

COURSES OF STUDIES

M.Sc. in ZOOLOGY

(Effective from the academic session 2023-2025)

Under Choice Based Credit System (CBCS)



VIKRAM DEV UNIVERSITY

JEYPORE - 764001

DIST- KORAPUT, ODISHA

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.

Scheme of Evaluation:

1. Each theory papers having 100 Marks is divided into 20 Marks of internal evaluation 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)

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



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.

| | |
|---|---|
| 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 in Porifera4. Polymorphism in Coelenterates, Ctenophora and its affinities |
| Unit II Higher Invertebrates Lectures:16 | <ol style="list-style-type: none">1. Host-parasite interactions2. Coelom,metamerism and segmental organs of Annelida3. Parasitic adaptations in helminths4. Excretory structures and functions 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 Crustaceans4. 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 Echinoderms4. Larval forms in Echinodermata |
|  | 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 C 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.

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| 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. Concept and organization of Gene and Chromosome3. Cell cycle and its regulations4. Cell Division and its regulation |
| 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 |
| | <p>Recommended Textbooks and References:</p> <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, California, USA |

Semester-One

ZOOL C 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.

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| <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 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. Phylogenetic tree, molecular phylogeny inference using DNA and protein sequences 3. Hardy-Weinberg Law 4. Isolating mechanisms, and Speciation |
| <p>Unit IV Ecology Lectures:16</p> | <ol style="list-style-type: none"> 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 |
|  | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 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 <i>et al.</i> 7. Essential of Ecology: Miller and Spoolman |

Semester-One

ZOOL C 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

| | |
|---|---|
| Unit I Biochemistry Lectures:16 | <ol style="list-style-type: none">1. Composition, structure, types and function of carbohydrates2. Composition, structure, types and function of lipids and steroids3. Composition, structure, types and function of amino acids and proteins4. Conformation of proteins (Ramachandran plot, secondary structure) |
| Unit II Biochemistry Lectures:16 | <ol style="list-style-type: none">1. Glycolysis and TCA cycle2. Oxidative phosphorylation, ETC and ATP synthesis3. Oxidation of Fatty acids4. Bioenergetics |
| Unit III Molecular Metabolism Lectures:16 | <ol style="list-style-type: none">1. Alternative metabolism of carbohydrates (Gluconeogenesis and HMP Shunt)2. Metabolism of amino acids and Urea cycle,3. Biosynthesis of Cholesterol4. Vitamins |
| Unit IV Enzymology Lectures:16 | <ol style="list-style-type: none">1. Enzyme structure and classification2. Principles of catalysis, enzyme kinetics, Michaelis-Menten Equation, Line-Weaver-Burke Equation3. Mechanism of enzyme action with special references to lysozyme4. Regulation of Enzyme action |
| | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none">1. Lehinger Principles of Biochemistry, D.L. Nelson, M.M. Cox, 07th Edition2. Biochemistry, J.M. Berg, L. Stryer, J.L. Tymoczko, G.J. Gatto, 08th Edition3. Harper's Illustrated Biochemistry, V.L. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennely, P.A. Weil, 31st Edition4. Principle of Biochemistry, Voet and Voet5. Biochemistry, Campbell |

Semester-One

ZOOL P 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.

| | |
|---|---|
| <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)2. Preparation of permanent slides (Specimen available)3. Identification with comments upon<ol style="list-style-type: none">a) Museum specimensb) Whole mount Specimensc) Permanent slides-Invertebrates4. Cytological preparations of chromosomes from onion root tip and grasshopper testes5. Demonstration of mitochondria by supravital staining in buccal epithelium6. Demonstration of Barr body in hair root and buccal epithelial cells7. Problem related to following aspect of genetics<ol style="list-style-type: none">a) law of independent assortmentb) Complementation testc) Sex linked inheritanced) Pedigree analysise) linkage map8. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys9. Construction of phylogenetic tree using basic morphological features10. Construction of phylogenetic tree using 16s rRNA gene sequences retrieved from NCBI database11. Construction of phylogenetic tree using COI (Cytochrome c oxidase) gene sequences retrieved from NCBI database12. 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 pH14. Demonstration and handling of micropipette15. Biochemical (Qualitative) tests for-<ol style="list-style-type: none">a) Protein, glycogen, ascorbic acid, phosphorus, nucleic acidb) Tests for salivary amylase and invertase |
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SEMESTER-II

Semester-Two

ZOOL C 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.

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| 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: Pisces Lectures:16 | <ol style="list-style-type: none">1. Biology and affinities of Dipnoi and Latimeria2. Swim bladder and lateral line system in fishes3. Parental care in amphibian,4. 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 C 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.

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| Unit I Nucleic Acids Lectures:16 | <ol style="list-style-type: none">1. Structure 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. Second messengers signaling pathway4. 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 C 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.

| | |
|---|---|
| Unit I Digestion, Excretion, and Circulation Lectures:16 | <ol style="list-style-type: none">1. Digestive System: Secretory function of alimentary canal, Digestion, absorption2. 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 | <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, hearing and taste4. 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 glands2. 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 |
| | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none">1. Endocrinology, Hadley2. Endocrinology, Turner and Bagnora3. Comparative Vertebrate Endocrinology, P.J. Bentley4. Text Book of Comparative Endocrinology, H.A. Bern5. Animal Physiology: Adaptation and Environmental, K.S. Nelson (ed) Cambridge University Press, Cambridge, UK6. Medical physiology, Guyton and Hall7. Histology, H.R. Michael |

Semester- Two

ZOOL C 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.

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| Unit I Ethology Lectures:16 | <ol style="list-style-type: none">1. Concept of animal behavior: Innate, Acquired; Social interaction in Insects and Primates2. Altruism and Kin selection3. Neural basis of learning and memory4. 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 pollution2. Global warming and its consequences3. Ozone layer depletion, Acid rain-causes & consequences4. Bioremediation |
| Unit III Microbiology-I Lectures:16 | <ol style="list-style-type: none">1. Bacteria structure and morphology and classification2. Structure and function of bacterial cell wall3. Genetic recombination in bacteria4. Antibiotics classification and mode of action |
| Unit IV Microbiology-II Lectures:16 | <ol style="list-style-type: none">1. Characteristics and classification of viruses2. Life cycle of Bacteriophages3. Pathophysiology of CoV, H₁N₁ and HIV4. Bioterrorism |
|  | <p>Recommended Textbooks and References:</p> <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., New Delhi.3. Campbell Biology, Reece, Urry, Cain <i>et al</i>4. Essential of Ecology, Miller, Spoolman5. Animal Behaviour, J. Alcock6. Principles of Animal Communications, J.W. Bradbury7. Microbiology Principles and Explorations, J.G. Black, L.J. Black, 9th Edition, Willey Publishers8. Prescott's Microbiology, J. Willey, K. Sandman, D. Wood, 11th Edition |

Semester- Two

ZOOL P 205

Laboratory Course Work-II

Credits



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.

| | |
|---|---|
| Biology of Chordates, Molecular Biology, Physiology, Endocrinology and Histology, Ethology, Applied Ecology, Biogeography and Palaeontology | <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 ofb) Lorenzini, placoid scale)c) Cycloid and ctenoid scales of bony fishes.d) <i>Calotes</i> (Blood vascular system, and hyoid apparatus)e) Pigeon (Blood vascular system, brain, air sacs, pecten, flight and perching muscles)f) Rat (Neck nerves, brain and vascular system)2. Identification and Comments upon<ol style="list-style-type: none">a) Museum specimensb) Bonesc) Permanent histological slides3. Ecological experiments to determine-<ol style="list-style-type: none">a) Acidity, alkalinity and chlorinity of water samplesb) Dissolved oxygen content of waterc) pH of soil and water samples4. Identification with comments upon animals with ecological adaptation and of evolutionary importance5. Collecting different local animals/ photographs (least concern category) and their classification using taxonomic keys6. Physiological experiments-<ol style="list-style-type: none">a) Haemin crystals, hemoglobin concentration, RBC and WBC countingb) Oxygen consumption in insects and rats7. Construction of Ethogram-available animal found in and around Bhanja Bihar University campus8. Habituation in Annelid, Arthropod and Mollusc9. Demonstration of Chemical communication in ants10. Preparation of culture media11. Gram staining12. Biochemical test (Catalase, oxidase, carbohydrate) |
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Semester-Two

ZOOL VAC 206

Bioinformatics, Biosafety and Bioethics

Credits



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.

| | |
|--|---|
| Unit I Bioinformatics-I Lectures:16 | <ol style="list-style-type: none">1. Introduction to Bioinformatics2. DNA and protein databsae3. Searching for sequence database like FASTA and BLAST algorithm4. Sequence allignment |
| Unit II Bioinformatics-II Lectures:16 | <ol style="list-style-type: none">1. Structural viewers of protein (PyMOL)2. Practical aspects of multiple sequence alignment (CLUSTALW/CLUSTAL X)3. Basic ideal about MEGA4. Construction of phylogenetic tree |
| Unit III Biosafety Lectures:16 | <ol style="list-style-type: none">1. Introduction to Biological safety2. Biosafety guideline-Govt of India, Basic biosafety practices in the laboratory3. Biological hazards4. Basic idea on GMO and LMO |
| Unit IV Bioethics Lectures:16 | <ol style="list-style-type: none">1. IPR and genetic resources2. Patent, Trade, Copyright and trade mark3. Indain patent Act, filing of patent application4. Biopiracy |
| An icon of an open book with two pages visible. | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none">1. Ganguli, P. (2001). <i>Intellectual Property Rights: Unleashing the Knowledge Economy</i>. New Delhi: Tata McGraw-Hill Pub.2. Mount, D. W. (2001). <i>Bioinformatics: Sequence and Genome Analysis</i>. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.3. Bourne, P. E., & Gu, J. (2009). <i>Structural Bioinformatics</i>. Hoboken, NJ: Wiley-Liss.4. Lesk, A. M. (2004). <i>Introduction to Protein Science: Architecture, Function, and Genomics</i>. Oxford: Oxford University Press.5. Lesk, A.M. (2002). <i>Introduction to Bioinformatics</i>. Oxford University Press6. Mount, D. W. (2001). <i>Bioinformatics: Sequence and Genome analysis</i>. Cold Spring Harbor, NY: Cold Spring Harbour Laboratory Press.7. Wayne W. Daniel, <i>Bioststistics: A foundation for analysis in the Health Sciences</i>.8. Rosner, B. (2000). <i>Fundamentals of Biostatistics</i>. Boston, MA: Duxbury Press.9. Daniel, W. W. (1987). <i>Biostatistics, a Foundation for Analysis in the Health Sciences</i>. New York: Wiley. |

SEMESTER-III

Semester- Three

ZOOL C 301

Immunology and Histochemistry

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. 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.

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| Unit I Basic Immunology Lectures:16 | <ol style="list-style-type: none">1. Innate immunity2. Adaptive immunity3. Multigene organization of immunoglobulin gene4. Immunoglobulin gene rearrangement |
| Unit II Components of Immune System Lectures:16 | <ol style="list-style-type: none">1. Generation of antibody diversity2. Antibody Engineering3. Vaccines4. Hypersensitivity |
| Unit III Histochemistry-I Lectures:16 | <ol style="list-style-type: none">1. Principles and chemistry of Fixation2. Metachromasia and Mordants3. Immunocytochemistry4. Quantitative histochemistry: Absorptiometry and Fluorimetry |
| Unit IV Histochemistry-II Lectures:16 | <ol style="list-style-type: none">5. Carbohydrates by PAS method6. Protein by Mercury bromophenol blue7. Lipid by Sudan black B method8. DNA by Feulgen method and RNA by methyl green pyronin Y |
| | Recommended Textbooks and References: <ol style="list-style-type: none">1. Kuby Immunology, J. Punt, S. Stanford, P. Jones, J.A. Owen, 8th Edition2. Understanding Immunology, P. Wood, 02nd Edition3. Basic Immunology, A.k. Abbas, A.H. Lichtman, 3rd Edition4. Clinical Immunology Principles and Practices, R.R. Rich, 04th Edition, Elsevier Publisher5. Essential Clinical Immunology, J.B. Jabrskie, Cambridge |

Semester-Three

ZOOL E 302

Entomology

Credits



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 acquainted with the different means of insect-pest management. They will also learn about the different application techniques of insecticides, and its management.

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| 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 apiculture2. 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 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 | <ol style="list-style-type: none">1. Social behaviour in Insects2. Physiology and mechanism of Compound vision3. Insect Hormones with special reference to Pheromones4. Thermoregulation in Insects |
| | Recommended Textbooks and References: <ol style="list-style-type: none">1. The Insects: An Outline of Entomology, P.J. Gullan, P.S. Cranston2. General Text book of Entomology, O.W. Richard, R.G. Davies, Part I & II3. 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, India6. 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



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 for their experimental purposes. The students also have clear understanding of data and its analysis that will help them in pursuing higher studies.

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| Unit I Microscopy, Centrifugation, Chromatography Lectures:16 | <ol style="list-style-type: none">1. Light and Electron microscopy2. Centrifugation3. Affinity chromatography (Paper and TLC)4. Adsorption chromatography (Ion exchange and Gel) |
| Unit II Spectroscopy and Radioisotope techniques Lectures:16 | <ol style="list-style-type: none">1. UV/Vis Spectrophotometry2. Autoradiography3. Immunodiffusion4. Application of Radioisotopes in Biology |
| Unit III Biostatistics-I Lectures:16 | <ol style="list-style-type: none">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 data3. 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. Confidence Intervals, Statistical Hypothesis Testing, significance level, p value, Relationship between Confidence Intervals and Statistical Significance, difference between parametric and non parametric test2. Student's t test, F test and ANOVA test (one way and two way), Chi- square test3. Probability distributions- Normal, Binomial and Poisson4. Simple correlation and Regression |
| | Recommended Textbooks and References: <ol style="list-style-type: none">1. Modern Spectroscopy, JM Hollas, Willey Publication2. Molecular Structure and Spectroscopy, G. Aruldash3. Experimental Biochemistry, Wilson and Walker4. Fundamental of light microscopy and electronic Imaging, Douglas Murphy5. Introductory biostatistics, C.T. Le, L.E. Eberly, John Wiley & Sons6. Biostatistics: A methodology for the health sciences, G. van Belle, L.D. Fisher, P.J. Heagerty, T. Lumley, Vol. 519, John Wiley & Sons7. Intuitive biostatistics: A nonmathematical guide to statistical thinking, H. Motulsky, Oxford University Press, USA |

Semester-Three

ZOOL P 305

Laboratory course work-III

Credits



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

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| Instrumentation, Biostatistics, Immunology, Histochemistry and Entomology | <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 methodb) Carbohydrate by PAS & toluidine blue methodc) Lipid by Sudan Black B method2. Identification with comments on histochemical slides3. Demonstrations of Electrophoresis4. Demonstrations of PCR5. Demonstration of Chromatography6. Demonstration of Centrifugation7. Demonstration of Spectrophotometer and Quantification of protein using Biuret method, lowry method8. Quantitive measurement of Biomolecules using Spectroscopy9. Tabular and Graphical presentation of Data using Excel and minitab10. Hypothesis testing-student t-test, F-test, NOVA test, Chi-Sqaure test,11. Practical related to simple correlation and regression analysis12. Demonstration of Blood group and Rh Antigen13. Permanent Slide of thymus and spleen14. External features of available field collected insects15. Methods of collection and preservation of insects16. Wing venation, types of wings and winf coupling apparatus17. Types of insect antenna, mouth parts and legs18. Insecticidal efficacy test |
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Semester-Three

ZOOL CT 300

Conservation


Biology*

Credits



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.

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| <p>Unit I Basic Concepts Lectures:16</p> | <p>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</p> |
| <p>Unit II Measuring Biodiversity Lectures:16</p> | <p>Alpha, Beta and Gamma diversity , Species Richness(S), Evenness(E) , Simpson index(D), Shannon-Weiner Index (H'), idea on biodiversity calculator software</p> |
| <p>Unit III International and National efforts for conserving biodiversity Lectures:16</p> | <p>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</p> |
| <p>Unit IV Conservation Measures and Molecular Phylogeny Lectures:16</p> | <p>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</p> |
|  | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 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



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.

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| 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 |
|  | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none">1. SA Lanham-New, TR Hill, AM Gallagher, HH Vorster, Introduction to human nutrition, 3rd Ed, Willey Blackwell2. MJ Gibney, HH Vorster, FJ Kok, Introduction to human nutrition, Willey Blacwell Publishing3. SR Mudambi, MV Rajagopal, Fundamental Food Nutrition and Diet Therapy, New Age International Publishers4. 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



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.

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| <p>Unit I Cytogenetics-I Lectures:16</p> | <ol style="list-style-type: none"> 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 |
| <p>Unit II Cytogenetics-II Lectures:16</p> | <ol style="list-style-type: none"> 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 |
| <p>Unit III Metabolic Disorders Lectures:16</p> | <ol style="list-style-type: none"> 1. Biochemistry of inherited and metabolic disorders: Phenylketoneuria, Alkaptonuria, Albinism 2. Neurochemical associated diseases: Alzheimer's disease, Parkinson's disease 3. Human nutrition and associated hazards 4. Molecular mechanism of senescence |
| <p>Unit IV Stress Physiology Lectures:16</p> | <ol style="list-style-type: none"> 1. Concept of Biological stress and strain 2. Stress adaptation- Resistance, stress tolerance, Acclimation and acclimatization 3. Stress associated disorders 4. Oxidative stress |
|  | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> 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



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

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| 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 Cancer Biology-I Lectures:16 | <ol style="list-style-type: none">1. Difference between normal cells and cancerous cell, Proto-oncogene, tumor suppressor genes and care taker genes2. 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, P²¹ and P16. |
| Unit III Cancer Biology-II Lectures:16 | <ol style="list-style-type: none">1. Limitless replicating potential: Metastasis, and Angiogenesis2. Apoptosis and Evasion of Apoptosis3. Self sufficiency in growth signal, and Insensitive to antigrowth signals4. Possible treatment of cancer: Radiation and chemotherapy |
|  | <p>Recommended Textbooks and References:</p> <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 Edition |

Semester-Four

ZOOL E 403


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 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 enterpreneurship skills and advance molecular tools techniques.

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| <p>Unit I Applied Genetics Lectures:16</p> | <ol style="list-style-type: none"> Human gene mapping- Physical mapping & map-based cloning, molecular markers in genome analysis (RFLP, AFLP, RAPD) Ribozyme technology and its application Cell and tissue culture methods for animals Transgenic animals, molecular approaches to diagnosis and strain identification. |
| <p>Unit II Applied Microbiology Lectures:16</p> | <ol style="list-style-type: none"> Microbial fermentation and production of small and macro molecules, Elementary Ideas of antibiotics (Classification and resistance) Genomics and its application to health and agriculture, including gene therapy. Biosensors, Bioterrorism (causative agents and consequences). |
| <p>Unit III Nanotechnology Lectures:16</p> | <ol style="list-style-type: none"> Nanotechnology- Break through an introduction Application of Nanotechnology, Bucky balls, Bucky tubes and their applications, Nanotechnology in drug delivery |
| <p>Unit IV Ecotechnology Lectures:16</p> | <ol style="list-style-type: none"> Solid waste management Biofertilizers Vermicomposting Biopesticide |
| <p>Unit IV Molecular Techniques Lectures:16</p> | <ol style="list-style-type: none"> Isolation of Genomic and plasmid DNA Polymerase Chain Reaction and its applications DNA, Protein sequencing methods Blotting techniques |
|  | <p>Recommended Textbooks and References:</p> <ol style="list-style-type: none"> Lewin's Genes X, J.E. Krebs, E.S. Golstein, S.T. Kilpatrick, Volume 10, Jones and bartlet Publishers 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 Microbiology Principles and Explorations, J.G. Black, L.J. Black, 9th Edition, Willey Publishers Prescott's Microbiology, J. Willey, K. Sandman, D. Wood, 11th Edition Basic Principles of Nanotechnology, W.C. Sanders, CRC Press Introduction to Nanotechnology, C.P. Pools, F.J. Owens, Willey Publishers A handbook of Nanotechnology, U. Kumar Nanophysics and Nanotechnology, E.L. Wolf, Willey Publications |

Semester-Four

ZOOL E 404

Developmental Biology and Radiation Biology

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 Radiation Biology with special emphasis on different radiation sources, its health impact, use of radiation in controlling pest and its role in inherited diseases.

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

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| Unit I Developmental Biology-I Lectures:16 | <ol style="list-style-type: none">1. Gonads structures (Testis and Ovary)2. Synthesis and action of male hormones3. Synthesis and action of female hormones4. Female reproductive/gonadial cycle |
| Unit I Developmental Biology-II Lectures:16 | <ol style="list-style-type: none">1. Structure of gametes (Male and Female)2. Gametogenesis and it's regulation3. Molecular mechanism of fertilization4. Cleavage and its pattern |
| Unit II Developmental Biology- III Lectures:16 | <ol style="list-style-type: none">1. Basic experiments of developmental biology2. 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 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 units2. 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 technique4. Radiation induced heritable diseases |
| | Recommended Textbooks and References: <ol style="list-style-type: none">1. Developmental Biology, S.F. Gilbert2. Introduction to Embryology, B.L. Balinsky3. The Logic of Scientific discovery, K. Popper4. Understanding Radiation Biology from DNA Damage to Cancer and Radiation Risk, K.H. Chadwick5. Essentials of Radiation Biology and Protection, S. Foshier |

Semester-Four

ZOOL D 405

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.

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| 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. |

Semester-Four

ZOOL AC 406

Cultural Heritage of South Odisha

Credits



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| 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 |