Post Graduate Department of Zoology

Berhampur University

Bhanja Bihar, Berhampur, Ganjam, Odisha

Berhampur- 760007

M.Sc. Syllabus (2021-23)

Curriculum Overview (M.Sc.)

Distribution of Course (Semester wise)

- Semester I: Four (04) Core Courses 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, Three (03) Electives, Project, Dissertation and Viva, One (01) Add-on Added Course

Value Added Courses:

Two value added courses, (ZOOL VAC 206) and (ZOOL VAC 306), 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:

1. Each theory papers having 100 Marks is devided into 20 Marks of internal ealuation and 80 Marks of final examination in each semester.
2. The question pattern is mentioned below

P.G. Sample / Model Question Paper for CBCS pattern

Symbol _____

2022

Time : 3 hours

Full Marks : 80

The figures in the right hand margin indicate marks.
Answer from both the Sections as per direction

(**Paper Title**)

Section-A

1.	*Answer all questions from the following:*		*(02x10=20)*
	(a)	Questions covering from ALL the unit	
	(b)		
	(c)		
	(d)		
	(e)		
	(f)		
	(g)		
	(h)		
	(i)		
	(j)		

Section-B

Answer all questions *(15x04=60)*

		(Unit-I)
3.	(a)	
		OR
	(b)	*Write Short Notes on:* *(a)* *(b)*
		(Unit-II)
4.	(a)	
		OR
	(b)	*Write Short Notes on:* *(a)* *(b)*
		(Unit-III)
5.	(a)	
		OR
	(b)	*Write Short Notes on:* *(a)* *(b)*
		(Unit-IV)
6.	(a)	
		OR
	(b)	*Write Short Notes on:* *(a)* *(b)*

OR

(c) Case study (wherever applicable)

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 P 105	Laboratory Course Work-I	06	100
		TOTAL	22	500
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	Entomology	04	100
3	ZOOL E 303	Bioinstrumentation and Biostatistics	04	100
4	ZOOL P 305	Laboratory Course Work-III	06	100
5	ZOOL CT 300	Conservation Biology *	04	100
6	ZOOL VAC 306	Human Nutrition	NC	NC
		TOTAL	22	500
SEMESTER FOUR				
1	ZOOL C 401	Cytogenetics and Stress Physiology	04	100
2	ZOOL E 402	Epigenetics and Cancer Biology	04	100
3	ZOOL E 403	Applied Biology	04	100
4	ZOOL E 404	Developmental Biology and Radiation Biology	04	100
5	ZOOL D 405	Project, Dissertation and Viva-Voce	06	100
6	ZOOL AC 406	Cultural Heritage of South Odisha	NC	50
		TOTAL	22	500
			88	2000

- Course offered for CBCT
- NC: Non Credit Value Added Courses

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.** Parasitic Protozoans with special reference to human host **3.** Origin of Metazoa, canal system in Porifera **4.** Polymorphism in Coelenterates, Ctenophora and its affinities
Unit II **Higher Invertebrates** **Lectures:16**	1. Host-parasite interactions 2. Coelom,metamerism and segmental organs of Annelida 3. Parasitic adaptations in heliminths 4. Excretory structures and functions in annelids
Unit III **Higher Invertebrates** **Lectures:16**	**1.** Structural organization and phylogenetic status of Limulus **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.** Molecular 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 **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 (Ramachandran plot, secondary structure)
Unit II **Biochemistry** **Lectures:16**	**1.** Glycolysis and TCA cycle **2.** Oxidative phosphorylation, ETC and ATP synthesis **3.** Oxidation of Fatty acids **4.** Bioenergetics
Unit III **Molecular Metabolism** **Lectures:16**	**1.** Alternative metabolism of carbohydrates (Gluconeogenesis and HMP Shunt) **2.** Metabolism of amino acids and Urea cycle, **3.** Biosynthesis of Cholesterol **4.** Vitamins
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 **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 P 105

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)** Cockroach (Nervous, reproductive & salivary systems) **c)** Squilla (Nervous system) **d)** Sepia (Nervous system) **e)** Loligo (Nervous system) **f)** Unio (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. 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 8. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys 9. Construction of phylogenetic tree using basic morphological features 10. Construction of phylogenetic tree using 16s rRNA gene sequences retrieved from NCBI database 11. Construction of phylogenetic tree using COI (Cytochrome c oxidase) gene sequences retrieved from NCBI database 12. Practical related to evaluation of diversity indices: Species Richness(S), Evenness (E), Simpson index (D), Shannon-Weiner Index (H') 13. Practical related to preparation of solution, buffer and measurment of pH 14. Demonstration and handling of micropipette 15. Biochemical (Qualitative) tests for- **a)** Protein, glycogen, ascorbic acid, phosphorus, nucleic acid **b)** Tests for salivary amylase and invertase

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 **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 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 and metatheria **4.** Dentition in Mammals
	Recommended Textbooks and References: **1.** Phylum Chordata, H. Newman **2.** The Life of Vertebrates, J.Z. Youn **3.** A Text Book of Zoology, T.J. Parker and W.A. Haswell, Vol. I and II

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 replication **3.** DNA damage and repair mechanism **4.** Recombination: Homologous and site-specific recombination
Unit II **Molecular Synthesis** **Lectures:16**	**1.** Mechanism of Transcription **2.** Post Transcriptional modifications and RNA processing **3.** Protein translation **4.** Post- translational modification of proteins
Unit III **Gene Regulation** **Lectures:16**	**1.** Prokaryotic gene regulation **2.** Eukaryotic gene regulations **3.** Topoisomerase, its role during replication and transcription **4.** Gene regulation and expression in viruses
Unit IV **Gene Regulation** **Lectures:16**	**1.** Hormones and their receptors, cell surface receptor, **2.** General principles of cell communication, Signaling through G-protein coupled receptors, **3.** Second messengers signaling pathway **4.** Quorum sensing
	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

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 Unin formation, and Osmoregulation. **4.** Cardiovascular System: Double circulation, cardiac cycle
Unit II **Nerve Conduction and Sense Organs, Respiration, and Thermoregulation** **Lectures:16**	**1.** Respiratory System: Mechanism of breathing, exchange of gases 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 **2.** Cell adhesion and cell adhesion molecules **3.** Histological details and functions of liver **4.** Histological details and functions of Spleen & Kidney
	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

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 morphology 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.** Characteristics and classification of viruses **2.** Life cycle of Bacteriophages **3.** Pathophysiology of CoV, H_1N_1 and HIV **4.** 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. **d)** *Calotes* (Blood vascular system, and hyoid apparatus) **e)** Pigeon (Blood vascular system, brain, air sacs, pectin, flight and perching muscles) **f)** Rat (Neck nerves, brain and vascular system) 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. Identification with comments upon animals with ecological adaptation and of evolutionary importance 5. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys 6. Physiological experiments- **a)** Haemin crystals, hemoglobin concentration, RBC and WBC counting **b)** Oxygen consumption in insects and rats 7. Construction of Ethogram-available animal found in and around Bhanja Bihar University campus 8. Habituation in Annelid, Arthropod and Mollusc 9. Demonstration of Chemical communication in ants 10. Preparation of culture media 11. Gram staining 12. 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.** Indain 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.** Generation of antibody diversity **2.** Antibody Engineering **3.** Vaccines **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**	**5.** Carbohydrates by PAS method **6.** Protein by Mercury bromophenol blue **7.** Lipid by Sudan black B method **8.** 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

Semester-Three

ZOOL E 302

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 important pests of Sugarcane. **3.** Morphology, Bionomics and Management of pests of sub-tropical and tropical fruits (Mango, 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 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 305

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. Tabular and Graphical presentation of Data using Excel and minitab 10. Hypothesis testing-student t-test, F-test, NOVA test, Chi-Sqaure test, 11. Practical related to simple correlation and regression analysis 12. Demonstration of Blood group and Rh Antigen 13. Permanent Slide of thymus and spleen 14. External features of available field collected insects 15. Methods of collection and preservation of insects 16. Wing venation, types of wings and winf coupling apparatus 17. Types of insect antenna, mouth parts and legs 18. Insecticidal efficacy test

Semester-Three

ZOOL CT 300

Conservation Biology*

Credits

4

Course Objectives: Objectives of the paper is to provide basic idea on Biodiversity, measuring biodiversity, international and national efforts, molecular phylogeny and different conservation measures to conserve biodiversity.

Student Learning Outcomes: Students after completion of this course are expected to get a holistic understanding on biodiversity and its importance, phylogeny, inculcate the value of bio-resources and develop compassion toward bio-resources.

Course Coordinator: Dr. J. K. Seth

Unit I **Basic Concepts** **Lectures:16**	Biodiversity (genetic diversity, species diversity, ecosystem diversity) and its use, Causes of biodiversity losses, IUCN red list of threatened species, Invasive species, Alien species, Indicator species, Keystone species, Umbrella species, Flagship species, Charismatic species
Unit II **Measuring Biodiversity** **Lectures:16**	Alpha, Beta and Gamma diversity , Species Richness(S), Evenness(E) , Simpson index(D), Shannon-Weiner Index (H'), idea on biodiversity calculator software
Unit III **International and National efforts for conserving biodiversity** **Lectures:16**	National Act and International Act related to Biodiversity Conservation: Biological diversity Act 2002, National Biodiversity Authority, People Biodiversity Registrar, Convention on Biological diversity, Cartagena Protocol and Nagoya Protocol, Sustainable Development Goal and Biodiversity, Aichi Biodiversity Targets, CITES, WWF
Unit IV **Conservation Measures and Molecular Phylogeny** **Lectures:16**	In-situ conservation (Indian context) (Sanctuaries, National and Biosphere reserves) and Ex-situ conservation (Indian context) (Botanical gardens, zoos, cryopreservation, gene bank) NCBI data base, basic idea on phylogenetic tree, Construction and interpretation of molecular phylogeny tree based on COI and 16s rRNA gene sequences using MEGA and other tools
	Recommended Textbooks and References: 1. Fundamental of Ecology : O.P Odum 2. Campbell Biology: Reece, Urry,Cain et al. 3. Evolutionary analysis : Herron and freeman 4. Convention of Biological diversity- https://www.cbd.int/ 5. Aichi Biodiversity Targets- https://www.cbd.int/sp/targets/ 6. IUCN-https://www.iucn.org/ 7. CITES-https://cites.org/eng 8. https://sustainabledevelopment.un.org/topics/biodiversityandecosystems 9. https://bch.cbd.int/protocol/ 10. https://www.cbd.int/abs/ 11. https://wwf.panda.org/ 12. http://moef.gov.in/ 13. http://nbaindia.org/

Semester-Three

ZOOL VAC 306

Human Nutrition

Credits

NC

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	Fundamentals of human nutrition and essential nutrients for human
Unit II	Basal metabolism and nutritional requirement variation with physiological changes and age, Supplementary and balanced diet
Unit III	Introduction to carbohydrate, protein, and fat. Different sources of these nutrients
Unit IV	Malnutrition and related disorders
	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.** Genomic analysis and 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.** Stress associated disorders **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 9. The Insects: An Outline of Entomology, P.J. Gullan, P.S. Cranston 10. General Text book of Entomology, O.W. Richard, R.G. Davies, Part I & II 11. Insect Biology-A textbook of Entomology, H.E. Evans, Wesley Publ. Co.. 12. General Entomology. M.S. Mani, Oxford & IBH Publ. Co. 13. Insects, M.S. Mani, National Book Trust, India 14. A Textbook of Entomology, H.H. Ross, C.A. Ross, J.R.P. Ross, John Wiley & Sons

Semester-Four

ZOOL E 402

Epigenetics 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-I** **Lectures:16**	**1.** Epigenetics- chromatin modifications and their mechanism of action, **2.** Epigenetics and genome imprinting - DNA methylation in mammals, genomic imprinting in mammals **3.** Epigenetics in *Saccharomyces cerevisiae* **4.** Gene silencing
Unit II **Epigenetics-II** **Lectures:16**	**1.** Epigenetic regulation of chromosome inheritance **2.** Epigenetic regulation of the X chromosomes in *C.elegans* **3.** Dosage compensation in *Drosophila* **4.** Dosage compensation in mammals; mechanism of chromatin remodeling.
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 III **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

Applied Biology

Credits

4

Course Coordinator:
Dr. T.K. Barik

Course Objectives: This course deals with human gene mapping, cell culture, transgenic, nano-technology, nano-particles and their application in drug delivery. The course also covers ecotechnology and Molecular techniques.

Student Learning Outcomes: Students after reading this course are expected to have knowledge orient towards industrial microbiology for self entrepreneurship development and application of nano-science in biological research. Further, it will enhance the students ability in various ecotechnological enterprenuership skills and advance molecular tools techniques.

Unit I **Applied Genetics** **Lectures:16**	**1.** Human gene mapping- Physical mapping & map-based cloning, molecular markers in genome analysis (RFLP, AFLP, RAPD) **2.** Ribozyme technology and its application **3.** Cell and tissue culture methods for animals **4.** Transgenic animals, molecular approaches to diagnosis and strain identification.
Unit II **Applied Microbiology** **Lectures:16**	**1.** Microbial fermentation and production of small and macro molecules, **2.** Elementary Ideas of antibiotics (Classification and resistance) **3.** Genomics and its application to health and agriculture, including gene therapy. **4.** Biosensors, Bioterrorism (causative agents and consequences).
Unit III **Nanotechnology** **Lectures:16**	**1.** Nanotechnology- Break through an introduction **2.** Application of Nanotechnology, **3.** Bucky balls, Bucky tubes and their applications, **5.** Nanotechnology in drug delivery
Unit IV **Ecotechnology** **Lectures:16**	**1.** Solid waste management **2.** Biofertilizers **3.** Vermicomposting **4.** Biopesticide
Unit IV **Molecular Techniques** **Lectures:16**	1. Isolation of Genomic and plasmid DNA 2. Polymerase Chain Reaction and its applications 3. DNA, Protein sequencing methods 4. Blotting techniques
	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.** Microbiology Principles and Explorations, J.G. Black, L.J. Black, 9th Edition, Willey Publishers **6.** Prescott's Microbiology, J. Willey, K. Sandman, D. Wood, 11th Edition **7.** Basic Principles of Nanotechnology, W.C. Sanders, CRC Press **8.** Introduction to Nanotechnology, C.P. Pools, F.J. Owens, Willey Publishers **9.** A handbook of Nanotechnology, U. Kumar **10.** Nanophysics and Nanotechnology, E.L. Wolf, Willey Publications

Semester-Four

ZOOL E 404

Developmental Biology 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.** Gonads structures (Testis and Ovary) **2.** Synthesis and action of male hormones **3.** Synthesis and action of female hormones **4.** Female reproductive/gonadial cycle
Unit I **Developmental Biology-II** **Lectures:16**	**1.** Structure of gametes (Male and Female) **2.** Gametogenesis and it's regulation **3.** Molecular mechanism of fertilization **4.** Clevage and its pattern
Unit II **Developmental Biology-III** **Lectures:16**	**1.** Basic experiments of developmental biology **2.** Axes and pattern formation in Drosophila **3.** Vulva formation in *Caenorhabditis elegans* **4.** Limb development and regeneration in vertebrates
Unit III **Radiation Biology** **Lectures:16**	**1.** Definition, scope and significance of radiation biology, classification of radiation, Ionizing radiation, types of electromagnetic radiation, radiation dose and units **2.** Electromagnetic radiation and its interaction with living matter with special reference to UV and Visible light **3.** Radiation in insect pest management: Types of radiation used, radiation induced dominant lethal mutation, sterile insect technique, F_1 sterility technique **4.** Radiation induced heritable diseases
	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

Semester-Four

ZOOL D 405

Project, Dissertation and Viava-Voce

Credits

6

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	At the end of their project, thesis 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:
Prof. P. K. Swain (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
	Recommended Textbooks and References: **1.**