

1. (L-1) Learning various organs, systems & their associate glands in human being and also their cooddinating action for smooth life process in various groups of animals.
2. (L-2) Understand the detailed mechanism of various endocrine glands, their hormones and also their functions for coordinating action of the body.
3. (L-3) Application of different enzymes and hormones and also the action of various systems occurs for sustaining the life smoothly in human being.
4. (L-4) Analyzing different disorders in various systems & different endocrine glands and also the analyzing the action due to hypo and hipper secretion of hormones and enzymes in human being.
5. (L-5 & L-6) Qualitative and Quantitative evaluation of the rate of hormone & enzyme secretion for controlling & coordinating action of various systems in human being.

PG THIRD SEMESTER
ZOO – 303

BIOMOLECULES & ENZYMOLOGY

FM: 30+70 (4 CH)

(Prerequisites-Knowledge of basic chemistry, different bonds, various biomolicules and their functions)

Course objective: -

(i) To understand the various forms of biomolecules, classification and their structural organization.
(ii) To elucidate the various mechanisms of bonding and action of biomolecules and enzymes.
(iii) To access the role of the biomolecules in different biochemical processes.

Unit - I	(i)	Structure and classification of carbohydrate (mono, di and polysaccharides)
	(ii)	Structural organisation of proteins.
	(iii)	Classification of proteins.
	(iv)	Structure of amino acids & peptide bond formation.
Unit - II	(i)	Structural and classification of lipids. (fatty acids, triglycerides, steroids)
	(ii)	Structure and classification of Vitamins.
	(iii)	Structure and classification of hormones.
Unit - III	(i)	Chemical nature of enzymes
	(ii)	Co enzymes , Iso enzymes and Ribozymes
	(iii)	Classification and nomenclature of enzymes
	(iv)	Mechanism of enzyme action
Unit - IV	(i)	Kinetic analysis of enzyme catalyzed reaction
	(ii)	Michaelis – Menten equation
	(iii)	Factors affecting enzyme action
	(iv)	Enzyme inhibition

Text Books: -

1. Fundamentals of Enzymology- Nicholas C. Price & Lewis Sterens- M/S Oxford Univ. Press
2. Enzymology & Enzyme Technology- S.M. Bhatt- M/S S. Chand & Company Ltd., New Delhi
3. Biomolecules : Chemistry of Living System- V.K. Ahluwalia- M/S Manakin Press, 2015
4. Chemistry of Biomolecules- S.P. Bhutani- M/S CRC Press, 2010

Reference Books: -

1. Biomolecules & Cell Biology- P.K. Gupta- M/S Rastogi Publication, Meerut
2. Biomolecules-The Molecules of Life-Part-I- Dr. Alok Tripathi- M/S Narendra Publishing House, New Delhi
3. Biomolecules- N. Arumugam- M/S Saras Publications
4. Fundamentals of Enzyme Kinetics- Athel Corvish-Bowden- M/S Butterworth-Heinemann
5. Enzymology- T. Devasena- M/S Oxford University Press
6. Fundamentals of Biochemistry- J.L. Jain- M/S S. Chand & Company Ltd., New Delhi
7. Enzymes-Biodiversity, Biotechnology, Clinical Chemistry- T. Palmer & P. Bonner- M/S Woodhead Publishing limited, UK

Course Outcome:-

1. (L-1) Identification of different groups of biomolecules.
2. (L-2) Discussion on the different structural organization of different biomolecules.
3. (L-3) Establish /show the inter relationships of different groups of biomolecules.

4. (L-4) Qualitative and Quantitative test of biomolecules.
5. (L-5 & L-6) Involvement of biomolecules in different biochemical processes and assessment of their significance.

PG THIRD SEMESTER

ZOO – 304

BIOCHEMISTRY OF METABOLIC PROCESSES

FM: 30+70 (4 CH)

Prerequisites: ***Structure of Biomolecules, Mitochondrial Functions, Anabolic and Catabolic activities within the cell.***

Course objective:-

(i) To understand the basic principles of various biochemical pathways.
(ii) To know about their mode of synthesis and regulations.
(iii) To relate the roles of metabolic pathways with physiological aspects of system during physiological adaptation.

Unit - I	(i)	Metabolism of carbohydrates – Glycolysis , Citric acid cycle, Gluconeo genesis , Glycogenesis , Glycogenolysis, HMP Shunt, Glycoxylate cycle.
	(ii)	Shuttle systems, (Malate – Aspartate shuttle, Glycerol – 3 – phosphate shuttle)
Unit - II	(i)	Energy metabolism and high energy compounds
	(ii)	Redox potential
	(iii)	Mitochondrial Electron Transport Chain
	(iv)	Oxidative Phosphorylation
	(v)	Formation and hydrolysis of ATP, Inhibitors, Uncouplers
Unit - III	(i)	Lipid metabolism – β-oxidation of saturated fatty acids, with even and odd number of carbon atoms
	(ii)	Bio synthesis of palmitic acid
	(iii)	Ketogenesis and its regulation
	(iv)	Metabolism of cholesterol
Unit - IV	(i)	Protein metabolism – catabolism of amino acids – transamination, deamination
	(ii)	Urea cycle
	(iii)	Fate of C – Skeleton of glucogenic and ketogenic amino acids
	(iv)	Interrelationship of carbohydrate, lipid and protein metabolism

Text Books: -

1. Fundamentals of Biochemistry- Jain & Jain- M/S S. Chand & Company Ltd., New Delhi
2. Principles of Biochemistry- Lehringer, Nelson & Cox- M/S W.H. Freeman & Co. Ltd., New York, ISBN-13-978-1429234146
3. Biochemistry- U. Satyanarayan & U. Chakrapani- M/S Books & Allied (P) Ltd., Kolkata
4. Biochemistry of Metabolic Processes- Asim Kumar Roy - M/S Kalyani Publishers, New Delhi

Reference Books: -

1. Biochemistry- S.N. Gupta- M/S Rastogi Publication, Meerut
2. Harper's Illustrated Biochemistry- Harper- M/S McGraw Hill Education
3. Elements of Biochemistry- H.S. Srivastava- M/S Rastogi Publication, Meerut
4. Text Book of Biochemistry- O.P. Agarwal- M/S Krishna Prakashan Media (P) Ltd.
5. Biochemistry- Power & Chatwal- M/S Himalaya Publishing House
6. Biochemistry- S.C. Rastogi- M/S Tata McGraw Hill Education
7. Text Book of Medical Biochemistry- Dr. S.K. Gupta- M/S Zanco Book, Dariya Ganj, New Delhi

Course Outcome:-

1. (L-1)Learning basic structure of biomolecules and their role in different metabolic processes.
2. (L-2) Understanding the pathways followed by different biomolecules for synthesis, elimination or regeneration of essential things for cell/ body.

3. (L-3) To see how regulation of metabolic cycle or metabolic product can make a difference in the survival of a living system.
4. (L-4) To analyze the role of metabolites with respect to the physiological function performed by a living system.
5. (L-5 & L-6) Finding out the ways to manipulate Physiological aspects of the system taking metabolic pathways in to consideration during physiological adaptation.

PG THIRD SEMESTER
ZOO – 305 PRACTICAL

PHYSIOLOGY, BIOMOLECULES, ENZYMOLOGY, BIOCHEMISTRY

FM: 100 (4 CH)

Course objective: -

(i) To acquire practical knowledge on various enzyme action and estimation process.
(ii) To make quantitative and qualitative analysis for estimation of various biological samples.
(iii) To apply the basic principles in applied biomedical practices.

1. Determination of Blood Group
2. Enumeration of RBC
3. Enumeration of WBC
4. Estimation of haemoglobin
5. Preparation of haemin crystal
6. Recording of blood pressure
7. Demonstration of reflex action
8. Quantitative tests of Carbohydrate, Protein & Lipid
9. Paper chromatography of amino acids
10. Action of salivary amylase on starch
11. Effect of pH, temperature on salivary amylase
12. Estimation of total proteins in the given solution
13. Study of enzymatic activity of trypsin and lipase
14. To perform the acid and alkaline phosphatase assay from serum/tissue
15. Examination of sections of mammalian tissue - oesophagus, stomach, duodenum, ileum, liver, kidney, trachea, lung, muscle fiber, neuron
16. Microtomy - Preparation of permanent slides of mammalian tissues

PG THIRD SEMESTER
ZOO – 306

GENERAL ZOOLOGY

FM: 30+70 (4 CH)

(Prerequisites-Knowledge of the Animal kingdom, classification of Animal kingdom, Food and nutrition ,Various types of diseases)

Course objective:-

(i) To make a detail survey of animal diversity, various physiological processes and beneficial animal groups.
(ii) To have an understanding about nutrition, nutritional deficiencies and various disorders.
(iii) To identify and use the environmentally important groups to increase the socio-economic status of people.

Unit-I
Origin of life.
Diversity of life and classification of animals – Nonchordates and chordates.
Evolution of man and its position in the animal kingdom.

Unit-II
Elementary idea on various systems and physiological processes of human beings and their related disorders.

Unit-III
Basic concept of food and nutrition
Classification of food & nutritional deficiencies
Communicable diseases (measles, polio, rabies, plague, leprosy, AIDS, chikungunya)
Non-communicable diseases (hypertension, heart stroke, diabetes, obesity, mental ill health.

Unit-IV
Beneficial insects (Honeybee, silk-moth, lac insects).
Economic importance of honey, silk and lac.
Common edible fishes of Odisha & fish products.
Common breeds of domestic animals.
Transgenic animals.

Text Books: -

1. New College Zoology, Paper-I, II & III- I.K. Bhattacharya, Rita Mahanta- M/S Kalyani Publishers, New Delhi
2. Animal biology : Taxonomy, Anatomy & Physiology- Adalina Woodberg- M/S Syrawood Publishing House, 2019
3. Economic Zoology- Praharaj, Mishra, Mohanty- M/S Kalyani Publishers, New Delhi
4. Food, Nutrition & Health- G. Biswal & C. Lenka- M/S Kalyani Publishers, New Delhi

Reference Books: -

1. A Text Book of Animal Diversity- R.L. Kotpal- M/S Rastogi Publication, Meerut
2. General Zoology-Vol.-I- Chaki, Kundu, Sarkar- M/S New Central Book Agency, Kolkata
3. Introduction to General Zoology-Vol.-II- Chaki, Kundu, Sarkar- M/S New Central Book Agency, Kolkata
4. Basic Biology- P.K. Mohanty & P.K. Mohapatra- M/S Kalyani Publishers, New Delhi
5. Nutrition Science- B. Sri Lakshmi- M/S New Age International Publishers
6. Concept of Zoology-Vol.-I (Class XI) & Vol.-II (Class-XII)- R.L. Kotpal- M/S Rastogi Publication, Meerut
7. Modern Zoology- Bhamrah & Juneja- M/S Rastogi Publication, Meerut

Course Outcome:-

1. (L-1)Identification of different groups of Chordates and Non-Chordates and the causative agents of various communicable and non communicable diseases.
2. (L-2) Explain/Discuss the pattern of evolution and explain the position of Man.
3. (L-3)Explain /Discuss how organisms function at the level of organ and organ system,
4. (L-4) Analyse/Examine various groups of communicable and non-communicable diseases, their causative agents ,mode of transfer and their preventive measures.
5. (L-5 & L-6) Develop an idea about various beneficial insects and their economic importance.

PG FOURTH SEMESTER

ZOO - 401

MOLECULAR BIOLOGY AND IMMUNOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Gene Concept, Chemical nature of genes, Structure of Biomolecules, Types of genes, History of immunity and vaccination, Grafting.***

Course Objective:

i. To understand the structural organisation of gene, DNA, RNA, chromosomes.
ii. To know about the mechanisms of gene action (Transcription and Translation) and their regulations.
iii. To understand the defense mechanism of body and the structures involved with it.
iv. To acquire the skills for the application of technology in boosting immune response.

Unit-I
(i) Nucleic acid as the genetic material.
(ii) Organization of DNA – Viral, bacterial and eukaryotic, Types of DNA
(iii) DNA replication – General mechanism, enzymes and inhibitors
(iv) Structure of RNA, Types of RNA, Regulatory RNAs
(v) Split genes, overlapping genes, jumping genes, transposons

Unit-II
(i) Genes and Chromosomes – Nature of genetic material – Central dogma
(ii) Genetic code – Properties & Deciphering
(iii) Transcription – Mechanism and its regulation, post transcriptional modifications and processing of RNA
(iv) Translation – Mechanism and post translational modifications
(v) Regulation of gene expression (Operon concept)

Unit-III
(i) Immunity – Innate and adaptive, cells, organs and molecules of immune system, B&T cell diversity
(ii) Antigens and antibodies – Structure, types, interactions of antigen and antibody in vivo and invitro, Immunoassays
(iii) Hybridoma technology – Production of monoclonal antibodies and their applications
(iv) Organ transplantation

Unit-IV
(i) MHC genes and their products. Endogenous & enogenous pathway of antigen presentation
(ii) Complements and their actions
(iii) Cytokines – Properties and functions
(iv) Immunotolerance, autoimmunity and hypersensitivity concepts
(v) Vaccines – Recombinant and DNA vaccines

Text Books: -

1. Molecular Cell Biology- Baltimore & Lodish- M/S W.H. Freeman, 8th Edition, 2016
2. Immunology- S.S. Lal & S. Kumar- M/S Rastogi Publication, Meerut
3. Immunology- Jaxis Kuby- M/S Science Books, 2001
4. Immunology- Asim Kumar Roy - M/S Kalyani Publishers, New Delhi
5. Essentials of Molecular Biology- A.C. Sahu- M/S Kalyani Publishers, New Delhi
6. Molecular Biology- Turner- M/S Viva Books Pvt. Ltd.

Reference Books: -

1. Text Book of Immunology- Ajay Paul- M/S Books & Allied Ltd.
2. Immunology- Raj Khanna- M/S Oxford Higher Education
3. A Text Book of Immunology- A.K. Berry- M/S Emkay Publications
4. Immunology & Immunotechnology- Ashim K. Chakravarty- M/S Oxford Higher Education
5. Simplified Courses in Molecular Biology- V.K. Agarwal- M/S S. Chand & Company Ltd., New Delhi
6. Fundamentals of Molecular Biology- V.B. Rastogi- M/S Ane Books Pvt. Ltd.
7. A Text Book of Molecular Biology- M.P. Arora- M/S Himalaya Publishing House
8. Molecular Biology- Verma & Agarwal- M/S S. Chand & Company Ltd., New Delhi

Course Outcome:-

1. (L-1) To Learn the structure of DNA, RNA and their types. Identification of components of Immune system.
2. (L-2) Understanding the role of DNA in a system. To Study various molecular processes associated with genetic material. Further to understand the role and production of antibodies.
3. (L-3) To perform in vitro genetic experiments in order to diagnose metabolic and genetic shortcomings and development therapeutics.
4. (L-4) analyzing the mechanism of DNA propagation and modification. Understanding of the cell communication system.
5. (L-5 & L-6) Utilization of Molecular knowledge to develop tools and techniques for biochemical study, experiment and development of molecular models.

PG FOURTH SEMESTER
ZOO - 402

BIOTECHNOLOGY

FM: 30+70 (4 CH)

Prerequisites: ***Genetic Engineering, Application of Genetic Engineering, Concepts of gene, vectors, Culture Techniques, Animal Ethics etc.***

Course Objective:

i. To acquire the basic understanding of genetic engineering & recombinant DNA technology & their basic processes.
ii. To apply the principles of recombinant DNA technology in cell culture, transfection, production of transgenic animals, pharmaceutical products, agricultural products and gene therapy.
iii. To aware the students about the uses and misuses of recombinant DNA technology and ethics related to it.

Unit-I
(i) Basic concept of Recombinant DNA technology
(ii) Enzymes of genetic engineering – Restriction enzymes, DNA ligage, Polymerase etc.
(iii) Cloning and expression vectors
(iv) Isolation of DNA, cDNA synthesis, Construction of genomic libraries
(v) Introduction of cloned genes into host cells

Unit-II
(i) Analysis and expression of cloned genes in host cells :- Blotting techniques, insitu hybridization, DNA sequencing
(ii) DNA fingerprinting
(iii) Polymerase chain reaction

Unit-III
(i) Animal cell culture
(ii) Transfection – Gene transfer in animals and production of transgenic animals
(iii) Transgenic animals and their applications
(iv) Ethical issues concerning transgenesis
(v) Biosafety, regulations of genetic engineerting – IPR, Biosensing, DNA microarrays

Unit-IV
(i) Application and impact of rDNA technology in agriculture:- Gene silencing (Antisense RNA technology)
(ii) Application of rDNA technology in medicines – Manufacture of Biopharmaceutical products like insulin, interferon and growth hormones
(iii) Diagnosis and cure of diseases by gene therapy
(iv) Biotechnology in Forensic medicine

Text Books: -

1. Biotechnology- B.D. Singh- M/S Kalyani Publishers, New Delhi
2. Biotechnology & Genomics- P.K. Gupta- M/S Rastogi Publication, Meerut
3. A Text Book of Biotechnology- R.C. Dubey- M/S S. Chand & Company Ltd., New Delhi
4. Biotechnology- U. Satyanarayana- M/S Books & Allied Ltd.

Reference Books: -

1. Elements of Biotechnology- P.K. Gupta- M/S Rastogi Publication, Meerut
2. Animal Biotechnology- Srivastava, Singh, Yadav- M/S Oxford & IBtt Publishing Co. Pvt. Ltd.

3. Text Book of Biotechnology- H.K. Das- M/S Wiley Publications
4. Molecular Biotechnology- S.B. Primrose- M/S PANIMA Publications
5. Introduction to Biotechnology- Ashim K. Chakravarty- M/S Oxford University Press
6. Laboratory Manual of Biotechnology- S.K. Bhatnagar & Deepika Abrol- M/S Vishal Publishing Co., Jalandhar
7. Essentials of Biotechnology- U.K. Patil & K. Muskan- M/S Dreamtech Press/West Villie Publishing House

Course Outcome:-

1. (L - 1) To study of basic knowledge of gene, gene amplification, genetic engineering, vectors and methods of culture.
2. (L-2) To understand the process of gene transfer along with the tools and techniques.
3. (L-3) Manufacturing of bioproducts in large scale . To develop better quality breeds , drugs, crops and their applicability.
4. (L-4) To analyse the behavioural aspects of gene with respect to its transfer to a host system and rate of success in production of transgenic animals.
5. (L-5 & L-6) Finding out suitable sources and methods to develop better biosources for products of high value and addressing various ethical issues concerning genetic engineering.

PG FOURTH SEMESTER

ZOO - 403

BIOPHYSICS, BIOPHYSICAL CHEMISTRY & INSTRUMENTATION

FM: 30+70 (4 CH)

Prerequisites: ***Physical and Biological Principles of Human Physiology, Microbes, Instruments, Chemistry of Biomolecules.***

Course Objective:

i. To understand the basic principles of biological systems and chemistry of various bio molecules.
ii. To know about the principles and working mechanisms of various instruments and techniques.
iii. To provide exposure to the students about handling instruments and effective uses of those in biological experiments.

Unit-I
(i) Principles of thermodynamics and their applications in biological system.
(ii) Concept of energy, standard free energy, free energy hydrolysis of ATP.
(iii) Intermolecular forces, Vander Wall's forces.
(iv) Chemical bonding - Ionic and Hydrogen bonding, Bond energy.
(v) Dipole – Dipole interactions

Unit-II
(i) Chemical foundations of physiology – Solutions, osmotic pressure, diffusion
(ii) Acid, bases, PH & PKa, Buffers and buffering action
(iii) Properties of water as a biological solvent.
(iv) Physical & chemical organization of protoplasm and its properties.

Unit-III
(i) Principles and uses of analytical instruments:- Balances, PH meter, calorimeter, spectrophotometer.
(ii) Microbial techniques – Media preparation, inoculation and growth monitoring
(iii) Microbial assays.
(iv) Cryo-techniques – Cryo-preservations of cells, tissues and organs

Unit-IV
(i) Microscopy – Principles and working mechanism of light, electron, phase contrast and fluorescence microscopes.
(ii) Separations techniques in biology – Molecular separation by chromatography, electrophoresis, organelles separation by centrifugation, cell separation by flow cytometry.

Text Books: -

1. Biophysical Chemistry-Vol.-I,II & III- Cantor- M/S W.H. Freeman & Co. Ltd., New York, 1980, ISBN-0716711885
2. Instrumental Methods of Analysis- B. Sivasankar- M/S Oxford University Press,2012
3. Essentials of Biophysics- P. Narayanan- M/S New Age International (P) Ltd.
4. Handbook of Biomedical Instrumentation- R.S. Khandpur & R. Khandpur- M/S McGraw Hill Education (India) Pvt. Ltd., New Delhi

Reference Books: -

1. Fundamentals of Biophysics- A.B. Das & N.P. Das- M/S Kalyani Publishers, New Delhi
2. Introduction to Biophysics- Dr. Pranab Kumar Banerjee- M/S S. Chand & Company Ltd., New Delhi
3. Biomedical Instrumentation (Technology & Applications)- R.S. Khandpur- M/S McGraw Hill Education
4. Biophysics-An Introduction- Rodney Cottenill- M/S Wiley Student Edition
5. A Text Book of Biophysics- Dr. R.N. Roy- M/S New Central Book Agency, Kolkata
6. Biophysical Chemistry- James P. Allen- M/S Wiley-Blackwell Publications
7. Biophysical Chemistry- Allen Cooper- M/S RSC Publishing (Royal Society of Chemistry Publishing)

Course Outcome:-

1. (L-1) To know basic physical and chemical events in a living system and its manifestation. To know principles of Thermodynamics, concepts of energy and bonding.
2. (L-2) To understand the role of biophysical and biochemical properties of biomolecules and their contribution towards the chemical foundation of physiology.
3. (L-3) Analysis of biosamples. To know basic principles and mechanism of various instruments and technology.
4. (L-4) Analysis of the application of thermodynamic principles on the biological system. Monitoring of microbial growth and assay.
5. (L-5 & L-6) Finding out the role of physical and chemical forces responsible for sustenance of life. Uses of various separation techniques and instruments.

PG FOURTH SEMESTER
ZOO - 404

BIOSTATISTICS

FM: 30+70 (4 CH)

Prerequisites: ***Biometry, Applied Biometry, Physical and Biological data and related problems, Mathematical Principles.***

Course Objective:

i. To understand the importance of biostatistics in biological groups and their usages.
ii. To conduct and solve various biostatistical problems in order to gain exposure and experience.
iii. To correlate theory with practical and to solve various hypothetical views with various hypothesis testing.

Unit-I
(i) Concept of sample and population, Sampling methods
(ii) Frequency Distribution (Normal, Binominal & Poisson)
(iii) Graphical representation of Data
(iv) Measures of central tendency - mean, median, mode
(v) Measures of Dispersion - Range, Quartile deviation, Standard deviation.

Unit-II
(i) Standard error of mean
(ii) Variance, coefficient of variance
(iii) ANOVA. One way classification of ANOVA, Two way classification of ANOVA, F-test
(iv) Probability, theorems of Probability.

Unit-III
(i) Testing of Hypothesis, Null Hypothesis, Alternate hypothesis
(ii) Test of single mean, test of difference of two means, test of significance based on students 't' test
(iii) x2 (Chi-square) test.

Unit-IV
(i) Correlation, types of correlation, measurement of correlation
(ii) Scatter diagram and Karl Pearson coefficient of correlation. Rank correlation
(iii) Regression Analysis. Lines of Regression and Regression coefficient.

Text Books: -

1. Elements Biostatistics- Satguru Prasad- M/S Rastogi Publication, Meerut
2. Business Statistics- Patri & Patri- M/S Kalyani Publishers, New Delhi
3. Statistical Methods- S.P. Gupta- M/S S. Chand & Company Ltd., New Delhi
4. Biostatistics- V.B. Rastogi- M/S Ane Books Pvt. Ltd., New Delhi

Reference Books: -

1. Introduction to Biostatistics- Pranab Kumar Banerjee- M/S S. Chand & Company Ltd., New Delhi
2. Biostatistics (Theory & Applications)- G.B.N. Chainy & Co.- M/S Kalyani Publishers, New Delhi
3. Biostatistics- Sharma, Pulliah, Reddy & Ravindra- M/S Daya Publishing House, New Delhi
4. Biostatistics- Arora & Malhan- M/S Himalaya Publishing House, Mumbai
5. Biostatistics- P. Ramakrishnan- M/S Saras Publications
6. Biostatistics- K. Balaji, A.V.S. Raghavaiah, K.N. Jayaveera- M/S Dreamtech Press
7. Introduction to Biostatistics and Research Methods- P.S.S. Sundar Rao & J.Richard- M/S PHI Learning Pvt. Ltd.

Course Outcome:-

1. (L-1) Types of sampling method and frequency distribution. Types of graphical representation data. Various measures central tendency and measures of dispersion. Types of correlation and regression.
2. (L-2) Differentiation between normal, binomial and poisson distribution. Classification of ANOVA. Testing of hypothesis. Theorems of probability.
3. (L-3) Interpretation and representation of data through graphs, charts, tables, etc. Testing of Hypothesis. Test of significance.
4. (L-4) Analysis of data by various measures of dispersion. Variance test, ANOVA test, t test, χ^2 Test, F Test, standard error of mean, etc.
5. (L-5 & L-6) Predication of results/Outcomes through probability test. Finding out and drawing in of diagrams for coefficient of correlation and regression coefficient. Application and evaluation of various tests in both physical and biological research. Interpretation of results by various hypothesis testing.

PG FOURTH SEMESTER

ZOO – 405 PROJECT / DISSERTATION

FM: 100 (4 CH)