# Syllabus
## MSc Zoology
### SEMESTER-I (ODD)
#### A. HARD CORE COURSES
<table>
<thead>
<tr>
<th>Course No</th>
<th>Course Title</th>
<th>Lectures</th>
<th>Credits</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo-101</td>
<td>Non Chordates, Biosystematics and Taxonomy</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Zoo-102</td>
<td>Cell Biology and Genetics</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-103</td>
<td>Physiology, Histology and Histochemistry</td>
<td>40</td>
<td>4</td>
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</tr>
<tr>
<td>Z00-104</td>
<td>Techniques and Instrumentation, Statistics and Computer application in Biology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-105</td>
<td>Practical related to theory papers</td>
<td>60</td>
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**Total Marks-500, Credits-22**

### SEMESTER-II (EVEN)
#### A. HARD CORE COURSES
<table>
<thead>
<tr>
<th>Course No</th>
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<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo-201</td>
<td>Biophysics, Biochemistry and Molecular Biology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Zoo-202</td>
<td>Microbiology and Immunology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-203</td>
<td>Endocrinology and Reproductive Physiology</td>
<td>40</td>
<td>4</td>
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</tr>
<tr>
<td>Z00-204</td>
<td>Environmental Biology and Wildlife</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-205</td>
<td>Practical related to theory papers</td>
<td>60</td>
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**Total Marks-500, Credits-23**

### SEMESTER-III (ODD)
#### A. HARD CORE COURSES
<table>
<thead>
<tr>
<th>Course No</th>
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<th>Lectures</th>
<th>Credits</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo-301</td>
<td>Chordates, Evolution and Paleo-Zoology</td>
<td>40</td>
<td>4</td>
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</tr>
<tr>
<td>Zoo-302</td>
<td>Economic Zoology and Aquaculture</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-303</td>
<td>Developmental Biology</td>
<td>40</td>
<td>4</td>
<td>100</td>
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<tr>
<td>Z00-304</td>
<td>Animal Behaviour and Adaptive Physiology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-305</td>
<td>Practical related to Theory papers</td>
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**Total Marks-500, Credits-23**

#### C. ALLIED ELECTIVE COURSE (Any two to be opted by students of allied subjects, i.e., Anthropology, Biotechnology, Botany, Chemistry, Physics, Statistics)
<table>
<thead>
<tr>
<th>Course No</th>
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<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>ZAC-1</td>
<td>Biology of Reproduction</td>
<td>40</td>
<td>4</td>
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</tr>
<tr>
<td>ZAC-2</td>
<td>World of Microbes</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>ZAC-3</td>
<td>Wildlife</td>
<td>40</td>
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**Total Marks-200, Credits-8**

#### D. FREE ELECTIVE COURSE (Any one open to students of all P.G. Departments)
<table>
<thead>
<tr>
<th>Course No.</th>
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<th>Credits</th>
<th>Marks</th>
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<tbody>
<tr>
<td>ZFC-1</td>
<td>Conservation Biology and Biodiversity</td>
<td>40</td>
<td>4</td>
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<tr>
<td>ZFC-2</td>
<td>Genetic Disorders and Genetic Counseling</td>
<td>40</td>
<td>4</td>
<td></td>
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<tr>
<td>ZFC-3</td>
<td>Human Physiology</td>
<td>40</td>
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</table>

**Credits-4**
B. CORE ELECTIVE COURSES (If more than one of these courses are offered in a year, a student is required to choose only one, i.e., ‘a’ or ‘b’ or ‘c’ or ‘d’)

Semester-IV (EVEN)
a) Applied Zoology and Biotechnology

<table>
<thead>
<tr>
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<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zoo-401a</td>
<td>Molecular Biology, Genetic Engineering and Biotechnology</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-402a</td>
<td>Microbial Biotechnology and Microbial Ecology</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Zoo-403a</td>
<td>Animal development and Neurobiology</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-404a</td>
<td>Conservation Biology and Environmental Biotechnology</td>
<td>40</td>
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<tr>
<td>Z00-405a</td>
<td>Practical related to theory</td>
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</table>

b) Organismic Biology

<table>
<thead>
<tr>
<th>Course No</th>
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<th>Lectures</th>
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<th>Marks</th>
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</thead>
<tbody>
<tr>
<td>Zoo-401b</td>
<td>Structure and Function of Vertebrates</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-402b</td>
<td>Population Genetics and Evolution</td>
<td>40</td>
<td>4</td>
<td>100</td>
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<tr>
<td>Zoo-403b</td>
<td>Environmental Biology and Toxicology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-404b</td>
<td>Statistics in Biology and Population Ecology</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-405b</td>
<td>Practical related to theory</td>
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c) Cell Biology

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Zoo-401c</td>
<td>Molecular Biology and Genetic Engineering</td>
<td>40</td>
<td>4</td>
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</tr>
<tr>
<td>Z00-402c</td>
<td>Microbial ecology and Microbial Biotechnology</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Zoo-403c</td>
<td>Animal Development and Vertebrate Immune System</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-404c</td>
<td>Cellular and Integrative Neurobiology, Environmental Biotechnology</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-405c</td>
<td>Practical related to theory</td>
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</table>

d) Medical Entomology (This paper is proposed to run at RMRC, Bhubaneswar subject to willingness and approval by Director, RMRC)

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</thead>
<tbody>
<tr>
<td>Zoo-401d</td>
<td>Morphology, Taxonomy and Biodiversity of Vectors</td>
<td>40</td>
<td>4</td>
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<tr>
<td>Z00-402d</td>
<td>Arthropods of Public Health Importance</td>
<td>40</td>
<td>4</td>
<td>100</td>
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<tr>
<td>Zoo-403d</td>
<td>Epidemiology and Biostatistics</td>
<td>40</td>
<td>4</td>
<td>100</td>
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<tr>
<td>Z00-404d</td>
<td>Control of Vector of Public Health Importance</td>
<td>40</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Z00-405d</td>
<td>Practical related to theory</td>
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</tbody>
</table>

Total Marks-500, Credits-22

Grand Total Marka-2200
Credits-102
Core papers

Zoo - 101 NON-CHORDATES, BIOSYSTEMATICS AND TAXONOMY

Non-Chordates
Unit-I
Unit-II

Biosystematics and Taxonomy
Unit-III
Definition and basic concepts of Biosystematics and Taxonomy, Historical resume of systematics, Importance and applications of biosystematics in biology, Materials basis of biosystematics: different attributes. Trends in biosystematics - concepts of different conventional and newer aspects like Chemotaxonomy, Cyto-taxonomy and Molecular taxonomy.
Unit-IV
Dimensions of speciation and taxonomic characters, Species concepts - species category, different species concepts, sub-species and other intraspecific categories and Theories of biological classification, Hierarchy of categories.
Unit-V

Zoo - 102 CELL BIOLOGY AND GENETICS

Cell Biology
Unit-I

Unit-II Cytoskeleton: Micro filaments and microtubules - structure and dynamics, Microtubules and Mitosis. Structure and function of cilia and flagella, Structure, orientation and behaviour of chromosomes, Cell Cycle, Cell signaling.

Unit-III Cell cloning and its application (Origin, Development and Future prospect), Genetic analysis in cell biology, Testing of genetic toxicity, Various experimental methods of harvesting of Cells (testes, bone marrow), Preparation of chromosomes and analysis.
Genetics
Unit-IV
Laws of heredity, Co-and incomplete dominance, Gene linkage, Varieties of Gene expression - lethal genes, multiple alleles, pleiotropic genes, gene interactions, epistasis, structural and numerical alterations of chromosomes and meiotic consequences, Cytoplasmic inheritance: Sex-chromosome systems; Different mechanisms of sex determination in animals (Drosophila, Man, Bees and Bonellia).

Unit-V
Human genetics - Chromosomal disorder, Some common human syndromes, Twin study, Superfoetation, Polyembryony, Free Martin, Multiple birth, Genetic counselling, Amniocentesis, Nature and function of genetic material, Chemical compounds causing genetic damage, Gene mapping and genome analysis.

Zoo - 103 PHYSIOLOGY, HISTOLOGY AND HISTOCHEMISTRY

Physiology
Unit-I
Transport across cell membrane Composition of blood, Blood groups and mechanism of blood coagulation, The lymphatic system.

Unit-II
Pulmonary ventilation, Respiratory surface and Gas exchange, Regulation of respiration, Transport of gases, Acid-base balance, Secretory system: Urine formation, Glomerular filtration, Tubular function, Renal mechanism of concentrating and diluting urine.

Unit-III
Osmoregulation-Fresh water, Marine and terrestrial invertebrates and vertebrates Nutrition-macro and Micro-nutrients, Diversity in vertebrate digestive structures, Vitamins.

Histology
Unit-IV
Basic requirement of a histological preparation Epithelial tissue: Classification, types of epithelial tissues and their function, Connective tissue: Classification, types of connective tissue and their functions, Bone and Cartilage.

Histochecmistry
Unit-V
Basic requirements of a histochemical test: General principles of demonstration of carbohydrates, lipids, protein and nucleic acids, Enzyme histochemistry: its important considerations, principles of demonstration of enzymes: dehydrogenases, esterases and phosphatases, Affinity histochemistry.

4
Zoo - 104 TECHNIQUES, INSTRUMENTATION, STATISTICS AND COMPUTER APPLICATION IN BIOLOGY

Unit-I

Unit-II
Instrumentation and Techniques-II Centrifugation: Principle of sedimentation, Methods in preparatory ultracentrifugation (Differential and density gradient Centrifugation), Chromatography: Principle and application of molecular exclusion chromatography, Ion exchange chromatography, Affinity chromatography, Gas-liquid chromatography and HPLC. Electrophoresis: Principle and application of electrophoretic separation, Types of solid support used (Cellulose acetate, Starch, Agar, Agarose and PAGE) and its importance, Isoelectrofocussing.

Unit III

Unit-IV Biostatistics*
Definition and scope of biostatistics, Measures of central tendency (Mean, Median, Mode), Measures of dispersion, Coefficient of variation, Equation and graphs of linear and exponential relation, Elementary idea about probability, Normal, Poisson, Binomial distribution, Tests of significance (t and chi-square tests), Simple correlation; Sampling techniques (Random sampling etc.), Analysis of variance (single factor design and their application to Zoology).

Unit-V Computer application**
Introduction to digital computers, Low-level and High-level languages, Binary number system, Flow charts and programming techniques, Introduction to MS-Office software (word processing, spreadsheets and Presentation software), Introduction to internet and its applications.

* Two questions from Biostatistics in theory.
** Questions from Computer application shall not be asked in theory paper. However, one question on the same may be set in the practical examination (105).
Z00 - 201 BIOPHYSICS, BIOCHEMISTRY AND MOLECULAR BIOLOGY

Unit-I

Biophysics
Concept of biomolecules: Chemical composition and bonding, three dimensional structure, Chemical reactivity, macromolecules and their monomeric submits, Weak interactions in aqueous system, ionization of water, weak acids, weak bases, buffers and buffering capacity, Principle of bioenergetics : Bioenergetics and thermodynamics, phosphoryl group transfers and ATP, Biological oxidation-reduction reactions.

Unit-II

Carbohydrates : Classification, Glycoconjugates (Proteoglycans, Glycoproteins and Glycolipids)
Lipids : Storage lipids, structural lipids in membranes, lipids as signals, cofactors and pigments Coenzymes and vitamins.

Unit-III

Biochemistry-II Enzymes : Nomenclature, Classification and properties, kinetics and mechanism of action (carboxypeptidase), Regulation (allosteric, phosphorylation and proteolytic cleavage), Metabolism of amino acids : Transamination, oxidative deamination and urea cycle.

Unit-IV


Unit-V Molecular Biology Physicochemical properties of nucleic acids, DNA double helical structure, types, structural peculiarities, size, sequence, organization in chromatin, supercoiling, sequencing methods of nucleic acids, DNA replication and repair, Types of RNA, mRNA synthesis, mRNA processing, RNA dependent synthesis of DNA, Genetic code, Protein synthesis.

Zoo - 202 MICROBIOLOGY AND IMMUNOLOGY

Microbiology

Unit-I
Introduction : Concept of microbiology, Microbes and man, History of microbiology, Divisions of Microbiology, Microscopy, Microscopic units, Microbial culture, Pure culture, Subculture, Stains of microbes. Structural organisation: Prokarytic microorganisms, Structural details of prokaryotic cell. Difference between prokaryotic and eukaryotic cell, Eukaryotic microbes (Protozoa). Structure of bacteria , virus (Bacteriophage) and multiplication (Lytic cycle and Lysogenic cycle).

Unit-II
Microbial genetics : Concept of genetic recombination of bacteria, Transformation, Transduction and Sexduction (Conjugation). Application and importance of microbiology : Bacterial diseases of man (Microbes in air, water and soil), Airborne, Foodborne, Waterborne, Soilborne, Sexually-transmitted and contact diseases), Viral diseases of man, Industrial microbiology, Biomineralization (Microbial leaching).
Immunolgy
Unit-III
Innate and adaptive Immunity: Organization and Structure of lymphoid organs, Antigens and Antibodies, Antigen-antibody reaction, Structure of immunoglobulins.

Unit-IV
Humoral and cell mediated immunity, Regulation of immune response, Major histocompatibility complex and HLA system, Complement and its action.

Unit-V
Immunological aspects of transplantation, Autoimmunity, Immunotolerance, Hypersensitivity concept, Vaccines, Interferons and Episomes.

Zoo - 203 ENDOCRINOLOGY AND REPRODUCTIVE PHYSIOLOGY

Endocrinology
Unit-I
Chemical messengers, Hormones and their feedback systems, Mechanisms of hormone action (Fixed membrane - and mobile-receptor mechanisms), Receptor signal transductions, Techniques in endocrinology (Bioassay and Radioimmunoassay) Pineal, Thymus and Gastrointestinal hormones Anatomy, Chemistry, Assay and Biological action of adenohypophysial and neurohypophysial hormones, Pituitary pathophysiology.

Unit-II
Hypothalamic control of adenohypophysial function, Neuroendocrine system and neurosecretion Clinical aspects of the hypothalamo-hypophysial system Thyroid gland: Anatomy, biosynthesis and function of thyroid hormones, Antithyroid agents and control of thyroid secretion, Parathyroid gland : Anatomy, Regulation of secretion and function of parathyroid hormone.

Unit-III

Reproductive Physiology
Unit-IV
Structure of male reproductive system, Testicular events and biosynthesis of testosterone, Structure of sperm, Biochemistry of semen, Capacitation of spermatozoa, Structure of female reproductive system, Folliculogenesis, Ovulation, Luteinization, Estrous cycle, Menstrual cycle, Menopause, Major endocrine disorder-related to reproduction, Endocrinology of implantation, Parturition, Role of hormones during pregnancy, Endocrinology of lactation.

Unit-V
Steroids and their biosynthesis, Steroid hormones and brain differentiation, Transport of steroid hormones in blood, Metabolism and excretion of steroid hormones, Sterility, its causes and control, Artificial insemination, in vitro fertilization and embryo transfer. Fertility control, Contraception: Natural and chemical methods, Oral contraception, Contraceptives of future.
Environmental Biology

Unit-I
Ecosystem: Component parts, energy sources and Energy flow in ecosystems, Food chains and Food webs, Trophic levels, Ecological Pyramids, Ecological niche, Ecological factors (temperature and light), Carbon and Nitrogen cycle, Resource Biology: Classification of resources, Non-renewable resources,- Mineral resources, Renewable resources.

Unit-II
Ecological succession, Microbes in decomposition and recycling process, Aquatic biology, Physiochemical and biological properties of water, Primary productivity.

Unit-III
Environment pollution : Air pollution, Water pollution, Soil Pollution, Noise pollution, e-pollution, Solid waste pollution, Ozone layer depletion, Hazardous wastes and Toxic chemicals, Acid rains, Green house effect, Global warming.

Wildlife

Unit-IV
Biography of India with reference of distribution of animals Rare and endangered species of India, Wildlife in Odisha.
(a) Mammals : Blackbuck, Bison, Swamp deer, Wild buffalo, Elephant, Lion, Indian rhinoceros, Tiger, Wild ass, Dugong.
(b) Birds : Horn bills, Pea fowl, White winged duck, Pink headed duck, Jerdon's cursor.
(c) Reptiles: Gavialis gangeticus, Crocodilus porosus, Crocodilus palustris, Monitor lizards Olive Ridley sea turtle, Indian python.
Threatened species of mammals of India, General methods of wildlife census, Wildlife Sanctuaries, National Parks, Biosphere Reserves and Zoos.

Wildlife Conservation

Unit-V
Crocodile conservation in India, Sea turtle conservation in India, Project tiger in India, Elephant conservation in India, Wildlife (Protection) Act of Government of India (1972), Forest Conservation Act (1980).

Zoo - 301 CHORDATES, EVOLUTION AND PALEOZOOLOGY

Chordates

Unit-I

Unit-II
Evolution
Unit-III
Evolutionary evidences and theories, Variation and selection as underlying mechanisms of evolution, Types and rates of mutation in population, Mechanism of isolation, Origin of species.

Unit-V
Evolutionary trends (micro, macro and mega patterns of evolution), Molecular and genomic evolution, Gene flow, Gene duplication and mosaic evolution, Modes of specification, Biological and Cultural evolution of man.

Palaeozoology
Unit-V
Survey of life through different geological era, Structure and affinities of trilobite, Evolution of camel and elephant, Formation and types of fossils.

Zoo - 302 ECONOMIC ZOOLOGY AND AQUACULTURE

Economic Zoology
Unit-I
Insects of commercial importance, Silkworm and sericulture, Honey bee and apiculture, Lac insect and lac culture, Insect pests of medical and veterinary importance with special reference to mosquitoes, flies, lice and ticks.

Unit-II
Insect pests of some major crops (rice, wheat, oilseeds, pulses and vegetables) Pests of stored food products and their control, Wetland resources. Earthworm and soil fertility, Economic importance of mollusks.

Aquaculture
Unit-III
Classification of fishes upto Orders, Ecology and productivity of fish ponds: Ecology and physical conditions, Biological conditions of water, Aquatic vegetation. Plankton, Chemical conditions of soil, Weeds and their control, Acid rain.

Unit-IV
Induced breeding, Bundh breeding, Fish seed trade, Fish Culture, Air breathing fishes, Composite fish culture, Pearl culture, Prawn farming, Sewage fed fisheries, Effects of pollutants on fish and fish food organisms.

Unit-V
Fish in relation to public health, Fish pathology, Parasitic infection and non-parasitic infection, Various types of nets. Traps, Crafts used in India, Electrofishing, Light fishing, Fish finding (Echosounder and sonar ) Post-harvesting technology: Freezing, Canning, Marketing and Fish farm management.
Zoo - 303 DEVELOPMENTAL BIOLOGY

Unit-I

Unit-II
Gametogenesis: Spermatogenesis, Oogenesis, Fertilization: morphological aspects, Biochemical events of fertilization.

Unit-III
Embryonic adaptations: Placentation and implantation in mammals, Biochemical aspects of placentation.
Organogenesis: Embryonic induction, Movement of cells over long distance (Neural crest and primordial germ cells).

Unit-IV
Growth: Growth at cellular and intracellular level, Growth at organismic level and Growth curves.
Regeneration: Regeneration in invertebrates and vertebrates, Role of nervous system in regeneration.

Unit-V
Metamorphosis: Biochemical aspects of metamorphosis in insects and amphibians, Nucleocytoplasmic interactions, Nuclear transplantation in vertebrate embryos, Homeotic genes and homeotic transformation in anuran tadpoles.

Zoo - 304 ANIMAL BEHAVIOUR AND ADAPTIVE PHYSIOLOGY

Animal Behaviour
Unit-I
Ethology as a branch of biology, Classification and analysis of behaviour patterns, Methods of behavioural study, Studies in nature or wild, Studies in laboratory, Neural and hormonal control of behaviour, Mammalian nervous system and behaviour.

Unit-II
Hormones and behaviour, Pheromones and behaviour, Biological rhythms, Circadian clock, Circannual clock, Orientation and Navigation, Migration of fish, Migration of bird.

Unit-III
Ecological aspects of behaviour, Habitat selection, Food selection, Aggression, Homing, Territoriality, Mimicry, Host parasite relation, Social behaviour, Aggression - Schooling in fish, Flocking birds, Herding in animals, Social organisation in insects and primates, Reproductive behaviour, Courtship, Mating systems, Mating groups, Parental care.

Adaptive Physiology
Unit-IV
Adaptation: Mechanisms of adaptation, Physiological adaptations in different environments. Freshwater, Ecological factors (Temperature and light), Parasitic, Stress Physiology, environmental stress and strain, Stress resistance, Stress avoidance and Stress tolerance.

Unit-V
Adaptation, Acclimation and Acclimatization, Homeostasis, Physiological adaptation to osmotic and ionic stress, Mechanism of cell volume regulation, Osmoregulation in aqueous environment, Physiological response to oxygen deficient stress.
ALLIED ELECTIVE COURSE (ZAC-1)
BIOLOGY OF REPRODUCTION

Unit I
Gametes formation and their functions
  1. Gametogenesis
  2. Hormonal control of gametogenesis
  3. Puberty and adolescence
  4. Menopause

Unit II
Physiology of male reproduction
  1. Male sex hormones
  2. Sperm maturation
  3. Chemistry of semen
  4. Significance of seminal plasma

Unit III
Physiology of female reproduction
  1. Female sex hormones
  2. Ovulation and fertilization
  3. Implantation and pregnancy
  4. Labor and parturitions

Unit IV
Infertility/sterility
  1. Causes of infertility in men
  2. Management of infertility in male
  3. Causes of sterility in women
  4. Management of sterility in female

Unit V
Assisted Reproductive Technologies (ART)
  1. Artificial insemination
  2. In – vitro fertilization
  3. Embryo Transfer
  4. Test-tube babies
ALLIED ELECTIVE COURSE (ZAC-2)
THE WORLD OF MICROBES

Unit I
1. Microbial ecology and concept of microbes
2. History of microbes
3. Scientific contribution in microbiology
4. Microbes in daily life

Unit II
1. Microbes and humans
2. Protozoan diseases in humans
3. Bacteria, types and structure
4. Bacteria in air and water

Unit III
1. Bacterial diseases of humans
2. Viral diseases of humans
3. Virus, types and structure
4. Parasitic worms of human body

Unit IV
1. HIV and AIDS
2. Sexually transmitted diseases (STDs)
3. Microbes in the soil
4. Infection, disease and types of diseases

Unit V
1. Microbiology of food, milk and dairy products. (Pasteurized milk, butter milk, Yoghurt, Cheese )
2. Industrial microbiology (Beer, Wine, Vinegar, Vitamins, Antibiotics)
3. Vaccine, Toxin and Antibiotics
4. Drugs and medicines and their effect
ALLIED ELECTIVE COURSE (ZAC-3)
WILDLIFE

Unit I
Biology of Indian Wildlife
1. Distribution of Wildlife in India
2. Rare and endangered species of Odisha (Mammals, Birds, Reptiles)
3. Conservation education on wildlife
4. Ethics and wildlife conservation

Unit II
Conservation of Wildlife in Odisha.
1. Crocodile
2. Sea turtle
3. Tiger
4. Elephant

Unit III
Anima, laws and policies in India
2. Wildlife (Transaction and Taxidermy) Rules, 1974
4. Major International Agreements (CITES, CBE, ITTA, UNFCCC etc.)

Unit IV
Protected areas and wildlife.
1. Keystone species
2. Biodiversity Hot Spots in India, Wetland Biodiversity
3. Zoos, wild life sanctuaries of Odisha. National parks and biosphere reserves
4. Organizations in wildlife conservation (BNHS, IUCN, WWF, SITES etc.)

Unit V
Wildlife health and Ecotourism
1. Management of wildlife health programme
2. Zoonoses
3. Ecotourism – a world wide view
4. Ecotourism in Indian context (case studies)
FREE ELECTIVE COURSE (ZFC-1)
CONSERVATION BIOLOGY AND BIODIVERSITY

Unit I
Conservation Biology and Biodiversity: a prologue
1. Role of Science in conservation Biology
2. Species and speciation
3. Extinct Species
4. Ethics and conservation

Unit II
Threats to Biological Diversity
1. Biodiversity Distribution
2. Over exploitation
3. Habitat destruction
4. Alien species

Unit III
Protected areas.
1. Wild life sanctuaries
2. National parks
3. Biosphere reserves
4. Wildlife corridors

Unit IV
Restoration Biology
1. Ecological restoration
2. Conservation strategies (in situ and ex situ)
3. Single species conservation
4. Conservation Laws

Unit V
Community based conservation
1. Community conservation partnership
2. Community conservation conflict
3. conservation management, Case studies
4. Bio- adoption
FREE ELECTIVE COURSE (ZFC-2)
GENETIC DISORDERS AND GENETIC COUNSELLING

Unit I
1. History and genesis of genetics
2. Genetics in relation to other sciences
3. Practical applications of genetics
4. Genetics and the animal world

Unit II
1. Genetics and terms associated with it
2. Mendel’s experimental approach
3. Monohybrid, Dihybrid and Polyhybrid cross
4. Mendel’s laws of inheritance

Unit III
1. Biological significance of Mendel’s laws
2. Hybrid vigour (Heterosis), Gene penetrance, Expressivity and Pleiotropism
3. Blood groups
4. Polygenic inheritance, Interaction of genes

Unit IV
1. Sex determination, Function of X and Y chromosomes
2. Sex-linked inheritance, Sex-limited genes, Sex-influenced genes
3. Cloning, Environmental mutagen and health
4. Variation in chromosome number (Heteroploidy)

Unit V
1. Disorders due to somatic chromosomes (Syndromes)
2. Disorders due to sex chromosomes (Syndromes)
3. Pedigree analysis.
4. Human twins, Genetic counselling, Heredity and environment
FREE ELECTIVE COURSE (ZFC-3)
HUMAN PHYSIOLOGY

Unit I
Circulation
1. Heart as a pump
2. Cardiac output and Blood pressure
3. Blood groups
4. Blood coagulation (clotting)

Unit II
Respiration
1. Structure of human lung
2. Work of breathing
3. Oxygen transport and delivery
4. Carbon dioxide expiration

Unit III
Digestion
1. Macro and micro nutrients
2. Vitamins
3. Secretory functions of the digestive system
4. Gastrointestinal disorders

Unit IV
Excretion
1. Body fluid compartments
2. Urine formation and micturition
3. Mechanism of concentrating and diluting urine
4. Artificial kidney

Unit V
Endocrine glands
1. Pituitary – The master gland
2. Thyroid – The metabolic regulator
3. Pancreas – The diabetes on settler
4. Pineal – The third eye
Core elective (Special Paper)
Applied Zoology and Biotechnology

Zoo - 401A MOLECULAR BIOLOGY, GENETIC ENGINEERING AND BIOTECHNOLOGY

Unit-I
Molecular Biology - I
Genes and genome in prokaryotes and eukaryotes, Regulation of gene expression in Prokaryotes: Operon concept, lac-operon; trp-operon, transcription attenuation, Lytic and Lysogemic cascades.

Unit-II
Molecular Biology - II
Regulation of gene expression in eukaryotes: Types of eukaryotic promoters, DNA-binding domains and protein-protein binding domains of regulatory proteins, Signal integration and combinational control, Transcriptional repressors, Signal transduction and control of transcription and control of transcriptional regulators, Gene silencing, siRNA.

Unit-III
Genetic Engineering - I
Genetic engineering: Enzymes, Vectors, Hosts, Cloning, Gene library and cDNA library.

Unit-IV
Genetic Engineering - II
Molecular techniques in genetic engineering : Isolation of DNA and RNA from animal tissues and blood, Probes, Polymerase chain reaction, Restriction Fragment Length Polymorphism, Blotting techniques (Southern, Northern and Western), Genome sequencing (Shortgun and paired end strategies and comparative genome analysis, Study of gene expression: Transgenic and Knockout animals, Gene silencing.

Unit-V
Biotechnology
Application of biotechnology in Medicine and Health : Diagnosis of diseases, Production of Pharmaceuticals (hormones), Recombinant vaccines and Gene therapy. Forensic science, Human genome project, Enzyme and whole cell mobilization and its industrial application.

Zoo - 402A MICROBIAL ECOLOGY AND MICROBIAL BIOTECHNOLOGY

Microbial Ecology
Unit-I
Distribution of microbes in soil, water, air, milk, Food, Microorganisms of the body, Microbes in metal containing habitat, Metal-microbe interactions, Microbial immobilisation and transformation of metals, Microbial application of metal removal.

Unit-II
Microbial adaptation to contaminated environment, Microbe-petroleum (Fuels) interactions, The problems and prospects of biomining, Biofuel production with reference to microbes, Role of microbes in decomposition process and waste utilisation.
Microbial Biotechnology

Unit-III
Bioprocess technology; Isolation and screening of industrially important microbes, Strain improvement, Production of antibiotics, Beverages, enzymes, Milk product, Vaccines, Fermentation.

Unit-IV
Principles of bioreactor engineering, Bacterial cloning other than *E. coli*, Down stream processing, operations, Production of microbial insecticides and Mycoherbicides.

Unit-V
Bioconversion, Waste control, Biogas production and Bioleaching, Plant-microbe interactions and Biofertilizers, Mushroom production technology.

Zoo-403A Animal Development and Neurobiology

Animal Development

Unit-I
Morphogenetic determinants in egg cytoplasm and Role of maternal contribution in early embryonic development, Differential gene expression during development, Application of Developmental Biology in medicine, Regeneration therapy, Gene therapy (Somatic cell gene therapy, Germline gene therapy), in vitro fertilization (FVF).

Unit-II

Unit-III
Stem cells, Embryonic stem cells, Adult stem cells, Transgenic stem cells.

Neurobiology

Unit-IV
General features of neurons, Cellular organisation of neurons, Dendrites and Axon, Glial cells, Schwann cells, Nerve cells as signaling units, Cytoskeleton of the neuron - Microtubule, Microfilament, Neurofilament, Synthesis of macromolecules by nerve cells, Synthesis and trafficking of neuronal proteins: Cytosolic protein, Nuclear and Mitochondrial protein, Cell membrane and Secretory proteins, Synaptic Transmission: Structure of the synapse, Correlation of structure mid function at the synapse, Transmission across the synapse, Pre- and post-synaptic events, Electrical and chemical synapse, Excitatory and inhibitory transmission.

Unit-V
Neurotransmitters: Synthesis, Storage, Release, Neuropeptides: Mode of action, Role of neuropeptides and coexistence of neuropeptides with other neurotransmitters, Learning and Memory, CSF and Blood brain barrier, Neurodegenerative Disorders: Parkinson’s and Alzheimer’s diseases, Senile dementia, Myasthenia Gravis.
Zoo - 404A CONSERVATION BIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

**Conversation Biology**

**Unit-I**
Importance: Ethical, Asthetic, Utilitarian and Ecological, Biodiversity: Types of biodiversity, Megabiodiversity countries, Keystone species, Biodiversity Hot spots in India, *in situ* and *ex situ* conservation, Germplasm conservation, Gene bank, Frozen zoos, Cryopreservation: Cryoprotectants and their physiochemical properties, Cryopreservation of gonads, Gametes and embryos.

**Unit-II**

**Environmental Biotechnology**

**Unit-III**
Bioremediation - *in situ* and *ex-situ* Gases - Biofilters, Solid waste treatment, Waste water treatment: Aerobic treatment, Aerobic reactors (fixed film digester, tricking filter digester, rotating biological contractors and dispersed growth digesters), Microorganisms involved in aerobis treatment, Anaerobic waste water treatment and Microbial digestion.

**Unit-IV**
Bioaccumulation of toxicants, Degradation of xenobiotic compounds - Hydrocarbons, Heavy metals, Coal waste, Microbial leaching and Biomining, Biopesticides and Biofuels, Vermitechnology and Biogas production, Bioprospecting of marine organisms, Sea weeds as food, Phycocolloids and Source of pharmaceuticals for marine organisms, Probiotics and Single Cell protein (SCP).

**Unit-V**
Hormonal manipulation in advancing maturity and reproduction, Biofermentation, Development of disease resistant stock, Artificial breeding of domestic and aquatic animals, Biotechnology in biodiversity conservation, Modelling of bioreactors.
b) Organismic Biology

Zoo - 401B STRUCTURE AND FUNCTION OF VERTEBRATES

Unit-I

Unit-II
Endoskeleton - Axial and appendicular, Feeding and nutrition - Functional modification of digestive tract in relation to feeding.

Unit-III
General plan of blood circulation in various groups : Blood, Evolution of heart, Aortic arches and Portal systems, Respiratory system : Cutaneous, Gill and Lung respiration, Air sacs in birds, characters of respiratory tissue.

Unit-IV
Nervous system and sense organs : General plan of brain structure, Evolution of cerebral hemispheres and cerebellum, Comparative anatomy of brain and spinal cord, Peripheral nervous system.

Unit-V
Structural modification of uninogenital system in vertebrates, Ultrastructure of kidney, Evolution of reproductive passages.

Zoo - 402B POPULATION GENETICS AND EVOLUTION

Unit-I
Theories of organic evolution (Darwinism) Neo-Darwinism, Hardy-Weinberg law of genetic equilibrium and destabilising forces of evolution (Mutation, Genetic drift, Migration, Natural selection)

Unit-II  Genetic variability: Genetics structure of a population, Phenotypic variation, Factors affecting human diseases. Population genetics : Patterns of change in nucleotides and Amino acids, Molecular variation, Emergence of New-Darwinism

Unit-III
Genetics of quantitative traits in populations, Estimation of heritability, Genotype-environment interactions, Inbreeding depression, Phenotypic plasticity, Analysis of quantitative traits.

Unit-IV

Unit-V

Zoo - 403B ENVIRONMENTAL BIOLOGY AND TOXICOLOGY

Unit-I
Energy flow in ecosystem, Food chains Population and its characteristics

Unit-II
Environmental pollution Green house effect Biotic community and Conservation of natural resources.
Unit-III
Toxicology: Definition and classification toxic agents and their mode of action, Pesticides, Solvents, Metals, Carcinogens, Xenobiotics.

Unit-IV
Environmental Toxicology, Food additives, air, water and soil pollutants, Principles of systemic toxicology, Genotoxicology.

Unit-V
Statistical methods in toxicology, Environmental policy and Environmental impact assessment (EIA), Regulatory toxicology, Residue analysis, Human toxicology and Medical ethics.

Zoo - 404B STATISTICS IN BIOLOGY AND POPULATION ECOLOGY

STATISTICS IN BIOLOGY
Unit I
Sampling methods, Data types: qualitative – quantitative, Tables Graphs, Averages (mean, median, mode), Dispersions: range, mean deviation, variance, standard deviation, standard error, Coefficient of dispersion.

Unit II
Descriptive statistics Population sample, parameter statistic, Sampling frame, sampling unit, Methods of sampling, simple random, systematic stratified, cluster. Determination of sample size, Binomial Poisson, Negative binomial, Normal distribution.

Unit III.
Applied statistics Level of significance: type I, type II errors, Null and alternative hypotheses, Chi-square tests, t-tests, ANOVA (one and two way), Correlation and Regression. Scatter diagram, Pearson’s correlation coefficient, rank correlation, least square regression, profit analysis, calculation of Lc50/Lc90 values.

Population Ecology
Unit-IV
Population growth: Exponential growth, Verhulst growth models, Case studies (Field and Laboratory), Stochastic and Time lag models of population growth, Stable age distribution, Predation: Models of pray-predatory dynamics, Optional foraging theory (patch choice, diet choice, prey selectivity, foraging time), Role of predation in nature.

Unit-V
Competition and Niche theory: Intra-and Intera specific competition, Niche concept, Theory of limiting Similarity, Extrinsic and Intrinsic mechanisms of population regulation.
c) Cell Biology

Zoo - 401C MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Unit-I
Basic concepts on genes and genome, Regulation of gene expression in prokaryotes, Structure of prokaryote gene, DNA - binding domains and protein to protein binding domains of regulatory proteins, Operon concept, Lac-operon, trp-operon, ara-operon, Transcription attenuation, Lytic and Lysogenic cascades.

Unit-II
Regulation of gene expression in eukaryotes : Types of eukaryotic genes, Eukaryotic promoters, Transcription factors, Transcription activators, Regulation of galactose metabolism in yeast, Intracellular and intracellular signals that regulate eukaryotic gene expression.

Unit-III
Basic concepts of genetic engineering : Enzymes, Vectors, Host, Cloning, Gene Library, cDNA expression.

Unit-IV
Molecular techniques in genetic engineering : Isolation of DNA and RNA from animal tissues and blood, Probes, Polymerase chain reaction, Restriction Fragment Length Polymorphism, Blotting techniques (Southern, Northern and Western), Genome sequencing (Shotgun and paired-end strategies and comparative genome analysis).

Unit-V
Application of biotechnology in Medicine and Health, Diagnosis of diseases such as AIDS, Tuberculosis and genetic defects such as Cystic fibrosis, Cancer, Muscular dystrophy, Production of pharmaceuticals : Hormones (Insulin, Growth hormone), Recombinant vaccines, Gene therapy, Forensic Science: DNA fingerprinting for criminal identity and Paternity testing, Disease-resistant and Transgenic plants Study of gene expression: Transgenes and Knockout animals, Gene silencing, Human genome project, Enzyme and whole cell immobilization and its industrial application.

Zoo, 402-C MICROBIAL ECOLOGY AND MICROBIAL BIOTECHNOLOGY

Microbial Ecology

Unit-I
Distribution of microbes in soil, water, air, milk, food, Microorganisms of the body, Microbes in metal containing habitat; Metal-microbe interactions, Microbial immobilisation and transformation of metals, Microbial application of metal removal.

Unit-II
Microbial adaptation to contaminated environment, Microbe-petroleum (Fuels) interactions, Problems and prospects of biomining, Biofuel production with reference to microbes, Role of microbes in decomposition process and waste utilisation.

Microbial Biotechnology

Unit-III
Bioprocess technology : Isolation and screening of industrially important microbes, Strain improvement, Production of antibiotics, Beverages, enzymes, Milk products, Vaccines, Fermentation.

Unit-IV
Principles of biocarctor engineering, Bacterial closing other than E, coli, Downstream processing operations, Production of microbial insecticides and mycoherbicides.

Unit-V
Bioconversion, Waste control, Biogas production and Bioleacting, Plant-microbe interactions and Biofertilizers, Mushroom production technology.
Unit-I
Morphogenetic determinants in egg cytoplasm and Role of maternal contributions in early embryonic development, Differential gene expression during development.

Unit-II
Organization of multicellular Embryo: Axis formation in amphibia and chick, Cellular basis of animal morphogenesis, Cytoplasmic fiber system, Cellular shape changes and epithelial folds, Mesenchyme shape change and cell mortality, Intercellular adhesion, Organogenesis: The vertebrate lens and Vertebrate limb.

Animal cell culture

Unit-III
Equipments and material for animal cell culture technology, Importance of culture media. Natural and defined media, Development and maintenance of primary cultures and established cell lines, Larges scale cultivation (Monolayer, Suspension and Microcarrier cultures, Fermentation Technology for growth of animal cells and their products), Use of embryonic tissues and embryo culture, Stem cells (embryonic and adult) their culture and their application in research and therapeutics, Hybridoma technology.

Vertebrate immune system

Unit-IV
Organization and expression Ig Gene structure, Models of Ig gene structure, Multigene organization, DNA rearrangements and mechanism, Generation of antibody diversity, Differential expression of Ig genes, BCR and TCR regeneration and diversity.

Unit-V
Immune response to infections diseases, AIDS and other immunodeficiencies, Application of immunological techniques.

Zoo- 404C CELLULAR AND INTEGRATIVE NEUROBIOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Cellular and Integrate Neurobiology

Unit-I
Neuromorphology and Neurocellular Anatomy: Anatomical organisation of Central Nervous System - General features of neurons, Cellular organisation of neurons, Dendrites and Axons, Gial cells, Schwann cells, Nerve cells as signaling units, Cytoskeleton of the neuron, Microtubule, Microfilament, Neurofilament, Synthesis and trafficking of neuronal proteins: Cytosolic protein, Nuclear and Mitochondrial protein, Cell membrane and secretory proteins.

Unit-II
Synaptic transmission and Ligand Gated Channels: Structure of the synapse, Correlation of structure and function at the synapse, Transmission across the synapse, Pre and Post synaptic events, Electrical and Chemical synapse, Transmitter gated channel and ion-gated channel, Synaptic transmission mediation by second messenger (c-AMP, c-GMP), Regulation of gene expression by second messengers, Excitatory and Inhibitory transmission, Neurotransmitters: Synthesis, Storage, Release, Sensory transduction.

Unit-III
Neuropeptides: Mode of action, Role of neuropeptides and Coexistence of neuropeptides with other neurotransmitters Learning and Memory, Hypothalamus and Limbic system: Homeostasis and Emotional behaviour, CSF and Blood-brain barrier, Neurodegenerative Disorders: Parkinson's and Alzheimer's diseases, Senile dementia, Myasthenia Gravis.
Environmental Biotechnology
Unit-IV
Unit-V
Cryopreservation of gametes and embryos, Hormonal manipulation in advancing maturity and reproduction, Biofermentation and Biofiltration, Waste utilization, Role of microbes in waste and sewage utilization, Development of disease resistant stock, Artificial breeding of domestic animals.

d) MEDICAL ENTOMOLOGY
Zoo-401D MORPHOLOGY TAXONOMY AND BIO-DIVERSITY OF VECTORS
Unit I
Morphology of medically important insects and other arthropods, Head: antenna, mouth parts, Thorax: wings, wing venation, legs, general structure, abdomen: Appendages, cerci, external genitalia.

Unit II
Taxonomic concepts and Classification of Arthropoda, Type concept, Population concept, Levels of Taxonomy: Taxonomic hierarchy; Species concept: species, infraspecific categories, sibling species, subspecies, variants within populations.

Unit III

Unit IV
Collection and preservation techniques and Biodiversity, Mosquitoes, sandflies, fleas, lices, ticks, flies, characteristics of biodiversity, Biodiversity hotspots, biosphere species documentation, Diversity indices, invasive species, Relationship between anthropogenic stressors, vector biodiversity.

Unit V.
Theory and practice of molecular taxonomy, Molecular techniques in mosquito taxonomy, RFLP-RAPD, Microsatellites, SNPs, Microarrays and DNA bar coding.

Zoo- 402D ARTHROPODS OF PUBLIC HEALTH IMPORTANCE
Unit I
Introduction to arthropods of public health importance Arthropods, diseases and epidemiological triad, vectors, pests, transmission, cyclic and secular trend of diseases.

Unit II
Arthropods as vectors of human diseases, Modes of disease transmission: vertical and horizontal transmission, biological, mechanical and contact transmission cycle, interseasonal maintenance.

Unit III
Anthroponotic diseases Malaria, filariasis, visceral leishmaniasis, onchocerciasis, trypanosomiasis, chagas diseases, scrub typhus, thick typhus, Disease vectors, distribution and transmission, socio-economic impact on human population.
Unit IV
Zoonotic diseases Cutaneous leishmaniasis, schistosomiasis, plague, Kyasanur Forest Disease(KFD), leptospirosis, dracunculiasis, Disease vectors, distribution and transmission, socio-economic impact on human population.

Unit V
Arthropods of public health nuisance and their management. Houseflies, cockroaches, lice, bugs, scorpions, centipede, millipede, wasps, bees, beetles, spiders, ants, distribution and impact on human health, toxins, venoms, allergy, asthma.

Zoo - 403D EPIDEMIOLOGY AND BIOSTATISTICS

Unit I
Principles of Epidemiology and epidemiological studies, Definition, aim and scope of epidemiology, target population, sampled population, Descriptive studies, Case reports, Case series – ecological and cross sectional studies. Analytical studies, observational (case-control, cohort), experimental (clinical/community trials), Surveillance concepts, tools and methods for vectors and disease, epidemic outbreak investigations.

Unit II
Epidemiological measures Rates, ratio, proportions(incidence, prevalence, risk difference, relative risk, odds ratio, attributable risk), Standardization of rates (direct/indirect), Association and causation (spurious, direct/indirect), Screening for disease (types and uses, sensitivity, specificity, positive and negative predictive values)

Unit III
Sampling methods, Data types: qualitative, quantitative, Tables, Graphs, Averages (mean, median, mode), Dispensions: range, mean deviation, variance, standard deviation, standard error, Coefficient of dispersion.

Unit IV.
Descriptive statistics, Population, sample, parameter statistic, Sampling frame, sampling unit, Methods of sampling: simple random, systematic, stratified, cluster, Determination of sample size, Binomial, Poisson, negative binomial, normal distribution.

Unit V
Applied statistics, Level of significance: type I, type II errors, Null and alternative hypotheses, Chi- square tests, t-tests. ANOVA (one and two way), Correlation and Regression, Scatter diagram, Pearson’s correlation coefficient rank correlation, least square regression, Profit analysis, Calculation of Lc50/Lc90 values.

Zoo-404D CONTROL OF VECTORS OF PUBLIC HEALTH IMPORTANCE

Unit I
Vector Control: Aims, objectives, goals, Importance and advantages, recent trends, Alternatives to the use of insecticides (chemical, microbial), Vector control at individual or at community or at both levels, Selection of appropriate control measures, self protection measures, Types of vector control, Selective, integrated and comprehensive vector control.

Unit II
Control of mosquitoes and flies (Black flies, Sand flies, Biting midges, Tabanids, Stable flies) Selection of suitable site specific control measures, Personal protection measures, zoonoprophylaxiz, Insecticide treated fabrics, Long lasting insecticide treated mosquito nets (LLINs), Insecticide spraying (larviciding, indoor residual spraying, space spraying), Alternatives, biological control, environmental management including source reduction.
Unit III
Control of Tsetse flies and Triatomine bugs, Tsetse fly: Prevention and control, Traps and insecticide impregnated screens, Insecticide spraying (ground and aerial), Triatomine bugs: Introduction to control measures, Application of insecticides, insecticides and formulations, House modification, improvement of peridomestic environment, insecticide treated bed nets, fumigant canisters.

Unit IV
Control of bedbugs, fleas, lice, ticks, mites and others, Bedbug Detection, repellents, household measures, insecticide treated bed nets, smoke generators, residual insecticide spraying, prevention and control of sand fleas or jigger fleas, lice (head, crab or pubic and body lice), ticks and mites, Cyclops, fresh water snails, rodents, venomous arthropods.

Unit V
Control of cockroaches and house flies, Cockroaches: Environmental management, cleanliness and hygiene, reduction of accessibility, chemical and biological control, baits and traps, repellents, modern methods, House flies: Inspection, Exclusion: Environmental sanitation and hygiene, habitat destruction, prevention of fly pathogen contact, food protection, prevention of man flies contact, Mechanical, Biological and Chemical control.

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