Post Graduate Department of Zoology

Berhampur University

Bhanja Bihar, Berhampur, Ganjam, Odisha

Berhampur- 760007

From

M.Sc. Syllabus (2025-26)

Curriculum Overview (M.Sc.)

Distribution of Course (Semester wise)

- Semester I: Four (04) Core Courses, one (01) Bharatiya Jyana Parampara and one Laboratory Course Work
- Semester II: Four (04) Core Courses, one Laboratory Course Work and one Value Added Course
- Semester III: One (01) Core Courses, Two (02) Electives, One (01) interdisciplinary choice elective, one (01) Laboratory Course Work and one (01) Value Added Course
- Semester IV: One (01) Core Courses, Two (02) Electives, Project Dissertation (Presubmission and Viva), One (01) Add-on Added Course

Value Added Courses:

Two value added courses, (ZOOL VAC 206) and (ZOOL VAC 305), is offered by the Department respectively in the second and third semester. Value Added Course is not mandatory to qualify for any programme and shall be offered as non-credit course. Value Added Courses completed by a student shall be reflected in the mark sheet as "completed VAC" in the 2nd and 3rd semester. It is a teacher assisted learning course open to students of the department without any additional fee. However, students shall pay the prescribed examination fee and register along with other courses in that particular semester. Classes for a VAC to be reflected in the time table. The value-added courses shall be also conducted during weekends/vacation period. A student will be permitted to register only one Value Added Course in a Semester. The course can be offered only if there are at least 10 students opting for it.

Add-on Course

This course is offered in the 4th Semester by the Department of Odia, Berhampur University. This course has been introduced with a view to familiarizing all the P.G. Students of Berhampur University with the excellent craftsmanship exemplified by the literary stalwarts including Kabi Samrat Upendra Bhanja along with the Arts, Culture andFolk Tradition of South Odisha

Scheme of Evaluation:

Each theory papers having 100 Marks is devided into **30 Marks** of internal evaluation (20 marks written mid semester and 05 marks based on assignment and quitezes/Group Discussion and 05 marks for attendance) and **70 Marks** of final examination in each semester.

M.Sc. Zoology General Course Framework & Structure

S.No	Paper No	Title	Credits	Proposed Marks
SEMESTER ONE				
1	ZOOL C 101	Biology of Non-Chordates	04	100
2	ZOOL C 102	Cytology and Inheritance Biology	04	100
3	ZOOL C 103	Biosystematics, Conservation Biology, Evolution and Ecology	04	100
4	ZOOL C 104	Biochemistry	04	100
5	ZOOL IKS 105	Indian Knowledge Systems (Bharatiya Jyana Parampara) in Zoology: Ethnozoology and Traditional Practices	04	100
6	ZOOL P 106	Laboratory Course Work-I	06	100
		TOTAL	26	600
SEMESTER TWO				
1	ZOOL C 201	Biology of Chordates	04	100
2	ZOOL C 202	Molecular Biology	04	100
3	ZOOL C 203	Physiology, Endocrinology and Histology	04	100
4	ZOOL C 204	Ethology, Applied Ecology and Microbiology	04	100
5	ZOOL P 205	Laboratory Course Work-II	06	100
6	ZOOL VAC 206	Bioinformatics, Biosafety and Bioethics	NC	NC
		TOTAL	22	500
SEMESTER THREE				
1	ZOOL C 301	Immunology and Histochemistry	04	100
2	ZOOL E 302	(A) Entomology (B) Environmental Science	04	100
3	ZOOL E 303	Bioinstrumentation and Biostatistics	04	100
4	ZOOL P 304	Laboratory Course Work-III	06	100
5	ZOOL CT 300	Human Health and Nutrition *	04	100
6	ZOOL VAC 305	Academic Writting	NC	NC
		TOTAL	22	500
SEMESTER FOUR				
1	ZOOL C 401	Cytogenetics , Stress Physiology and Metabolic disorders	04	100
2	ZOOL E 402	Epigenetics, Molecular Technique and Cancer Biology	04	100
3	ZOOL E 403	Developmental Biology, Nanotechnology and Radiation Biology	04	100
4	ZOOL D 404	Project Dissertation (Presubmission presentation)	06	100
5	ZOOL D 405	Project Dissertation (Viva-Voce)	06	100
6	ZOOL AC 410	Cultural Heritage of South Odisha	NC	100
		TOTAL	24	500
		TOTALCREDITS	94	2100

Course offered for CBCT

NC: Non Credit Value Added Courses *All PG students are required to complete one SWAYAM Course (minimum 02 credits) on or before completion of 3rd semester. The Coordinator of SWAYAM Course shall contact to the departmental Nodal Officer and finalizecourse to be opted by students. **The course credit shall be included in the 3rd semester grade sheet.** *Optional Summer internship (04 weeks) after second semester.

SEMESTER-I

Semester-One

ZOOL C 101

Biology of Non-Chordates

Credits:

4

Course Objectives: Objective of the paper is to provide brief idea about each taxon of the non-chordates with some important biological features.

Student Learning Outcomes: Students after completion of this course are expected to know about the non-chordate diversity, evolutionary relationship, and some basic aspects parasitism.

Course Coordinator: Mr. L.K. Murmu

Unit I **Lower Invertebrates** **Lectures:16**	1. Locomotion, nutrition and reproduction in Protozoa 2. Origin of Metazoa 3. Canal system and reproduction in *Porifera* 4. Polymorphism in Coelenterates and affinities in *Ctenophora*
Unit II **Higher Invertebrates** **Lectures:16**	1. Host-parasite interactions 2. Coelom,metamerism and segmental organs of Annelida 3. Parasitic adaptations in heliminths 4. Helminth parasites of human being
Unit III **Higher Invertebrates** **Lectures:16**	1. Structural organization and phylogenetic status of *Limulus* and *Trilobite* 2. Parasitic castration with reference to the life cycle of *Sacculina* 3. Larval forms in Crustaceans 4. Structural organization and phylogenetic status of *Peripatus*
Unit IV **Higher Invertebrates** **Lectures:16**	1. Respiration in Molluscs 2. Torsion and de-torsion in Gastropoda 3. Water vascular system of Echinoderms 4. Larval forms in Echinodermata
	Recommended Textbooks and References: 1. Invertebrate Zoology, R.D. Barnes 2. The invertebrates, L.H. Hyman, Vol I to VI 3. Invertebrate structure, Barrington, Nelson 4. Invertebrate Zoology, R.L. Kotpal 5. The Invertebrates: Function and Form, W. Sherman, V.G. Sherman 6. A Text Book of Zoology, T.J. Parker, W.A. Haswell, Vol-I and II

Semester-One

ZOOL C 102

Cytology and Inheritance Biology

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about cell biology and inheritance pattern.
Student Learning Outcomes: Students after completion of this course are expected to know different cellular organelles and their functions, cell cycle regulations, basic inheritance pattern and basic gene mapping techniques.

Course Coordinator: Dr. S.K. Dash

Unit I **Cytology-I** **Lectures:16**	1. Structure and organization of Cell membrane 2. Membrane transporter: Structure and function 3. Mechanism of membrane transports 4. Cell-cell interactions
Unit II **Cytology-II** **Lectures:16**	1. Structure and function of Cytoskeleton and its role in motility 2. Structure, Biogenesis and function of Lysosome and Peroxisomes 3. Endoplasmic Reticulum, and compartmentalization of Golgi, protein targeting in ER and Glycosylation 4. Structure and function of Mitochnodria and protein targetting
Unit III **Cytology-III** **Lectures:16**	1. Nucleus and nuclear transport 2. Concept and organization of Gene and Chromosome 3. Cell cycle and its regulations 4. Cell Division and it's regulation
Unit IV **Mendelism Neo-Mendelism** **Lectures:16**	1. Mendelian Genetics 2. Neo-Mendelism, Pleiotropy, genomic imprinting, penetrance and expressivity 3. Linkage and crossing over 4. Extra-chromosomal Inheritance, Pedigree analysis, Complementation tests
	Recommended Textbooks and References: 1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin 2. Molecular Biology of the Cell, Alberts *et al*., (2008), Garland Science, New York, USA 3. The Cell: A molecular approach, Geoffrey, M. Cooper, R.E. Hausman (2004) ASM Press 4. Cell and Molecular biology , Gerald Karp (2015)John wiley and sons 5. Principles of Genetics, Snustad and Simmons, (4th Ed. 2005), John Wiley & Sons, USA 6. Genetics, J. Russell, Benjamin-Cummings Publishing Company, California, USA

Semester-One

ZOOL C 103

Biosystematics, Conservation Biology, Evolution, and Ecology

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about classical and modern taxonomic approaches, Biodiversity and conservation of bio-resources, makes student aware about the evolutionary process and various components of ecosystem and their importance.

Student Learning Outcomes: Students after completion of this course are expected to get a holistic understanding of taxonomy, inculcate the value of natural environment and develop compassion toward bio-resources. Students are also expected to know the principle of evolutionary process and its application.

Course Coordinator: Dr. J. K. Seth

Unit I **Biosystematics** **Lectures:16**	1. History of taxonomy and development of systematic, importance and application of systematic in biology, International code of zoological nomenclature (ICZN), concept of keys, type specimens 2. Moropho-taxonomy, cyto-taxonomy, molecular-taxonomy, DNA bar-coding 3. Species concept, IUCN red list of threatened species, Invasive species, Alien species, Indicator species, Keystone species, Umbrella species, Flagship species, Charismatic species 4. Modes of collection and preservation of animals, Outline classification of animals
Unit II **Bioconservation** **Lectures:16**	1. Biodiversity (genetic diversity, species diversity, ecosystem diversity) and its use, biodiversity hotspot in India. 2. Measuring Biodiversity: alpha, beta and gamma diversity , Species Richness(S), Evenness(E) , Simpson index(D), Shannon-Weiner Index (H') 3. National Act and International Act related to Biodiversity Conservation 4. In-situ conservation (Indian context) (Sanctuaries, National and Biosphere reserves) and Ex-situ conservation (Indian context) (Botanical gardens, zoos, cryopreservation, gene bank).
Unit III **Evolution** **Lectures:16**	1. Theories of organic evolution (Lamarkism and Darwinism) and the Modern synthetic theory 2. Phylogenetic tree, molecular phylogeny inference using DNA and protein sequences 3. Hardy-Weinberg Law 4. Isolating mechanisms, and Speciation
Unit IV **Ecology** **Lectures:16**	1. Ecosystem structure and characteristics 2. Species Interactions 3. Population characteristics and dynamics 4. Community Ecology: Nature of communities; community structure and attributes; Ecological Succession
	Recommended Textbooks and References: **1.** Principle of Animal Taxonomy; G.G. Simpson. Oxford IBH Publishing Company. **2.** Elements of Taxonomy. E. Mayer. **3.** Theory and Practice of Animal Taxonomy. V.C. Kapoor, Oxford & IBH Publishing Co. **4.** Evolution : Strickberger **5.** Evolutionary analysis : Herron and freeman **6.** Campbell Biology: Reece, Urry,Cain *et al*. **7.** Essential of Ecology: Miller and Spoolman

Semester-One

ZOOL C 104

Biochemistry

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about structure, and function of bio-molecules. The papers also focus on metabolism of Bio-molecules, basic idea about enzyme, its kinetics and regulation.

Student Learning Outcomes: Students after completion of this course are expected to know different bio-molecules, their biological functions and role of enzymes in cellular metabolism

Course Coordinator: Mr. L.K. Murmu

Unit I **Biochemistry** **Lectures:16**	1. Composition, structure, types and function of carbohydrates 2. Composition, structure, types and function of lipids and steroids 3. Composition, structure, types and function of amino acids and proteins 4. Conformation of proteins (structure of protein, Ramachandran plot)
Unit II **Biochemistry** **Lectures:16**	1. Glycolysis and its regulation 2. TCA cycle and Energetics 3. Gluconeogenesis and HMP shunt 4. Glycogenesis
Unit III **Molecular Metabolism** **Lectures:16**	1. Synthesis of amino acids 2. Oxidation of Fatty acids 3. Biosynthesis of Cholesterol 4. ETC & Oxidative phosphorylation
Unit IV **Enzymology** **Lectures:16**	1. Enzyme structure and classification 2. Principles of catalysis, enzyme kinetics, Michaelis-Menten Equation, Line-Weaver-Burke Equation 3. Mechanism of enzyme action with special references to lysozyme and chymotrypsin 4. Regulation of Enzyme action
	Recommended Textbooks and References: 1. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition 2. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition 3. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition 4. Principle of Biochemistry, Voet and Voet 5. Biochemistry, Campbell

Semester-One

ZOOL IKS 105

Indian Knowledge Systems (Bharatiya Gyana Parampara) in Zoology: Ethnozoology and Traditional Practices

Credits

4

Course Objectives: This paper aims to explore the relevance of Indian Knowledge Systems (IKS) to Zoology, focusing on traditional knowledge of Indian animals including classification, nomenclature, and ethnomedical uses. It also analyzes Ayurvedic zoology's approaches to animal conservation, examines traditional Indian practices in wildlife conservation, including community-led initiatives and sacred groves, and discusses modern applications and future directions for these knowledge systems in zoology.

Student Learning Outcomes: Upon completion of this course, students are expected to understand the broader perspectives of Indian knowledge systems concerning animals, including their sustainable use in relation to human health. They will be familiar with traditional conservation practices and capable of bridging Indian traditional knowledge with modern scientific approaches.

Course Coordinator: Head, Dept. of Zoology

Unit I **Ethnozoology and Traditional Knowledge** **Lectures:16**	1. Overview of Indian Knowledge Systems (IKS) and its relevance to zoology 2. Definition, scope, and importance of ethnozoology 3. Traditional Classification and Nomenclature of Animals: Classification systems in IKS (e.g., Ayurvedic, folk); Nomenclature of animals in IKS (e.g., Sanskrit, vernacular names) 4. Ethnomedical Uses of Animals: Overview of ethnomedical uses of animals in India; Case studies of animals used in traditional medicine
Unit II **Ayurvedic Zoology and Animal Conservation** **Lectures:16**	1. Introduction to Ayurvedic Zoology: Overview of Ayurveda and its relevance to zoology 2. Ayurvedic Approaches to Animal Conservation: Principles of Ayurvedic conservation; Case studies of Ayurvedic conservation practices 3. Animal-Based Ayurvedic Medicines: Overview of animal-based Ayurvedic medicines; Case studies of animal-based medicines 4. Ayurvedic Veterinary Medicine: Overview of Ayurvedic veterinary medicine; Case studies of Ayurvedic veterinary practices
Unit III **Indian Traditional Practices in Wildlife Conservation** **Lectures:16**	1. Community-Led Conservation Initiatives: Overview of community-led conservation initiatives in India; Case studies of successful community-led conservation projects 2. Sacred Groves and Community Forests: Significance and management of sacred groves and community forests; Case studies of sacred groves and community forests 3. Traditional Fishing and Marine Conservation Practices: Overview of traditional fishing practices in India; Case studies of traditional marine conservation practices 4. Human-Wildlife Conflict Mitigation: Overview of human-wildlife conflict mitigation strategies; Case studies of community-led human-wildlife conflict mitigation practices
Unit IV **Modern Applications and Future Directions** **Lectures:16**	1. Integration of Traditional and Modern Knowledge: Case studies on integrating traditional ecological knowledge with contemporary conservation practices; Challenges and opportunities in bridging traditional and modern zoological sciences. 2. Bioprospecting and Medicinal Uses: Exploration of traditional medicinal knowledge related to animals; Ethical considerations in bioprospecting and intellectual property rights. 3. Role of Indigenous Knowledge in Climate Change Adaptation: Contribution of traditional knowledge to climate change adaptation strategies; Case studies on indigenous communities and climate resilience. 4. Policy Implications and Advocacy: Policy frameworks supporting the integration of traditional knowledge in conservation; Advocacy for the recognition and preservation of indigenous knowledge systems.
	Recommended Textbooks and References: 1. "The Web of Life: A New Scientific Understanding of Living Systems" by Fritjof Capra - While not specifically about Indian knowledge systems, this book explores the interconnectedness of life and ecosystems, which could align with some Indian philosophies. 2. "The Knowledge Book: Key Concepts in Philosophy, Science and Culture" by National Book Trust - This book provides an overview of various philosophical and cultural concepts, including some from Indian traditions, which could be used to contextualize zoological concepts. 3. "Indian Zoology: Humane Approach" by Ramesh Gupta - This book discusses zoology with a focus on ethical and humane treatment of animals, which could resonate with Indian philosophical perspectives. 4. “History of Science in India”. Vol 04, part 2 By NCDutta et al.published by the National Academy of Science, India and Ramakrishna Mission. 5. Alves, Rômulo & Albuquerque, Ulysses. (2017) Ethnozoology: Animals in Our Lives. Academic Press.

Semester-One

ZOOL P 106

Laboratory Course Work-I

Credits

6

Course Objectives: Objectives of the paper is to provide 1) hands on exposure in collection, preservation and identification of invertebrates using basic taxonomic key, 2) observation and preparation of different slides related to cell biology 3) solving different problem related to inheritance biology,4) construction of phylogenetic tree, and 5) Hand on experience on ecological adaptation and performing different biochemical experiments.

Student Learning Outcomes: Students will be able to know about collection, preservation, identification and drawing phylogenetic tree of organisms.

Course Coordinator: Head, Department of Zoology

Biology of Non-Chordate, Cellular Biology & Inheritance Biology, Biosystematics, conservation Biology, Evolution and Ecology, Biochemistry	1. Invertebrate Anatomy of preserved animals available in the market **a)** Prawn (Nervous system & Statocyst) **b)** Squilla (Nervous system) **c)** Sepia (Nervous system) **d)** Loligo (Nervous system) 2. Preparation of permanent slides (Specimen available) 3. Identification with comments upon **a)** Museum specimens **b)** Whole mount Specimens **c)** Permanent slides-Invertebrates 4. Cytological preparations of chromosomes from onion root tip and grasshopper testes 5. Demonstration of mitochondria by supravital staining in buccal epithelium 6. Demonstration of Barr body in hair root and buccal epithelial cells 7. Study of various animal associations 8. Problem related to following aspect of genetics **a)** law of independent assortment **b)** Complementation test **c)** Sex linked inheritance **d)** Pedigree analysis **e)** linkage map 9. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys 10. Construction of phylogenetic tree using basic morphological features 11. Construction of phylogenetic tree using 16s rRNA gene sequences retrieved from NCBI database 12. Construction of phylogenetic tree using COI (Cytochrome c oxidase) gene sequences retrieved from NCBI database 13. Practical related to evaluation of diversity indices: Species Richness(S), Evenness (E), Simpson index (D), Shannon-Weiner Index (H') 14. Practical related to preparation of solution, buffer and measurment of pH 15. Demonstration and handling of micropipette 16. Biochemical (Qualitative) tests for- **a)** Protein, glycogen, ascorbic acid, phosphorus, nucleic acid **b)** Tests for salivary amylase and invertase 17. Documentation of traditional fishing crafts and gears used by people of southern Odisha 18. Documentation of traditional knowledge on animals and their products for human health

SEMESTER-II

Semester-Two

ZOOL C 201

Biology of Chordates

Credits

4

Course Objectives: Objective of the paper is to provide brief idea about each taxon of chordates with some important biological features.

Student Learning Outcomes: Students after completion of this course are expected to know the chordate diversity and some of the important features with respect to their evolutionary relationship.

Course Coordinator: Dr. T.K. Barik

Unit I **Ptotochordates** **Lectures:16**	1. Biology and evolutionary significance of Hemichordates, Cephalochordates and Urochordates; retrogressive metamorphosis in Herdmania 2. General organization, classification and affinities of Cyclostomata 3. Structural organization of Petromyzon and its comparison with Myxine 4. Origin of chrodates
Unit II **Superclass: Pisces** **Lectures:16**	1. Biology and affinities of Dipnoi and Latimeria 2. Swim bladder and lateral line system in fishes 3. Parental care in amphibian, 4. Neoteny, paedogenesis and metamorphosis in amphibian
Unit III **Class: Repilia and Birds** **Lectures:16**	1. Structural organization and phylogenetic significance of Sphenodon 2. Adaptive radiation in reptiles 3. Origin and evolution in birds 4. Flight adaptation in birds
Unit IV **Class: Mammalia** **Lectures:16**	1. Origin of mammal 2. Aquatic mammals 3. Prototheria, metatheria and Eutheria 4. Dentition in Mammals
	Recommended Textbooks and References: 1. Phylum Chordata, H. Newman 2. The Life of Vertebrates, J.Z. Young 3. A Text Book of Zoology, T.J. Parker and W.A. Haswell, Vol. I and II 4. Vertebrate Biology, Donald Linzey 5. Life of Birds, David Attenborough 6. Mammals, L.P. Rema

Semester- Two

ZOOL C 202

Molecular Biology

Credits

4

Course Objectives: The objectives of this paper is to provide comprehensive idea about the structure and function of nucleic acid and regulations of gene expression.

Student Learning Outcomes: Students after attending the course will understand role of bio-molecule involved in control and expression of genetic information and gene regulation at the level of transcription and translation in a better way.

Course Coordinator: Dr. P.K. Dixit

Unit I **Nucleic Acids** **Lectures:16**	1. Structure of Nucleic acids 2. DNA mutation 3. DNA damage and repair mechanism 4. Recombination: Homologous and site-specific recombination
Unit II **Molecular Synthesis** **Lectures:16**	1. Prokaryotic gene regulation 2. Eukaryotic gene regulation 3. Prokaryotic DNA replication 4. Eukaryotic DNA replication
Unit III **Gene Regulation** **Lectures:16**	1. Transcription & Post transcription modification 2. Prokaryotic Translation 3. Eukaryotic Translation 4. Posttranslational modifications
Unit IV **Chemical signalling** **Lectures:16**	1. Chemistry of hormones 2. Hormones and their receptors 3. General principles of cell communication, Signaling through G-protein coupled receptors, 4. Second messengers signaling pathway
	Recommended Textbooks and References: 1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin 2. Cell Biology, G. Karp 3. Cell and Molecular Biology, De Robertis 4. Molecular Biology of the Cell, Alberts *et al*., Garland Science, New York, USA 5. Histology: A Text and Atlas, with Correlated Cell and Molecular Biology, Michael H. Ross

Semester- Two

ZOOL C 203

Physiology, Endocrinology and Histology

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about various physiological processes, endocrine system and basic aspect of Histology.

Student Learning Outcomes: Students after completion of this course are expected to learn basic histological features of important organ, the role of physiological processes and hormones involved in maintaining homeostasis.

Course Coordinator: Dr. S. K. Dash

Unit I **Digestion, Excretion, and Circulation** **Lectures:16**	1. Digestive System: Secretory function of alimentary canal, Digestion, absorption 2. Physiology and Biochemistry of Blood coagulation. 3. Excretory System: Nephron, Mechanism of Urine formation, and Osmoregulation. 4. Lymph and lymphatic circulation
Unit II **Nerve Conduction and Sense Organs, Respiration, and Thermoregulation** **Lectures:16**	1. Respiratory System: Mechanism of respiration and its regulation 2. Nervous System: Neurons, synapse and synaptic transmission and mechanism of nerve conduction. 3. Sense Organs: Vision, hearing and taste 4. Types of muscle and mechanism of muscle contraction.
Unit III **Endocrinology** **Lectures:16**	1. Structure, chemistry and function of Pituitary glands 2. Structure, chemistry and function of Thyroid and para-thyroid gland 3. Structure, chemistry and function of Pancreas and Adrenal gland 4. Mechanism of hormone actions
Unit IV **Histology** **Lectures:16**	1. Structure and function of epithelial tissue and connective tissue (Bone, cartilage and Blood) 2. Cell adhesion and cell adhesion molecules 3. Histological details and functions of liver 4. Histological details and functions of Spleen
	Recommended Textbooks and References: 1. Endocrinology, Hadley 2. Endocrinology, Turner and Bagnora 3. Comparative Vertebrate Endocrinology, P.J. Bentley 4. Text Book of Comparative Endocrinology, H.A. Bern 5. Animal Physiology: Adaptation and Environmental, K.S. Nelson (ed) Cambridge University Press, Cambridge, UK 6. Medical physiology, Guyton and Hall 7. Histology, H.R. Michael 8. A Textbook of Histology, Harvey Ernest Jordan

Semester- Two

ZOOL C 204

Ethology, Applied Ecology, and Microbiology

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about different aspects of animal behaviour, applied ecology and microbial world.

Student Learning Outcomes: Students after completion of this course are expected to learn social organisation and their impotence in animals, pollution and its causative agents, bacterial and viral diversity, their genetics and their implication.

Course Coordinator: Dr. T.K. Barik

Unit I **Ethology** **Lectures:16**	1. Concept of animal behavior: Innate, Acquired; Social interaction in Insects and Primates 2. Altruism and Kin selection 3. Neural basis of learning and memory 4. Hypothalamus and regulation of animal behaviour
Unit II **Applied Ecology** **Lectures:16**	1. Pollution and abatement of land, air and water, noise pollution 2. Global warming and its consequences 3. Ozone layer depletion, Acid rain-causes & consequences 4. Bioremediation
Unit III **Microbiology-I** **Lectures:16**	1. Bacteria structure and classification 2. Structure and function of bacterial cell wall 3. Genetic recombination in bacteria 4. Antibiotics classification and mode of action
Unit IV **Microbiology-II** **Lectures:16**	1. Viruses and their classification 2. Life cycle of Bacteriophages 3. Pathophysiology of CoV, and HIV 4. Viruses in bioterrorism
	Recommended Textbooks and References: 1. Ecology, E.P. Odum, R. Holt, Winston Inc., USA, 2. C.S. Binoda, M.P. Nayar, River Pollution In India. APH Publ. Corpn., New Delhi. 3. Campbell Biology, Reece, Urry, Cain *et al* 4. Essential of Ecology, Miller, Spoolman 5. Animal Behaviour, J. Alcock 6. Principles of Animal Communications, J.W. Bradbury 7. Microbiology Principles and Explorations, J.G. Black, L.J. Black, 9th Edition, Willey Publishers 8. Prescott's Microbiology, J. Willey, K. Sandman, D. Wood, 11th Edition

Semester- Two

ZOOL P 205

Laboratory Course Work-II

Credits

6

Course Coordinator: **Head, Department of Zoology**

Course Objectives: Objectives of the paper is to provide 1) hand on exposure in collection, preservation and identification of vertebrates using basic taxonomic key, 2) observation and preparation of different slides related to histology 3) experiment related to human physiology, 4) practical related to animal behaviour, 5) performing different ecological experiments and basic microbological experiments.

Student Learning Outcomes: On completion of this course, students are expected to learn collection, preservation, identification of vertebrates, blood physiology, histological details of impotant organs, experience animal behavior, physicochemical analysis of water and soil, media preparation for microbial growth and basic staining methods.

Biology of Chordates, Molecular Biology, Physiology, Endocrinology and Histology, Ethology, Applied Ecology, Biogeography and Palaeontology	1. Vertebrate Anatomy of preserved animals available in Market:- **a)** Scoliodon (Afferent and Efferent blood vessels, cranial nerves, internal ear, ampula of **b)** Lorenzini, placoid scale) **c)** Cycloid and ctenoid scales of bony fishes. 2. Identification and Comments upon **a)** Museum specimens **b)** Bones **c)** Permanent histological slides 3. Ecological experiments to determine- **a)** Acidity, alkalinity and chlorinity of water samples **b)** Dissolved oxygen content of water **c)** pH of soil and water samples 4. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys 5. Physiological experiments- **a)** Haemin crystals, hemoglobin concentration, RBC and WBC counting **b)** Oxygen consumption in insects and rats 6. Habituation in Annelid, Arthropod and Mollusc 7. Demonstration of Chemical communication in ants 8. Preparation of culture media 9. Gram staining 10. Biochemical test (Catalase, oxidase, carbohydrate)

Semester-Two

ZOOL VAC 206

Bioinformatics, Biosafety and Bioethics

Credits

NC

Course Objectives: The objectives of this course is to provide theory and practical experience to analyze different biological data using common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts in Bioinformatics. The objectives of this course are to educate students about the fundamental concepts of bioprocess technology and its related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry. To become familiar with India's IPR Policy; To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products.

Student Learning Outcomes: Student should be able to develop an understanding of basic theory of these computational tools; to gain working knowledge of these computational tools and methods; appreciate their relevance for investigating specific contemporary biological questions and to critically analyse and interpret results of their study. Students should be able to appreciate relevance of microorganisms from industrial context; to carry out stoichiometric calculations and specify models of their growth; to give an account of design and operations of various fermenters; to calculate yield and production rates in a biological production process, and also interpret data etc.

Course Coordinator: Dr. L. K. Murmu

Unit I **Bioinformatics-I** **Lectures:16**	1. Introduction to Bioinformatics 2. DNA and protein databsae 3. Searching for sequence database like FASTA and BLAST algorithm 4. Sequence allignment
Unit II **Bioinformatics-II** **Lectures:16**	1. Structural viewers of protein (PyMOL) 2. Practical aspects of multiple sequence alignment (CLUSTALW/CLUSTAL X) 3. Basic ideal about MEGA 4. Construction of phylogenetic tree
Unit III **Biosafety** **Lectures:16**	1. Introduction to Biological safety 2. Biosafety guideline-Govt of India, Basic biosafety practices in the laboratory 3. Biological hazards 4. Basic idea on GMO and LMO
Unit IV **Bioethics** **Lectures:16**	1. IPR and genetic resources 2. Patent, Trade, Copyright and trade mark 3. Indian patent Act, filing of patent application 4. Biopiracy
	Recommended Textbooks and References: 1. Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.*New Delhi: Tata McGraw-Hill Pub. 2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press. 3. Bourne, P. E., & Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss. 4. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function,and Genomics*. Oxford: Oxford University Press. 5. Lesk, A.M. (2002). Introduction to Bioinformatics. Oxford University Press 6. Mount, D. W. (2001). Bioinformatics: Sequence and Genome analysis. Cold Spring Harbor, NY: Cold Spring Harbour Laboratory Press. 7. Wayne W. Daniel, Bioststistics: A foundation for analysis in the Health Sciences. 8. Rosner, B. (2000). *Fundamentals of Biostatistics*. Boston, MA: Duxbury Press. 9. Daniel, W. W. (1987). *Biostatistics, a Foundation for Analysis in the Health Sciences*. New York: Wiley.

SEMESTER-III

Semester- Three

ZOOL C 301

Immunology and Histochemistry

Credits

4

Course Objectives: Objective of the paper is to provide comprehensive idea about human immunology with special emphasis on the types of immunity and immune cells, maturation and activation of B and T-cells, antibody diversity and interaction with antigens. The paper also deals with Histochemical techniques

Student Learning Outcomes: Students after completion of this course are expected to know in details about human immune system and mechanism of immunity. The histochemical technique shall help the students in development of their research skills.

Course Coordinator: **Dr. S.K. Dash**

Unit I **Basic Immunology** **Lectures:16**	1. Innate immunity 2. Adaptive immunity 3. Multigene organization of immunoglobulin gene 4. Immunoglobulin gene rearrangement
Unit II **Components of Immune System** **Lectures:16**	1. Antibody structure and function 2. Generation of antibody diversity 3. Antibody engeenering 4. Hypersensitivity
Unit III **Histochemistry-I** **Lectures:16**	1. Principles and chemistry of fixation 2. Metachromasia and Mordants 3. Immunocytochemistry 4. Quantitative histochemistry: Absorptiometry and Fluorimetry
Unit IV **Histochemistry-II** **Lectures:16**	1. Carbohydrates by PAS method 2. Protein by Mercury bromophenol blue and ninhydrin 3. Lipid by Sudan black B method 4. DNA by Feulgen method and RNA by methyl green pyronin Y
	Recommended Textbooks and References: 1. Kuby Immunology, J. Punt, S. Stanford, P. Jones, J.A. Owen, 8th Edition 2. Understanding Immunology, P. Wood, 02nd Edition 3. Basic Immunology, A.k. Abbas, A.H. Lichtman, 3rd Edition 4. Clinical Immunology Principles and Practices, R.R. Rich, 04th Edition, Elsevier Publisher 5. Essential Clinical Immunology, J.B. Jabrskie, Cambridge 6. Histochemistry, Richard W. Horobin 7. Histochemistry, Jinsong Zhou

Semester-Three

ZOOL E 302 (A)

Entomology

Credits

4

Course Objectives: To enable the students to get acquainted with origin and classification of insects. It also give insight to commercial entomology, public health entomology, house hold pest, Integrated Pest Management modules for various important crops. They will also learn about the various management strategy especially eco-friendly means of control.

Student Learning Outcomes: After the completion of the course the students will be acquainted with the different vectors, their characteristics and process of transmission and infection. The students will also learn about the management techniques of different vectors. Further, the students will also be aquainted with the different means of insect-pest management. They will also learn about the different application techniques of insecticides, and its management.

Course Coordinator: Dr. T.K. Barik

Unit I **Origin and Classification of Insects** **Lectures:16**	1. Origin and Evolution of Insects 2. Classification of insectsupto order with examples. 3. Growth development and metamorphosis of Insect 4. Collection and preservation of insects
Unit II **Economical Entomology** **Lectures:16**	1. Biology of honey bees and apiculture 2. Lac insects and their management. 3. Prospects and status of Silk producing species - their distribution and life cycle, structure of the silk gland. 4. Predators, parasites and pathogens of Insects
Unit III **Morphology and Bionomics of Insects** **Lectures:16**	1. Morphology, Bionomics and Management of important pests of Rice. 2. Morphology, Bionomics and Management of pests of Mango 3. Morphology, Bionomics and Management of pests of Banana 4. Morphology, Bionomics and Management of household pests (Mosquitoes and Housefly)
Unit IV **Social and Physiological Aspects of Insects** **Lectures:16**	1. Social behaviour in Insects 2. Physiology and mechanism of Compound vision 3. Insect Hormones with special reference to Pheromones 4. Thermoregulation in Insects
	**Recommended Textbooks and References:** 1. The Insects: An Outline of Entomology, P.J. Gullan, P.S. Cranston 2. General Text book of Entomology, O.W. Richard, R.G. Davies, Part I & II 3. Insect Biology-A textbook of Entomology, H.E. Evans, Wesley Publ. Co.. 4. General Entomology. M.S. Mani, Oxford & IBH Publ. Co. 5. Insects, M.S. Mani, National Book Trust, India 6. A Textbook of Entomology, H.H. Ross, C.A. Ross, J.R.P. Ross, John Wiley & Sons

Semester-Three

ZOOL E 302 (B)

Environmental Science

Credits

4

Course Objectives: To enable the students to get acquainted with origin and classification of insects. It also give insight to commercial entomology, public health entomology, house hold pest, Integrated Pest Management modules for various important crops. They will also learn about the various management strategy especially eco-friendly means of control.

Student Learning Outcomes: After the completion of the course the students will be acquainted with the different vectors, their characteristics and process of transmission and infection. The students will also learn about the management techniques of different vectors. Further, the students will also be aquainted with the different means of insect-pest management. They will also learn about the different application techniques of insecticides, and its management.

Course Coordinator: Dr. T.K. Barik

Unit I **Ecosystem** **Lectures:16**	1. Ecosystem- Laws of thermodynamics, energy flow, mineral cycling, food chain, food web, ecological pyramids and productivity 2. Major aquatic and terrestrial ecosystems of the world 3. Biotic and Abiotic factors- (Soil, light and temperature) 4. Bio-geo chemical cycles (Carbon, Nitrogen and Sulphur)
Unit II **Community & Population Ecology** **Lectures:16**	1. Biotic community- Structure & organization 2. Ecological succession 3. Population dynamics 4. Concept of Habitat and Ecological niches
Unit III **Natural resources & Conservation** **Lectures:16**	1. Natural Resources and their conservation 2. Conservation of wild life 3. An outline of soil, air, water and noise pollution 4. Climate change and Global warming
Unit IV **Ecotechnology** **Lectures:16**	1. Ozone layer depletion 2. Acid rain and its consequences 3. Bioremediation 4. Vermicomposting
	Recommended Textbooks and References: 7. The Insects: An Outline of Entomology, P.J. Gullan, P.S. Cranston 8. General Text book of Entomology, O.W. Richard, R.G. Davies, Part I & II 9. Insect Biology-A textbook of Entomology, H.E. Evans, Wesley Publ. Co.. 10. General Entomology. M.S. Mani, Oxford & IBH Publ. Co. 11. Insects, M.S. Mani, National Book Trust, India 12. A Textbook of Entomology, H.H. Ross, C.A. Ross, J.R.P. Ross, John Wiley & Sons

Semester- Three

ZOOL E 303

Bioinstrumentation and Biostatistics

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea about working principles and application of different instruments and methods used in biological sciences.The course also designed to give statistical analysis of biological data.

Student Learning Outcomes: Students after completion of this course are expected to handle and operate basic instruments forananananananan their experimental purposes. The students also have clear understanding of data and its analysis that will help them in persuing higher studies.

Course Coordinator: **Dr. P. K. Dixit**

Unit I **Microscopy, Centrifugation, Chromatography** **Lectures:16**	1. Light and Electron microscopy 2. Centrifugation 3. Affinty chromatography (Paper and TLC) 4. Adsorption chromatography (Ion exchange and Gel)
Unit II **Spectroscopy and Radioisotope techniques** **Lectures:16**	1. UV/Vis Spectrophotometry 2. Autoradiography 3. Immunodiffusion 4. Application of Radioisotopes in Biology
Unit III **Biostastics-I** **Lectures:16**	1. Introduction and scope of Biostatistics, Levels of Measurements: Variables, Nominal scale, ordinal scale, interval and ratio scale of measurements. 2. Tabular and graphical representation of data 3. Descriptive statistics: Point estimates (Mean, Mode, Median, Percentile); Interval Estimates (Range, IQR, MAD, Variance, Standard Deviation, SEM, CV and CD); Error bars- various methods to calculate error bar: Standard Deviation (SD), Standard Error of the Mean (SEM), 95% Confidence Intervals (CI), Median, Range and Quartiles. 4. Moments, Skewness and Kurtosis
Unit IV **Biostastics-II** **Lectures:16**	1. Confidence Intervals, Statistical Hypothesis Testing, significance level, p value, Relationship between Confidence Intervals and Statistical Significance, difference between parametric and non parametric test 2. Student's t test, F test and ANOVA test (one way and two way), Chi- square test 3. Probability distributions- Normal, Binomial and Poisson 4. Simple correlation and Regression
	Recommended Textbooks and References: **1.** Modern Spectroscopy, JM Hollas, Willey Publication **2.** Molecular Structure and Spectroscopy, G. Aruldash **3.** Experimental Biochemistry, Wilson and Walker **4.** Fundamental of light microscopy and electronic Imaging, Douglas Murphy **5.** Introductory biostatistics, C.T. Le, L.E. Eberly, John Wiley & Sons **6.** Biostatistics: A methodology for the health sciences, G. van Belle, L.D. Fisher, P.J. Heagerty, T. Lumley, Vol. 519, John Wiley & Sons **7.** Intuitive biostatistics: A nonmathematical guide to statistical thinking, H. Motulsky, Oxford University Press, USA

Semester-Three

ZOOL P 304

Laboratory course work-III

Credits

6

Course Objectives: Objectives of the paper is to provide a hand on exposure of different instruments used in biological sciences, basic practical on methods in biology, application of statistics in presentation of biological data and solving biological problems, basic embryological and immunological experiments.

Student Learning Outcomes: Students are expected to learn instrumentation and their operation, stastical analysis of data, identification of various stages of chick embryo and blood grouping

Course Coordinator: Head, Department of Zoology

Instrumentation, Biostatistics, Immunology, Histochemistry and Entomology	1. Permanent histochemical preparation for the localization of – a. Protein by mercuric bromophenol blue method b. Carbohydrate by PAS & toluidine blue method c. Lipid by Sudan Black B method 2. Identification with comments on histochemical slides 3. Demonstrations of Electrophoresis 4. Demonstrations of PCR 5. Demonstration of Chromatography 6. Demonstration of Centrifugation 7. Demonstration of Spectrophotometer and Quantification of protein using Biuret method, lowry method 8. Quantitive measurement of Biomolecules using Spectroscopy 9. Estimation of casein content in milk 10. Identification with comments upon animals with ecological adaptation and of evolutionary importance 11. Tabular and Graphical presentation of Data using Excel and minitab 12. Hypothesis testing-student t-test, F-test, NOVA test, Chi-Sqaure test, 13. Practical related to simple correlation and regression analysis 14. Demonstration of Blood group and Rh Antigen 15. Permanent Slide of thymus and spleen 16. External features of available field collected insects 17. Methods of collection and preservation of insects 18. Wing venation, types of wings and winf coupling apparatus 19. Types of insect antenna, mouth parts and legs 20. Insecticidal efficacy test

Semester-Three

ZOOLVAC 305

Academic Writing

Credits

NC

Course Objectives: Objective of the course is to differentiate between various kinds of technical writing and to identify and avoid the common mistakes made by students while writing research paper.

Student Learning Outcomes: It will helpful in making the students easier and enhance their skills in writing various scientific articles and target the same for a suitable journal for publication. These courses also aware the students regarding various OERs in teaching, learning, research and also make them aware about plagiarism and implication.

Course Coordinator: Dr. P.K. Dixit

Unit I **Technical Writing** **Lectures:16**	Technical writing overview, Importance of Technical Writing, Basic rules of technical writing, English in technical writing, Style of research writing
Unit II **Plagiarism** **Lectures:16**	Plagiarism overview, tools for detection of Plagiarism, Avoiding the plagiarism, Ethics in technical writing, Journal Metrics, Author metrics
Unit III **Review of Literature** **Lectures:16**	Literature review: source and process, online literature database, literature management tools, Research Paper writing, Referencing and citation, Submission and Post Submission
Unit IV **Callenges in Research** **Lectures:16**	Challenges in Indian Research and writing, team and time management, Abstract writing, Research proposal writing, OER: basic concept and licenses, OER for learning and research
	Recommended Textbooks and References: **1.** Academic Writing, S. Bailey **2.** https://swayam.gov.in **3.** Bird, A. (2006): Philosophy of Science, Routledge **4.** Maclntyre, A. (1967): A short history of Ethics, London **5.** P. Chaddah (2018): Ethics in competitive Research: Do not get scooped, do not get plagiarized **6.** National Academy of Sciences (2009): on being a Scientist: a guide to responsible conduct in Research, 3rd Edition **7.** Resnik D. B. (2011): What is ethics in research and why it is important? National Institute of Environmental Health Sciences, 1-10 **8.** Beall J (2012): Predetory publishers are corrupting open access, Nature, 489, 179-179 **9.** INSA, Ethics in Science Education, Research and Governance (2019), ISBN: 978-81-939482-1-7

Semester-Three

ZOOL CT 300

Human Health & Nutrition

Credits

4

Course Objectives: Objective of the paper is to provide brief idea about the human nutrition and nutrients.

Student Learning Outcomes: Students, after completion of this course, are expected to know about different essential nutrients, their role in human health and abnormalities associated with their deficiencies.

Course Coordinator: Dr. S. K. Dash

Unit I **Nutrition & nutrientional requirement** **Lectures:16**	1. Fundamentals of human nutrition and essential nutrients for human; 2. Carbohydrates, fats, proteins 3. Minerals and water 4. Vitamins
Unit II **Metabolism, supplementation and defficiency** **Lectures:16**	1. Basal metabolism 2. Nutritional requirement variation with physiological changes and age, 3. Supplementary and balanced diet, 4. Diseases associated with nutrientional defficiency
Unit III **Communicable Diseases** **Lectures:16**	1. Air borne diseases: Tuberculosis, Chicken pox; 2. Water borne diseases: Cholera, Typhoid; 3. Sexually transmitted diseases: HIV, Syphilis; 4. Vector borne diseases: Malaria and Dengue
Unit IV **Food safety hazards** **Lectures:16**	1. Biological and Biotechnology related hazards, 2. Chemical hazards, 3. Food additives and fast food, 4. Food associated allergy
	Recommended Textbooks and References: 1. SA Lanham-New, TR Hill, AM Gallagher, HH Vorster, Introduction to human nutrition, 3rd Ed, Willey Blackwell 2. MJ Gibney, HH Vorster, FJ Kok, Introduction to human nutrition, Willey Blacwell Publishing 3. SR Mudambi, MV Rajagopal, Fundamental Food Nutrition and Diet Therapy, New Age International Publishers 4. AA Agrawal, SA Udipi, Textbook of human nutrition, Jeypee Publishers. 5. T Rekhi, H Yadav, Fundamentals of food and nutrition, Elite publishing House. 6. C. Gopalan, BVR Sastri, SC Balasubhramanian, Nutritive values of Indian Food, ICMR, NIN

SEMESTER-IV

Semester-Four

ZOOL C 401

Cytogenetics, Stress Physiology and Metabolic disorders

Credits

4

Course Objectives: The objective of course is to provide advanced knowledge on cytogenetics, stress physiology and metabolic disorders.

Student Learning Outcomes: Students are expected to learn differences aspects of genomic analysis, meiotic abnormalities, different sex linked diseases and in situ techniques. Also, the course will help students in understanding the physiology of stress and various metabolic disorders.

Course Coordinator: Dr. J.K. Seth

Unit I **Cytogenetics-I** **Lectures:16**	1. C-value paradox 2. Human cytogenetics- Human karyotype, banding and nomenclature, Numerical and structural abnormalities of chromosomes 3. Meiotic abnormalities- Non-disjunction of chromosomes, mis-division of centromere 4. Repetitive and Non-repetitive DNA sequence
Unit II **Cytogenetics-II** **Lectures:16**	1. Amniocentesis, Monogenic disorders: Autosomal dominant (Huntington's diseases), Autosomal recessive (Cystic fibrosis), 2. Sex linked (Color blindness and Hemophilia). 3. In situ- hybridization and its applications: FISH and GISH 4. Transposons and associated disorders
Unit III **Metabolic Disorders** **Lectures:16**	1. Biochemistry of inherited and metabolic disorders: Phenylketoneuria, Alkaptonuria, Albinism 2. Neurochemical associated diseases: Alzhimer's disease, Parkinson's disease 3. Human nutrition and associated hazards 4. Molecular mechanism of senescence
Unit IV **Stress Physiology** **Lectures:16**	1. Concept of Biological stress and strain 2. Stress adaptation- Resistance, stress tolerance, Acclimation and acclimatization 3. Thermoregulation in animals 4. Oxidative stress
	Recommended Textbooks and References: 1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin 2. Cell Biology, G. Karp 3. Cell and Molecular Biology, De Robertis 4. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition 5. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition 6. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition 7. Principles of Cancer Biology, L.J. Kleinsmith 8. Cancer Biology, R.J.B. King, M.W. Robins, 03rd Edition

Semester-Four

ZOOL E 402

Epigenetics, Molecular Techniques and Cancer Biology

Credits

4

Course Objectives: The objective of the course is to provide a comprehensive idea about epigenetic and its mechanism,and cancer cells biology

Student Learning Outcomes: The students are expected to learn epigenetic related disorders and their consequences, differences aspects of cell transformation from normal to cancer cells, different proteins and genes involved in different types of cancers, and treatment

Course Coordinator: Mr. L.K. Murmu

Unit I **Epigenetics** **Lectures:16**	1. Epigenetics: chromatin modifications and their mechanism of action, 2. Dosage compensation in mammal 3. Gene silencing 4. Ribozyme Technology
Unit II **Mol. Techniques** **Lectures:16**	1. Isolation of genomic and plasmid DNA 2. PCR and its application 3. DNA and protein sequencing methods 4. Blotting techniques
Unit III **Cancer Biology-I** **Lectures:16**	1. Difference between normal cells and cancerous cell, Proto-oncogene, tumor suppressor genes and care taker genes 2. Loss of function and gain of function mutation, 3. Cancer stem cells and its possible origin. 4. Brief idea on different genes/proteins related to cancer: p53, APC, src, ras, Rb, BRCA1 and BRCA2, P^{21} and P16.
Unit IV **Cancer Biology-II** **Lectures:16**	1. Limitless replicating potential: Metastasis, and Angiogenesis 2. Apoptosis and Evasion of Apoptosis 3. Self sufficiency in growth signal, and Insensitive to antigrowth signals 4. Possible treatment of cancer: Radiation and chemotherapy
	Recommended Textbooks and References: 1. Lewin's Genes X, J.E. Krebs, E.S. Golstein, S.T. Kilpatrick, Volume 10, Jones and bartlet Publishers 2. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition 3. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition 4. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition 5. Principles of Cancer Biology, L.J. Kleinsmith 6. Cancer Biology, R.J.B. King, M.W. Robins, 03rd Edition

Semester-Four

ZOOL E 403

Developmental Biology, Nanotechnology and Radiation Biology

Credits

4

Course Objectives: The main objective of Developmental Biology course is make student understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development, molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences. This paper also deal with Radiation Biology with special emphasis on different radiation sourses, its health impact, use of radiation in controlling pest and its role in inherited diseases.

Student Learning Outcomes: Students are expected to lean the basic principle and process of developmental biology and Radiation Biology and able to make themselves aware to deleterious effects radiation too

Course Coordinator: Dr. P. K. Dixit

Unit I **Developmental Biology-I** **Lectures:16**	1. Gonadial hormones, synthesis and regulations 2. Female reproductive cycle 3. Structure of gamet (Male and Female) 4. Gametogenesis and its regulations
Unit II **Developmental Biology-II** **Lectures:16**	1. Molecular mechanism of fertilization 2. Clevage and its pattern 3. Basic experiments of developmental biology 4. Axes and pattern formation in Drosophila
Unit III **Nanotechnology** **Lectures:16**	1. Nanotechnology- Break through an introduction 2. Application of Nanotechnology, 3. Bucky balls, Bucky tubes and their applications 4. Nanotechnology in drug delivery
Unit IV **Radiation Biology** **Lectures:16**	1. Definition, scope and significance of radiation biology, Ionizing radiation, types of electromagnetic radiation 2. Electromagnetic radiation and its interaction with living matter with special reference to UV 3. Visible light and its interaction with living organism 4. Radiation in insect pest management: Types of radiation used, radiation induced dominant lethal mutation, sterile insect technique, F_1 sterility technique
	Recommended Textbooks and References: 1. Developmental Biology, S.F. Gilbert 2. Introduction to Embryology, B.L. Balinsky 3. The Logic of Scientific discovery, K. Popper 4. Understanding Radiation Biology from DNA Damage to Cancer and Radiation Risk, K.H. Chadwick 5. Essentials of Radiation Biology and Protection, S. Fosher 6. Introduction to Nanotechnology, C.P. Pools, F.J. Owens, Willey Publishers 7. A handbook of Nanotechnology, U. Kumar

Semester-Four

ZOOL D 404 & 405

Project, Dissertation (Presubmission presentation and Viava-Voce)

Credits

12

Course Objectives: The objectives of this course are to develop research aptitude, scientific temper and critical analysis among students.

Student Learning Outcomes: Students are expected to gain the basic skill in project handling and writing of their project report.

Course Coordinator: Head, Department of Zoology

Plan and Excution	Students will be grouped and assigned to Concern faculties to plan and carryout projects on a topic of interest in order address critical issue or persue new and novel inventions. The students will carry out projects with self-involvement through thorough understanding and learning of different research tools and techniques. During their research tenure the students will also be tought about skills of writing thesis, articles, and projects for their future benefit.
Dissertation Thesis	Before submission of the Dissertation, students has to present a seminar based on his/her research topics and the same will be evaluated and incorporated in the final mark/grade. At the end of their project, dissertation has to be written giving full details about their project. Students will be insisted to publish their research findings in Journals of National and Interantional repute or file patent.

Semester-Four

ZOOL AC 406

Cultural Heritageof South Odisha

Credits

NC

Course Objectives: Kabi Samrat Upendra Bhanja is the master-spirit of Odia Language and Culture during Medieval period. The campus of Berhampur University has been rightly named after Kabi Samrat Upendra Bhanja as 'BHANJA BIHAR'. South Odisha is the adorable storehouse of literary and cultural wealth of ancient and medieval Odisha which has elicited remarkable national acclaim. This course has been introduced with a view to familiarizing all the P.G. Students of Berhampur University with the excellent craftsmanship exemplified by the literary stalwarts including Kabi Samrat Upendra Bhanja along with the Arts, Culture and Folk Tradition of South Odisha.

Student Learning Outcomes: The teaching imparted to the P.G. students of Berhampur University on the various dimensions of the literary and cultural heritage of South Odisha will help them to acquire a valuable understanding of the same. They will be inspiredadequately to take the positives learnt from the course and use them in future in their personal literary and cultural pursuits and thereby promote the literature and culture of Odisha on a global scale.

Course Coordinator: Head, Post Graduate Department of Odia

Unit I	Literary works of Kabi Samrat Upendra Bhanja
Unit II	Other Litterateurs of South Odisha
Unit III	Cultural Heritage of South Odisha
Unit IV	Folk and Tribal Traditions of South Odisha