

Revised Syllabus: 2020-21

**For
(M.Sc., M.Phil. and Pre-Ph.D.
Zoology Courses)**



Department of Zoology, Berhampur University

Bhanja Bihar, Berhampur, Ganjam, Odisha-760007

1. Department Profile

The Department of Zoology offers two years P.G. Course in Zoology with major focus on Modern Biology. The M.Phil. and Ph.D. Program of the Department has been designed to facilitate the students with both theoretical and practical knowledge in different cutting edge area of biological sciences. The major thrust area of department includes Biochemistry, Physiology, Applied Entomology, Nano-technology, Biodiversity, Conservation Biology, Molecular Systematics, Evolutionary Biology, Molecular Parasitism, Molecular Diagnosis and Biosensor.

2. Student Strength

- a. P.G. Part-I: 50
- b. P.G. Part-II: 50
- c. M.Phil.: 08
- d. Ph.D.: As per the availability of the slots

3. Faculty Strength

Sl. No	Name and Designation	Qualification	Contact No.	E-Mail	Area of Research interest
1	Dr. G. Mishra, Professor	Ph.D.	9437592010/ 9337633384	gmishra.bu@gmail.com	Biochemistry
2	Dr. P.K. Dixit, Reader and Head	Ph.D.	9437090190/ 9090790807	drdixit2001@gmail.com	Physiology, Biochemistry
3	Dr. T.K. Barik, Asst. Professor	Ph.D.	9583500088/ 8917289089	tkbarik@rediffmail.com	Applied Entomology, Nanotechnology
4	Dr. J.K. Seth, Asst. Professor	Ph.D.	9658887688	jkseth52@gmail.com	Biodiversity, Conservation Biology, Molecular Systematic, Evolutionary Biology
5	Mr. L.K. Murmu, Asst. Professor	M.Phil.	9090457648	murmu.laxmankumar36@gmail.com	Molecular Parasitism
6	Dr. S.K. Dash, Asst. Professor	Ph.D.	9438764504	dashsandipkumar@gmail.com	Molecular Diagnosis,

					Biosensor.
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4. Supporting Staff:

Sl. No.	Name of the Employee	Contact	E-Mail
1	Mr. K.C. Panda	9861280550	
2	Dr D. Sahu	9437030878	deben_sahu@yahoo.co.in
3	Mr. Abhiram Palai	9861346150	
4	Mr. Y. Rajeswar Rao	8596045003	

5. Courses offered

P.G.: Semester-I: Biology of Non-Chordate, Cytology, Inheritance Biology, Biosystematics, Conservation Biology, Evolution and Ecology, Biochemistry, Laboratory Course Work-I; **Semester-II:** Biology of Chordates, Molecular Biology, Physiology, Endocrinology and Histology, Ethology, Applied Ecology, Microbiology, Laboratory Course Work-II **Semester-III:** Instrumentation and methods in Biology, Immunology, Developmental Biology and Biostatistics, Elective 1: Academic Writing/ Entomology, Laboratory Course Work-III **Semester-IV:** Cytogenetic, Cancer Biology, Applied Entomology, Epigenetic, Stress Physiology, Molecular Parasitism, Elective 2: Applied Biology/Animal Biotechnology, Project, Dissertation and Viva

M. Phil. Level: Basic Research Methodology, Advanced tools and Techniques in Biology, Seminar Presentation, Dissertation and Viva.

Research (Ph.D.) in the specialized areas of Biochemistry, Physiology, Applied Entomology, Nano-technology, Biodiversity, Conservation Biology, Molecular Systematics, Evolutionary Biology, Molecular Parasitism, Molecular Diagnosis and Biosensor.

Besides this, P.G. Department of Biotechnology (SFC) with capacity of 40 students is attached to our Department. The Department started during 2005 to offer two years P.G. course of Biotechnology with emphasis on Advanced Techniques and Modern Biology.

6. Academic Dimension: In addition to above, the department is conducting weekly seminar for both P.G. Part I and II students, also annual intra and inter class quizzes, essay writing in current event in the field of Science and Technology. The students are also participating in the study tour/field trip each year.

Alumni Meet: Alumni, Department of Zoology, were established in 1994 to include more than 1500 members by now with a record of reunion every year along with the Annual Day celebration of the Zoology Seminar. Executive body meeting is carried out 2-3 times a year. The basic objectives being reunion, financial and professional cooperation, felicitation of meritorious

students, superannuated alumni. Besides, a bulletin citing activities achievements around the year is published.

7. Student Facilities

- a. **Seminar Library:** About 1403 books of national and International repute and more than previous volumes of Research Journals are available.
- b. **Audio-Visual aids:** LCD Projector, Audio system, and the Department is planning to run dust-free smart classes near future.
- c. **Proctorial classes** for the students are held on regular basis
- d. **Museum:** One of the best Zoology museums of the state with thousands of well-preserved specimens.

M.Sc. Zoology General Course Framework & Structure

S.No	Paper No	Title	Credits	Proposed Marks
SEMESTER ONE				
1	ZOOL-CC-101	Biology of Non-Chordate	04	100
2	ZOOL-CC-102	Cytology and Inheritance Biology	04	100
3	ZOOL-CC-103	Biosystematics, Conservation Biology, Evolution and Ecology	04	100
4	ZOOL-CC-104	Biochemistry	04	100
5	ZOOL-CC-105	Laboratory Course Work-I	04	100
TOTAL			20	500
SEMESTER TWO				
1	ZOOL-CC-201	Biology of Chordates	04	100
2	ZOOL-CC-202	Molecular Biology	04	100
3	ZOOL-CC-203	Physiology, Endocrinology and Histology	04	100
4	ZOOL-CC-204	Ethology, Applied Ecology and Microbiology	04	100
5	ZOOL-CC-205	Laboratory Course Work-II	04	100
TOTAL			20	500
SEMESTER THREE				
1	ZOOL-CC-301	Instrumentation and methods in Biology	04	100
2	ZOOL-CC-302	Immunology	04	100
3	ZOOL-CC-303	Developmental Biology and Biostatistics	04	100
4	ZOOL-CE-304	Elective 1*	04	100
5	ZOOL-CC-305	Laboratory Course Work-III	04	100
TOTAL			20	500
SEMESTER FOUR				
1	ZOOL-CC-401	Cancer Biology, Cytogenetic and Applied Entomology	04	100
2	ZOOL-CC-402	Epigenetic, Stress Physiology and Molecular Parasitism	04	100
3	ZOOL-CE-403	Elective 2**	04	100
4	ZOOL-CP-404	Project, Dissertation and Viava-Voce	08	200
TOTAL			20	500
			80	2000

Recommended Electives

ZOOL-CE-304* Elective I: A) Academic Writing B) Entomology

ZOOL-CE-403** Elective II: C) Applied Biology D) Animal Biotechnology

Semester-One

ZOOL-CC-101

Biology of Non-Chordate


Credits:



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	<ol style="list-style-type: none">1. Locomotion, nutrition and reproduction in Protozoa2. Parasitic Protozoans with special reference to human host3. Origin of Metazoa, canal system and reproduction in Porifera4. Polymorphism in Coelenterates, Corals and coral reef formation, Ctenophora and its affinities
Unit II Higher Invertebrates Lectures:16	<ol style="list-style-type: none">1. Parasitism and parasitic adaptations in helminths2. Coelom: Its Origin and function3. Excretory structures and functions in annelids4. Metamerism and segmental organs in annelids
Unit III Higher Invertebrates Lectures:16	<ol style="list-style-type: none">1. Structural organization and phylogenetic status of Limulus2. Parasitic castration with reference to the life cycle of Sacculina3. Larval forms in Crustaceans, Vision in arthropods4. Structural organization and phylogenetic status of Peripatus
Unit IV Higher Invertebrates Lectures:16	<ol style="list-style-type: none">1. Respiration in Molluscs2. Torsion and de-torsion in Gastropoda3. Water vascular system of Echinoderms, Larval forms in Echinoderms4. Structure and affinities of Rotifera, Brachiopoda, and Phoronida
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Invertebrate Zoology, R.D. Barnes2. The invertebrates, L.H. Hyman, Vol I to VI3. Invertebrate structure, Barrington, Nelson4. Invertebrate Zoology, R.L. Kotpal5. The Invertebrates: Function and Form, W. Sherman, V.G. Sherman6. A Text Book of Zoology, T.J. Parker, W.A. Haswell, Vol-I and II

Semester-One

ZOOL-CC-102

Cytology and Inheritance Biology

Credits



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. J.K. Seth

Unit I Cytology-I Lectures:16	<ol style="list-style-type: none">1. Molecular organization of Cell membrane2. Membrane transporter: Structure and function3. Mechanism of membrane transports4. Cell-cell interactions
Unit II Cytology-II Lectures:16	<ol style="list-style-type: none">1. Structure and function of Cytoskeleton and its role in motility2. Structure, Biogenesis and function of Lysosome and Peroxisomes3. Endoplasmic Reticulum and compartmentalization of Golgi4. Structure and function of Mitochondria and protein targeting
Unit III Cytology-III Lectures:16	<ol style="list-style-type: none">1. Nucleus and nuclear transport2. Organization of genes and chromosomes3. Cell Division and its regulation4. Cell cycle and its regulations
Unit IV Mendelism Neo- Mendelism Lectures:16	<ol style="list-style-type: none">1. Mendelian Genetics2. Neo-Mendelism, Pleiotropy, genomic imprinting, penetrance and expressivity3. Linkage and crossing over4. Extra-chromosomal Inheritance, Pedigree analysis, Complementation tests and QTL mapping
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin2. Molecular Biology of the Cell, Alberts <i>et al.</i>, (2008), Garland Science, New York, USA3. The cell: A molecular approach, Geoffrey, M. Cooper, R.E. Hausman (2004) ASM Press4. Cell and Molecular biology , Gerald Karp (2015)John wiley and sons5. Principles of Genetics, Snustad and Simmons, (4th Ed. 2005), John Wiley & Sons, USA6. Genetics, J. Russell, Benjamin-Cummings Publishing Company,

Semester-One

ZOOL-CC-103

Biosystematics, Conservation Biology, Evolution, and Ecology

Credits




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

<p>Unit I Biosystematics Lectures:16</p>	<ol style="list-style-type: none"> 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. Morpho-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
<p>Unit II Bioconservation Lectures:16</p>	<ol style="list-style-type: none"> 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: Biological diversity Act 2002, National Biodiversity Authority, People Biodiversity Registrar, Convention on Biological diversity, Cartagena Protocol and Nagoya Protocol, Aichi Biodiversity Targets, CITES, WWF. 4. In-situ conservation (Indian context) (Sanctuaries, National and Biosphere reserves) and Ex-situ conservation (Indian context) (Botanical gardens, zoos, cryopreservation, gene bank).
<p>Unit III Evolution Lectures:16</p>	<ol style="list-style-type: none"> 1. Theories of organic evolution (Lamarckism and Darwinism) and the Modern synthetic theory. 2. Origin of basic biological molecules; Abiotic synthesis of organic

	<p>monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells</p> <p>3. Phylogenetic tree, molecular phylogeny inference using DNA and protein sequences, neutral evolution, molecular divergence and molecular clocks; origin of new genes and proteins; Gene duplication and divergence.</p> <p>4. Hardy-Weinberg Law, Isolating mechanisms, Speciation, Convergent evolution; Sexual selection; Co-evolution.</p>
<p>Unit IV Ecology Lectures:16</p>	<p>1. Population characteristics and dynamics</p> <p>2. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.</p> <p>3. Community Ecology: Nature of communities; community structure and attributes; edges and ecotones; Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.</p> <p>4. Ecosystem structure and characteristics</p>
	<p>Recommended Textbooks and References:</p> <p>1. Principle of Animal Taxonomy; G.G. Simpson. Oxford IBH Publishing Company.</p> <p>2. Elements of Taxonomy. E. Mayer.</p> <p>3. Theory and Practice of Animal Taxonomy. V.C. Kapoor, Oxford & IBH Publishing Co.</p> <p>4. Fundamental of Ecology : O.P Odum</p> <p>5. Evolution : Strickberger</p> <p>6. Evolutionary analysis : Herron and freeman</p> <p>7. Campbell Biology: Reece, Urry, Cain <i>et al.</i></p> <p>8. Essential of Ecology: Miller and Spoolman</p>

Semester-One

ZOOL-CC-104

Biochemistry

Credits




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

<p>Unit I Biochemistry</p>	<p>1. Composition, structure, types and function of carbohydrates</p> <p>2. Composition, structure, types and function of lipids and steroids</p> <p>3. Composition, structure, types and function of amino acids and proteins</p>
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Lectures:16	4. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds)
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 and inhibition
	Recommended Textbooks and References: 1. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07 th Edition 2. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08 th Edition 3. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31 st Edition 4. Principle of Biochemistry, Voet and Voet 5. Biochemistry, Campbell

Semester-One

ZOOL-CC-105

Laboratory Course Work- I

Credits



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

<p>Biology of Non-Chordate, Cellular Biology & Inheritance Biology, Biosystematics, conservation Biology, Evolution and Ecology, Biochemistry</p>	<ol style="list-style-type: none"> 1. Invertebrate Anatomy of preserved animals available in the market <ol style="list-style-type: none"> 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) g) Mytilus (Nervous system) h) Pila (Nervous system & Otolith) i) Aplysia (Nervous system) j) Starfish (Water vascular system & Tube foot) k) Sea Urchin (Aristotle's lantern) 2. Preparation of permanent slides (Specimen available) 3. Identification with comments upon <ol style="list-style-type: none"> 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 <ol style="list-style-type: none"> 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 measurement of pH 14. Demonstration and handling of micropipette 15. Biochemical (Qualitative) tests for- <ol style="list-style-type: none"> a) Protein, glycogen, ascorbic acid, phosphorus, nucleic acid b) Tests for salivary amylase and invertase
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Semester-Two

ZOOL-CC-201

Biology of Chordates

Credits



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 Protochordates Lectures:16	<ol style="list-style-type: none">1. Biology and evolutionary significance of Hemichordates, Cephalochordates and Urochordates2. General organization, classification and affinities of Cyclostomata3. Structural organization of Petromyzon and its comparison with Myxine4. Origin of chordates
Unit II Superclass: Pices Lectures:16	<ol style="list-style-type: none">1. Biology and affinities of Dipnoi2. Biology and Phylogenetic significance of Latimeria3. Osmoregulation in fishes, Swim bladder and lateral line system in fishes4. Parental care in amphibian, Neoteny and metamorphosis in amphibian
Unit III Class: Reptilia and Birds Lectures:16	<ol style="list-style-type: none">1. Structural organization and phylogenetic significance of Sphenodon2. Adaptive radiation in reptiles3. Origin and evolution in birds4. Flight adaptation in birds
Unit IV Class: Mammalia Lectures:16	<ol style="list-style-type: none">1. Origin of mammal2. Aquatic mammals3. Prototheria and metatheria4. Dentition in Mammals
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Phylum Chordata, H. Newman2. The Life of Vertebrates, J.Z. Youn3. A Text Book of Zoology, T.J. Parker and W.A. Haswell, Vol. I and II

Semester- Two

ZOOL-CC-202

Molecular Biology

Credits



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	<ol style="list-style-type: none">1. Structure and conformation of Nucleic acids2. DNA replication3. DNA damage and repair mechanism4. Recombination: Homologous and site-specific recombination
Unit II Molecular Synthesis Lectures:16	<ol style="list-style-type: none">1. Mechanism of Transcription2. Post Transcriptional modifications and RNA processing3. Protein translation4. Post- translational modification of proteins
Unit III Gene Regulation Lectures:16	<ol style="list-style-type: none">1. Prokaryotic gene regulation2. Eukaryotic gene regulations3. Topoisomerase, its role during replication and transcription4. Gene regulation and expression in viruses
Unit IV Gene Regulation Lectures:16	<ol style="list-style-type: none">1. Hormones and their receptors, cell surface receptor,2. General principles of cell communication, Signaling through G-protein coupled receptors,3. Signal transduction pathways, second messengers4. Quorum sensing
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin2. Cell Biology, G. Karp3. Cell and Molecular Biology, De Robertis4. Molecular Biology of the Cell, Alberts <i>et al.</i>, Garland Science, New York, USA

Semester- Two

ZOOL-CC-203

Physiology, Endocrinology and Histology

Credits



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. P.K. Dixit

Unit I Digestion, Excretion, and Circulation Lectures:16	<ol style="list-style-type: none">1. Digestive System: Secretory function of alimentary canal, Digestion, absorption2. Blood and circulation: Blood corpuscles, haemopoiesis and Mechanism of Blood coagulation.3. Excretory System: Nephron, Mechanism of Unin formation, water and electrolyte balance.4. Cardiovascular System: Heart, Double circulation, Principles of ECG
Unit II Nerve Conduction and Sense Organs, Respiration, and Thermoregulation Lectures:16	<ol style="list-style-type: none">1. Respiratory System: Mechanism of breathing, exchange of gases and its regulation2. Nervous System: Neurons, synapse and synaptic transmission and mechanism of nerve conduction.3. Sense Organs: Vision, hearing4. Types of muscle and mechanism of muscle contraction.
Unit III Endocrinology Lectures:16	<ol style="list-style-type: none">1. Structure, chemistry and function of Pituitary and peneal gland2. Structure, chemistry and function of Thyroid and para-thyroid gland3. Structure, chemistry and function of Pancreas and Adrenal gland4. Mechanism of hormone actions
Unit IV Histology Lectures:16	<ol style="list-style-type: none">1. Structure and function of epithelial tissue and connective tissue2. Cell adhesion and cell adhesion molecules3. Histological details and functions of liver4. Histological details and functions of Spleen & Kidney
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Endocrinology, Hadley2. Endocrinology, Turner and Bagnora

	<ol style="list-style-type: none"> 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
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Semester- Two

ZOOL-CC-204

Ethology, Applied Ecology, and Microbiology

Credits



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	<ol style="list-style-type: none"> 1. Concept of animal behavior: Innate, Acquired; Social interaction in Insects and Primates 2. Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Altruism 3. Neural basis of learning and memory 4. Hypothalamus and regulation of animal behaviour
Unit II Applied Ecology Lectures:16	<ol style="list-style-type: none"> 1. Pollution and abatement of land, air and water, noise pollution 2. Global warming, Ozone layer depletion, Acid rain-causes & consequences 3. Concept of Sustainable Development and its goals 4. Bioremediation
Unit III Microbiology-I Lectures:16	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 1. Characteristics and classification of viruses 2. Life cycle of Bacteriophages 3. Pathophysiology of CoV, H₁N₁ and HIV 4. Bioterrorism
	Recommended Textbooks and References: <ol style="list-style-type: none"> 1. Ecology, E.P. Odum, R. Holt, Winston Inc., USA, 2. C.S. Binoda, M.P. Nayar, River Pollution In India. APH Publ. Corpn.,

	<p>New Delhi.</p> <ol style="list-style-type: none"> 3. Campbell Biology, Reece, Urry, Cain <i>et al</i> 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
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Semester- Two

ZOOL-CC-205

Laboratory Course Work-II

Credits



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 microbiological experiments.

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

<p>Biology of Chordates, Molecular Biology, Physiology, Endocrinology and Histology, Ethology, Applied Ecology, Biogeography and Palaeontology</p>	<ol style="list-style-type: none"> 1. Vertebrate Anatomy of preserved animals available in Market:- <ol style="list-style-type: none"> 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) Toad (cranial nerves, Blood vascular system and hyoid apparatus) e) <i>Calotes</i> (Blood vascular system, and hyoid apparatus) f) Pigeon (Blood vascular system, brain, air sacs, pecten, flight and perching muscles) g) Rat (Neck nerves, brain and vascular system) 2. Identification and Comments upon <ol style="list-style-type: none"> a) Museum specimens b) Bones c) Permanent histological slides 3. Ecological experiments to determine-
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	<ul style="list-style-type: none"> 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- <ul style="list-style-type: none"> 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)
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Semester- Three

ZOOL-CC-301

Instrumentation and methods in Biology

Credits




Course Coordinator: Dr. S.K. Dash

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.

Student Learning Outcomes: Students after completion of this course are expected to handle and operate basic instruments for their experimental purposes.

Unit I Microscopy, Centrifugation,	<ul style="list-style-type: none"> 1. Light, Fluorescent and Electron microscopy 2. Centrifugation 3. Chromatography
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Chromatography Lectures:16	4. Electrophoresis
Unit II Spectroscopy and Spectrophotometry Lectures:16	1. UV/Vis Spectrophotometry 2. FTIR and Raman spectroscopy 3. X-ray diffraction 4. NMR spectroscopy and Mass spectrometry
Unit III Basic Molecular Techniques Lectures:16	1. Isolation of RNA, genomic and plasmid DNA 2. DNA and Protein sequencing methods, 3. Isolation and analysis of carbohydrate and lipid molecules 4. Radio labelling techniques
Unit IV Advanced Molecular Techniques Lectures:16	1. Blotting techniques 2. Polymerase Chain Reaction and its applications 3. Gene cloning and expression 4. Genetic engineering and its application
	Recommended Textbooks and References: 1. Introduction to Spectroscopy, Pavia, Lampman, Kriz, Vivyan, Cengage Learning 2. Modern Spectroscopy, JM Hollas, Willey Publication 3. Molecular Structure and Spectroscopy, G. Aruldash 4. Understanding NMR Spectroscopy, J Keeler, Wiley Publications 5. Principles of NMR Spectroscopy, DP Goldberg 6. Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin 7. Experimental Biochemistry, Wilson and Walker 8. Experimental Biochemistry, Rodney Boyer 9. Fundamental of light microscopy and electronic Imaging, Douglas Murphy

Semester- Three

ZOOL-CC-302

Immunology

Credits




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.

Student Learning Outcomes: Students after completion of this course are expected to know in details about human immune system and mechanism of immunity.

Course Coordinator: Dr. S.K. Dash

Unit I Basic Immunology	1. Immunity, cells and molecules of immunity 2. Innate immunity: inflammatory response, complement system
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Lectures:16	<ol style="list-style-type: none"> Adaptive immunity-humoral and cell mediated MHC Class and function and toll-like receptors
Unit II Components of Immune System Lectures:16	<ol style="list-style-type: none"> Cluster of differentiation and immunophenotyping Structure, types and functions of antibodies Vaccines Hypersensitivity
Unit III Genetic Rearrangement of Ig Genes Lectures:16	<ol style="list-style-type: none"> Multigene organization of immunoglobulin gene Immunoglobulin light chain gene rearrangements Immunoglobulin heavy-chain gene rearrangements Recombination signal sequences and enzymes for rearrangement
Unit IV Antibody Diversity and Generation Lectures:16	<ol style="list-style-type: none"> Antibody class switching Generation of antibody diversity Antibody Engineering Monoclonal antibodies and hybridoma technology.
	Recommended Textbooks and References: <ol style="list-style-type: none"> Kuby Immunology, J. Punt, S. Stanford, P. Jones, J.A. Owen, 8th Edition Understanding Immunology, P. Wood, 02nd Edition Basic Immunology, A.k. Abbas, A.H. Lichtman, 3rd Edition Clinical Immunology Principles and Practices, R.R. Rich, 04th Edition, Elsevier Publisher Essential Clinical Immunology, J.B. Jabrskie, Cambridge

Semester-Three

ZOOL-CC-303

Developmental Biology and Biostatistics


Credits



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 application of basic mathematical and statistical aspects in biological sciences. Students after attending the course will understand fundamental process during development from gametogenesis to fertilization, blastulation and gastrulation, basic aspects of morphogenesis and organogenesis.

Student Learning Outcomes: Students are expected to learn the basic principle and process of developmental biology and able to apply the principle of mathematics and statistics in solving different biological problems.

Course Coordinator: Dr. J.K. Seth

Unit I Developmental Biology-I Lectures:16	<ol style="list-style-type: none"> 1. Gonads and gonadial hormones 2. Structure of gametes and gametogenesis 3. Molecular mechanism of fertilization 4. Cleavage and its pattern
Unit II Developmental Biology-II Lectures:16	<ol style="list-style-type: none"> 1. Basic experiments of developmental biology 2. Axes and pattern formation in <i>Drosophila</i> 3. Vulva formation in <i>Caenorhabditis elegans</i> 4. Limb development and regeneration in vertebrates
Unit III Biostatistics-I Lectures:16	<ol style="list-style-type: none"> 1. Basic aspect in Biostatistics and Mathematical Biology: An Introduction, Scope and Philosophical Framework, Critical Thinking and Scientific methodology, Type of studies: Observational, Experimental, classification based on data analysis, 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 Biostatistics-II Lectures:16	<ol style="list-style-type: none"> 1. Concepts of Population, Sample and 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, Mann-Whitney U test 3. Probability distributions- Normal, Binomial and Poisson 4. Simple correlation and Regression
	<p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 1. Developmental Biology, S.F. Gilbert 2. Introduction to Embryology, B.L. Balinsky 3. Biostatistical Analysis, J.H. Zar 4. Introductory biostatistics, C.T. Le, L.E. Eberly, John Wiley & Sons 5. Biostatistics: A methodology for the health sciences, G. van Belle, L.D. Fisher, P.J. Heagerty, T. Lumley, Vol. 519, John Wiley & Sons 6. Intuitive biostatistics: A nonmathematical guide to statistical thinking, H. Motulsky, Oxford University Press, USA 7. The Logic of Scientific discovery, K. Popper

ZOOL-CE-304 A
**Academic
 Writing**


Credits



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

<p>Unit I Technical Writing Lectures:16</p>	<p>Technical writing overview, Importance of Technical Writing, Basic rules of technical writing, English in technical writing, Style of research writing</p>
<p>Unit II Plagiarism Lectures:16</p>	<p>Plagiarism overview, tools for detection of Plagiarism, Avoiding the plagiarism, Ethics in technical writing, Journal Metrics, Author metrics</p>
<p>Unit III Review of Literature Lectures:16</p>	<p>Literature review: source and process, online literature database, literature management tools, Research Paper writing, Referencing and citation, Submission and Post Submission</p>
<p>Unit IV Challenges in Research Lectures:16</p>	<p>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</p>
	<p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 1. Academic Writing, S. Bailey 2. https://swayam.gov.in 3. Bird, A. (2006): Philosophy of Science, Routledge 4. MacIntyre, 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): Predatory 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-CE-304 B

Entomology

Credits




Course Objectives: 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: 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. T.K. Barik

Unit I Origin and Classification of Insects Lectures:16	<ol style="list-style-type: none">1. Origin and Evolution of Insects2. Classification of insects upto order with examples.3. Growth development and metamorphosis of Insect4. Collection and preservation of insects
Unit II Economical Entomology Lectures:16	<ol style="list-style-type: none">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	<ol style="list-style-type: none">1. Morphology, Bionomics and Management of pests of Rice.2. Morphology, Bionomics and Management of pests of Sugarcane.3. Morphology, Bionomics and Management of pests of sub-tropical and tropical fruits (Mango, Banana and Guava)4. Morphology, Bionomics and Management of household pests (Mosquitoes and Housefly)
Unit IV Social and Physiological Aspects of Insects	<ol style="list-style-type: none">1. Social behaviour in Insects2. Physiology and mechanism of Compound vision3. Insect Hormones with special reference to Pheromones

Lectures:16	4. Thermoregulation in Insects
	<p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 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

Laboratory course work-III

Credits



Course Coordinator:
Head, Department of Zoology

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

<p>Instrumentation and methods in Biology, Immunology, Developmental Biology and Mathematical Biology</p>	<ol style="list-style-type: none"> 1. Permanent histochemical preparation for the localization of – <ol style="list-style-type: none"> 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. Isolation and estimation genomic DNA 4. Demonstrations of Electrophoresis and PCR 5. Demonstration of Chromatography 6. Demonstration of centrifugation 7. Demonstration of Spectrophotometer and Quantification of protein using Biuret method, lowry method 8. Estimation of casein, glycogen and lipid 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. Mounting of chick embryo 13. Permanent slides of different stages of chick embryo development 14. Demonstration of Blood group 15. Permanent Slide of thymus and spleen
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Semester-Four

ZOOL-CC-401

Cancer Biology, Cytogenetics, and Applied Entomology

Credits




Course Objectives: The objective of course is to provide basic idea on cancer cells biology, cytogenetic and elementary idea on applied entomology.

Student Learning Outcomes: Students are expected to learn differences aspects of cell transformation from normal to cancer cells, different proteins and genes involved in different types of cancers, various chromosomal abnormalities and economical aspects of some insects and integrated pest management.

Course Coordinator: Dr. J.K. Seth

Unit I Cancer Biology Lectures:16	<ol style="list-style-type: none">1. Difference between normal cells and cancerous cell, Proto-oncogene, tumor suppressor genes and care taker genes, loss of function and gain of function mutation, Cancer stem cells and its possible origin.2. Brief idea on different genes/proteins related to cancer: p53, APC, src, ras, Rb, BRCA1 and BRCA2, P²¹ and P16.3. Hall mark of cell transformation from normal to cancer(I): a)Limitless replicating potential , b)details mechanism of Metastasis, c)details mechanism of Sustained Angiogenesis4. Hall mark of cell transformation from normal to cancer (II): a)Apoptosis and Evasion of Apoptosis, b)how cancer cell develops Self sufficiency in growth signal, c) how cancer cell develops Insensitive to antigrowth signals
Unit II	<ol style="list-style-type: none">1. Meiotic abnormalities- Non-disjunction of chromosomes, mis-

<p>Cytogenetics Lectures:16</p>	<p>division of centromere</p> <ol style="list-style-type: none"> Human cytogenetics- Techniques in human chromosome analysis, Human karyotype, banding and nomenclature, Numerical and structural abnormalities of chromosomes Amniocentesis, Monogenic disorders: Autosomal dominant (Huntington's diseases), Autosomal recessive (Cystic fibrosis), Sex linked (Color blindness and Hemophilia). In situ- hybridization and its applications: FISH and GISH; Genomic analysis and C-value paradox
<p>Unit III Metabolic Disorders Lectures:16</p>	<ol style="list-style-type: none"> Biochemistry of inherited and metabolic disorders: Phenylketoneuria, Alkaptonuria, Albinism Neurochemical associated diseases: Alzheimer's disease, Parkinson's disease Human nutrition and associated hazards Molecular mechanism of senescence
<p>Unit IV Applied Entomology Lectures:16</p>	<ol style="list-style-type: none"> Biology of Honey bee and Apiculture Biology of Silk moth and Sericulture Predator parasites and pathogens of insects Integrated pest management
	<p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> Molecular Cell Biology, Lodish, Berk, Kaiser, Krieger, Bretscher, Ploegh, Amon, Martin Cell Biology, G. Karp Cell and Molecular Biology, De Robertis Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition Principles of Cancer Biology, L.J. Kleinsmith Cancer Biology, R.J.B. King, M.W. Robins, 03rd Edition The Insects: An Outline of Entomology, P.J. Gullan, P.S. Cranston General Text book of Entomology, O.W. Richard, R.G. Davies, Part I & II Insect Biology-A textbook of Entomology, H.E. Evans, Wesley Publ. Co.. General Entomology. M.S. Mani, Oxford & IBH Publ. Co. Insects, M.S. Mani, National Book Trust, India A Textbook of Entomology, H.H. Ross, C.A. Ross, J.R.P. Ross, John Wiley & Sons

Semester-Four

ZOOL-CC-402

Course Objectives: The objective of the course is to provide a comprehensive idea about epigenetic and its mechanism, Stress physiology and molecular basis of parasitism.

Student Learning Outcomes: The students are expected to learn epigenetic related disorders and their consequences, importance of stress physiology and molecular mechanism involved in host -parasite interaction.

Epigenetics, Stress Physiology and Molecular Parasitism

Credits



Course Coordinator: Mr. L.K. Murmu

Unit I Epigenetics-I Lectures:16	<ol style="list-style-type: none">1. Epigenetics- chromatin modifications and their mechanism of action,2. Epigenetics and genome imprinting - DNA methylation in mammals, genomic imprinting in mammals3. Epigenetics in <i>Saccharomyces cerevisiae</i>4. Gene silencing
Unit II Epigenetics-II Lectures:16	<ol style="list-style-type: none">1. Epigenetic regulation of chromosome inheritance2. Epigenetic regulation of the X chromosomes in <i>C.elegans</i>3. Dosage compensation in <i>Drosophila</i>4. Dosage compensation in mammals; mechanism of chromatin remodeling.
Unit III Stress Biology Lectures:16	<ol style="list-style-type: none">1. Concept of Biological stress and strain2. Stress adaptation- Resistance, stress tolerance, Acclimation and acclimatization3. Stress associated disorders4. Oxidative stress
Unit IV Molecular Parasitism Lectures:16	<ol style="list-style-type: none">1. Recognition and entry processes of different pathogens like bacteria, viruses into animal2. Alteration of host cell behavior by pathogens3. Virus-induced cell transformation, pathogen-induced diseases in animals4. Cell-cell fusion in both normal and abnormal cells
	Recommended Textbooks and References: <ol style="list-style-type: none">1. Lewin's Genes X, J.E. Krebs, E.S. Golstein, S.T. Kilpatrick, Volume 10, Jones and Bartlett Publishers2. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition3. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition4. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition5. Principles of Cancer Biology, L.J. Kleinsmith6. Cancer Biology, R.J.B. King, M.W. Robins, 03rd Edition7. Medical Parasitology, CP Baveja, V Babheja8. Parasitism, TM Goater, CP Goater, GW Esch

Semester-Four

ZOOL-CE-403 C

Applied Biology

Credits



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 brief ideas about radiation biology..

Student Learning Outcomes: Students after reading this course are expected to have knowledge on types of radiations, their adverse effects and safety measures, orient towards industrial microbiology for self entrepreneurship development and application of nano-science in biological research.

Course Coordinator: Dr. T.K. Barik

Unit I Applied Genetics Lectures:16	<ol style="list-style-type: none">1. Human gene mapping- Physical mapping & map-based cloning, molecular markers in genome analysis (RFLP, AFLP, RAPD)2. Ribozyme technology and its application3. Cell and tissue culture methods for animals4. Transgenic animals, molecular approaches to diagnosis and strain identification.
Unit II Applied Microbiology Lectures:16	<ol style="list-style-type: none">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	<ol style="list-style-type: none">1. Nanotechnology- Break through an introduction2. Application of Nanotechnology,3. Bucky balls, Bucky tubes and their applications,5. Nanotechnology in drug delivery
Unit IV Radiation Biology Lectures:16	<ol style="list-style-type: none">1. Definition, scope and significance of radiation biology, classification of radiation, Ionizing radiation, types of electromagnetic radiation, radiation dose and units, principles of radiation dosimetry.2. Electromagnetic radiation and its interaction with living matter with special reference to UV and Visible light3. Radiation in insect pest management: Types of radiation used, radiation induced dominant lethal mutation, sterile insect technique, F₁ sterility technique5. Radiation induced heritable diseases



Recommended Textbooks and References:

1. Lewin's Genes X, J.E. Krebs, E.S. Golstein, S.T. Kilpatrick, Volume 10, Jones and Bartlett Publishers
2. Lehninger 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. Understanding Radiation Biology from DNA Damage to Cancer and Radiation Risk, K.H. Chadwick
8. Essentials of Radiation Biology and Protection, S. Foshier
9. Basic Principles of Nanotechnology, W.C. Sanders, CRC Press
10. Introduction to Nanotechnology, C.P. Pools, F.J. Owens, Willey Publishers
11. A handbook of Nanotechnology, U. Kumar
12. Nanophysics and Nanotechnology, E.L. Wolf, Willey Publications

Semester-Three

ZOOL-CE-403 D

Animal Biotechnology

Credits




Course Objectives: The objectives of this course are basic idea in research and cutting edge area on animal biotechnology.

Student Learning Outcomes: Students are expected to orient themselves towards various aspects of cutting edge research in the field of animal biotechnology.

Course Coordinator: Dr. T.K. Barik

Unit I Animal Culture Lectures:16	Cell	<ol style="list-style-type: none">1. Laboratory requirements and general techniques in animal cell culture; Sterilization procedures;2. Preparation of media; Balanced salt solutions;3. Various type of cell culture media;
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	4. Contact inhibition; Anchorage dependence; Cell senescence.
Unit II Plant Cell Culture Lectures:16	<ol style="list-style-type: none"> 1. Mechanical and enzymatic desegregation of tissue and setting up of primary cultures 2. Cell culture in continuous, perfusion and hollow-fiber reactor 3. Preparation of chick fibroblast; Organ and histotypic cultures 4. Measurement of cell death; Cell transfection.
Unit III Characterization of Cultured Cells Lectures:16	<ol style="list-style-type: none"> 1. Measurement of viability; Cytotoxicity and Biological characterization of the cultured cells 2. Maintenance of cell culture; Cryo- preservation 3. Primary and established cell lines 4. Cell separation and synchronization; Cell transformation
Unit IV Gene Transfer Technologies Lectures:16	<ol style="list-style-type: none"> 1. Transfection of animal cell lines and their immortalization; 2. Construction of animal viral vectors for gene transfer into cell lines; 3. Sperm mediated gene transfer; Embryo transfer technology; 4. Micromanipulation; Application of animal cell culture; Somatic cell genetics.
	<p>Recommended Textbooks and References:</p> <p>Freshney, Culture of Animal Cells, 5th Edition.</p> <ol style="list-style-type: none"> 2. Animal Cell Culture-Practical Approach., R.W. John, Masters, 3. Animal Cell Culture Techniques, M. Clynes, 4. Reproduction in Farm Animals, B. Hafez, E.S.E Hafez, 5. Transgenic Animals: Generation and Use, L-M Houdebine

Semester-Four

ZOOL-CP-404

Project,
Dissertation and
Viava-Voce

Credits



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 Execution	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 taught 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.

M.Phil. and Pre-Ph.D. Zoology

S.No	Paper No	Title	Credits	Proposed Marks
SEMESTER ONE				
1	ZOOL-MC-101	Basic Research Methodology	04	100
2	ZOOL-MC-102	Research Tools and Techniques	04	100
3	ZOOL-MC-201	Seminar and Pre-Submission Presentations	04	100
4	ZOOL-MD-202	Dissertation and Viva	12	200
TOTAL			24	500

Semester-One

ZOOL-MC-101

Basic Research Methodology

Credits:




Course Objectives: This course focuses on the basics of science and ethics, research integrity and publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citation, h-index, Impact factor, etc) and plagiarism tools will be introduced in this course.

Student Learning Outcomes: This course makes aware the students about the publication ethics and publication misconduct.

Course Coordinator: Dr. P.K. Dixit

Unit I Scientific Ethics Lectures:16	<ol style="list-style-type: none"> 1. Philosophy and ethics in research 2. Scientific conduct 3. Publication ethics
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Unit II Research Publication Lectures:16	<ol style="list-style-type: none"> 1. Open Access Publishing 2. Publication Misconduct 3. Database and Research Metrics
Unit III Research Writing Lectures:16	<ol style="list-style-type: none"> 1. Reading and critical analysis of scientific literature 2. Communicating research results in peer-reviewed journals 3. Acknowledgement of contributions, authorship issues and Plagiarism
Unit IV Dissertation Lectures:16	<ol style="list-style-type: none"> 1. Dissertation/Thesis writing-I 2. Dissertation/Thesis writing-II 3. Dissertation/Thesis writing-III
	Recommended Textbooks and References: <ol style="list-style-type: none"> 1. Philosophy of Science, A. Bird, Routledge 2. A short history of Ethics, A. MacIntyre, London 3. Ethics in competitive Research: Do not get scooped, do not get plagiarized, P. Chaddah 4. On being a Scientist: a guide to responsible conduct in Research, National Academy of Sciences, 3rd Edition 5. What is ethics in research and why it is important? D.B. Resnik, National Institute of Environmental Health Sciences 6. Predatory publishers are corrupting open access, J. Beall, Nature, 489, 179-179. 7. Research and Governance, INSA, Ethics in Science Education

Semester-One

ZOOL-MC-102

Research Tools and Techniques

Credits




Course Objectives: Objective of the course is to Provide a descriptive knowledge to the aspirant of M.Phil. Degree in various basic and advanced laboratory based tools and techniques for application in their research area.

Student Learning Outcomes: The students after completion of this course are expected to have a comprehensive idea and hands on experience regarding handling different routinely used instruments and techniques for their future research endeavour including biosafety measures required for handling animals.

Course Coordinator: Dr. T.K. Barik

Unit I Cell Culture Lectures:16	<ol style="list-style-type: none"> 1. Aseptic technique and preparation of media 2. Types of cell culture 3. Applications of cell culture 4. Microscopy
Unit II	<ol style="list-style-type: none"> 1. Colorimetry; Spectrophotometry

Instrumentation Lectures:16	<ol style="list-style-type: none"> 2. Preparative Centrifugation 3. Immunological techniques 4. Electrophoretic techniques
Unit III Laboratory Practices Lectures:16	<ol style="list-style-type: none"> 1. Good laboratory practice; Safety and bio- and radio- hazards, safety and precautions 2. Disposal of biological and chemical wastes 3. Accuracy of liquid transfer 4. Preparation of Reagents, chemicals, buffers
Unit IV Animal Ethics Lectures:16	<ol style="list-style-type: none"> 1. Animal handling and ethics 2. Maintenance of animals 3. Various routes of injections and sample collection 4. CPCSEA guidelines; Institutional ethics committees
	Recommended Textbooks and References: <ol style="list-style-type: none"> 1. Introduction to Spectroscopy, Pavia, Lampman, Kriz, Vivyan, Cengage Learning 2. Modern Spectroscopy, J.M. Hollas, Willey Publication 3. Molecular Structure and Spectroscopy, G. Aruldash 4. Experimental Biochemistry, Wilson and Walker 5. Experimental Biochemistry, Rodney Boyer 6. CPCSEA Manual for Animal Handling and experimentation

Semester-Two

ZOOL-MC-201

Seminar and Pre-Submission Presentations

Credits



Course Objectives: This paper is designed to give the student an exposure to the methodology in preparation of his/her dissertation and improve the communication/presentation skills.

Student Learning Outcomes: Students after completion of this course will be aquented with presentation and discussion of scientific thoughts along with development of understandings and skills.

Course Coordinator: Head, Department of Zoology

	Presentation on review of literature, Research Proposal and plan of research
	Final pre-submission presentation

Semester-Two

ZOOL-MD-202

Basic Research Methodology

Credits:



Course Objectives: This course has been designed to enrich the students with skills in writing and designing experiments and individual project proposal during their career.

Student Learning Outcomes: The students after completion of the course are expected to be prepared for future research and carryout independent research works.

Course Coordinator: Concern Supervisor

	Dissertation and Viva-voce
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