

St. Xavier's College (Autonomous),  
Mumbai



Syllabus of the courses offered by the  
Department of Zoology  
(2016 onwards)



# St. Xavier's College – Autonomous Mumbai

## Syllabus For I Semester Courses in Zoology (June 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.1.01 - Invertebrate Systematics and Biomolecules

S.Zoo.1.02 - Genetics and Evolution

Practical Syllabus for Course: S.Zoo.1.PR

## F.Y.B.Sc. Zoology

S.ZOO.1.01

### INVERTEBRATE SYSTEMATICS AND BIOMOLECULES

#### Learning Objectives:

- To teach student basic classification and characteristics of invertebrates and special adaptations of these phyla
- To understand the structure and functioning of basic biomolecules.

#### UNIT I

##### INVERTEBRATE CLASSIFICATION -I

- Salient features and adaptations for Phyla and classes.
  - Phylum Protozoa – Reproduction and Skeleton
  - Phylum Porifera- Spicules, canal system
  - Phylum Coelenterata / Cnidaria – Polymorphism, Corals and Coral reefs
  - Phylum Platyhelminthes – Parasitic adaptations in helminthes
  - Phylum Nematoda – Life cycle of ascaris

#### UNIT II

##### INVERTEBRATE CLASSIFICATION -II

- Salient features and adaptations for Phyla and classes.
  - Phylum Annelida – Metamerism and Reproduction
  - Phylum Arthropoda – Crustacean larvae
  - Phylum Mollusca – Foot and shells, Torsion
  - Phylum Echinodermata – Water vascular system

#### UNIT III

##### BIOMOLECULES

- **Proteins:**
  - Amino acids: Structure and types of amino acids (aliphatic, aromatic, essential, non-essential amino acids)
  - Definition and structure (primary, secondary, tertiary and quaternary) and types of proteins (fibrous, globular, homonomous, heteronomous and oligomeric)
  - Biological role of proteins.
- **Carbohydrates:**
  - Definition of carbohydrates and its classification with egs. Monosaccharides – Glucose, fructose, galactose. Disaccharides – maltose, sucrose, lactose. Polysaccharides – Starch, glycogen, cellulose, chitin and heparin
  - Biological role of Carbohydrates
- **Lipids:**
  - Definition of Lipids, properties and its classification with egs.
  - Essential fatty acids and its importance
  - Biological role of lipids
- **Nucleic acids:**
  - Definition of nucleic acids and its types – DNA and RNA



## F.Y.B.Sc. Zoology

S.ZOO.1.02

### GENETICS AND EVOLUTION

#### Learning Objectives:

- To understand the fundamentals of Mendelian genetics and its application
- To understand the basic molecular mechanisms in Mendelian genetics
- To be acquainted with the basics of evolution and the driving forces for the same

Number of lectures: 45

#### Unit 1

##### Mendelian Genetics

(20 lectures)

- History of Mendelian genetics
- Concept of gene and allele in genetics.
- Concept of Dominance, Segregation and Independent Assortment
- Mendelian Monohybrid inheritance.
- Exceptions to Monohybrid inheritance: Lethal genes, Co-dominance and Incomplete dominance.
- Mendelian Dihybrid inheritance.
- Variations of Dihybrid inheritance: Recessive Epistasis, Dominant Epistasis, Inhibitory gene interaction.
- Multiple Alleles: Concept. Human Blood group system and Coat colour in Rabbits: Understanding the emergence of these multiple allelic system
- Cytoplasmic inheritance: Kappa particles in Paramecium, Shell coiling in Snails

#### Unit 2

##### Human Genetics

(10 lectures)

- Mendelian genetics in humans: Autosomal Dominant inheritance: Huntington's Chorea disorder, Autosomal recessive inheritance: Phenylketonuria, X-linked recessive inheritance: Duchenne muscular dystrophy, X-linked Dominant inheritance: X-linked hypophosphatemic rickets.
- Human pedigree analysis based on inheritance patterns.
- Chromosomal Abberations: - Numerical abnormality: Monosomy – Turner Syndrome; Tetrasomy/Trisomy – Down Syndrome.

#### Unit 3

##### Evolution

(15 lectures)

- Why study evolution
- Theories of Evolution:
  - Prebiotic evolution
  - Panspermia
  - Biotic evolution
- Concept of Microevolution and Co-evolution
- Concept of Variation and Genetic drift in population
- Speciation mechanisms: Allopatric and Sympatric speciation
- Isolating mechanisms in nature: Spatial, Ethological, Reproductive
- From water to land: the evolution of legs

**Recommended References:**

1. Genetics – Strickberger. CB publications
2. iGenetics – Russel.
3. Genetics – Gardener
4. Genetics – Winchester. Oxford IBH publication
5. Principles of Genetic - Sinnott, Dunn and Dobzansky. McGraw Hill Publication
6. Basic human genetics - E.J.Mange and A.P.Mange. Rastogi Publication

**Practical Course:**

1. Modification of feet in Birds
2. Modification of beaks in Birds
3. Study of fossil and living fossils: Ammonite, Trilobite, Lingula, Limulus
4. Human Pedigree analysis: X-linked recessive, X-linked dominant, autosomal dominant, autosomal recessive trait
5. Multiple alleles
6. Study of Geological Time Scales

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# St. Xavier's College – Autonomous Mumbai

## Syllabus For II Semester Courses in Zoology (November 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.2.01 - Vertebrate Systematics and Ecology

S.Zoo.2.02 - Biotechniques and Comparative Physiology

Practical Syllabus for Course: S.Zoo.2.PR

## F.Y.B.Sc. Zoology

S.ZOO.2.01

### VERTEBRATE SYSTEMATICS AND ECOLOGY

#### Learning Objectives:

- To teach student basic classification and characteristics of vertebrates and special adaptations of these phyla
- To understand how environment affects distribution of animals

Number of lectures: 45

#### Unit 1

##### Lower Chordate classification:

(15 lectures)

- Phylum Hemichordata
- Phylum Chordata
  - Subphylum Urochordata
  - Subphylum Cephalochordata.

#### Unit 2

##### Vertebrate classification:

(15 lectures)

- Subphylum Vertebrata
  - ❖ Superclass: Agnatha
    - Class Cyclostomata
  - ❖ Superclass: Gnathostomata
    - Class Pisces – swimbladder, breeding and parental care
    - Class Amphibia – neoteny and parental care
    - Class Reptilia – adaptive radiation
    - Class Aves - Migration
    - Class Mammalia – Prototheria, Metatheria, Eutheria and Marine Mammals

#### Unit 3

##### Ecology

(15 lectures)

- Concept of Ecosystem
- Concept of energy flow, food chain and food web
- Concept of biogeochemical cycles (Carbon, oxygen, nitrogen, phosphorus and water cycles)
- Human activities affecting biogeochemical cycles
- Ecological niches and adaptation
- Biodiversity Definition of Biodiversity hotspots, benefits of biodiversity, Conservation of biodiversity, biotic and abiotic theories of species richness
- Abiotic factors and distribution patterns



### **Recommended References:**

1. Vertebrates by Kotpal
2. Chordate Zoology by Dhama and Dhama
3. Vertebrates by Jordan and Verma
4. Ecology: Principles and application by Chapman and Reiss
5. Essentials of Ecology by Tyler and Miller
6. Biodiversity by SVS Rana

### **Practical Course:**

1. Determination of pH of soil
2. Estimation of Dissolved Oxygen in the water sample
3. Estimation of Hardness of water in the water sample
4. Study and identification of Foraminiferan shells
5. Estimation of frequency, density and dominance
6. Vertebrate classification:
  - Hemichordata: Balanoglossus
  - Urochordata: Ascidia, Salpa, Herdmania
  - Cephalochordata: Amphioxus
  - Cyclostomata: Petromyzon, Myxine, Ammocoete larva
  - Pisces: Chondrichthyes – Shark, sting ray, electric ray  
Osteichthyes – Flying fish, Puffer fish and Sea horse
  - Amphibia: Frog, toad, Caecilian, salamander, Siren
  - Reptilia: Chameleon, Calotes/Gecko, turtle, tortoise, snake, crocodile,  
Phrynosoma
  - Aves: Kite, duck, Owl
  - Mammalia: Hedgehog, Bat, Guinea pig and Marine Mammals (Dugong, Blue  
Whale, Dolphin)
7. Parental Care : Bony fish (Siamese fighter, Tilapia and Guppy), Mid wife toad and Surinam toad
8. Neoteny : Axolotl larva
9. Adaptive radiations: sea snake, rattle snake, flying lizard
10. Study of swim bladders in fish

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## F.Y.B.Sc. Zoology

## S.ZOO.2.02

### BIOTECHNIQUES AND COMPARATIVE PHYSIOLOGY

#### Learning Objectives:

- To help students appreciate the complexity of systems and differences in the physiology of animals.
- To understand different techniques used in biology

**Number of Lectures: 45**

#### Unit 1

##### **Biotechniques:**

**(15 lectures)**

- Concept of sterilization: Filtration, Dry heat sterilization, Wet sterilization, Radiation.
- Preparation of solutions: Molar, Normal, Percent solutions, PPM, PPB, Dilutions — serial dilutions
- Separation of Biomolecules:
  - Chromatography: Principle and applications i) Paper ii) Thin Layer iii) Ion exchange
  - Electrophoresis: Paper and gel (Agarose and Polyacrylamide)
- Cell counting techniques: Use of haemocytometer (by using suitable stain)
- Principles of different types of microscopes: a) Simple b) Compound c) Phase contrast d) Electron e) Fluorescence f) Confocal.

#### Unit 2

##### **Comparative Physiology 1:**

**(15 lectures)**

- Movement and locomotion:
  - Amoeboid movement
  - Ultrastructure of cilia and ciliary movement
  - Ultrastructure of myofibril and sliding filament theory
  - Action of muscle (Role of muscle in movement)
- Nutrition:
  - Animals without alimentary canal e.g. Amoeba
  - Animals with incomplete alimentary canal e.g. Hydra
  - Animals with complete alimentary canal e.g. Bird
  - Brief account of physiology of digestion in vertebrates and symbiotic digestion in Ruminants.
- Respiration:
  - Types of respiratory surfaces: Trachea, spiracles, gills, lungs of Frog and Human, Air sacs of birds.
- Circulation:
  - Types of circulating fluids: Water, coelomic fluids, lymph and blood.
  - Types of circulation: Protoplasmic streaming
  - Open and closed circulation, single and double circulation.
  - Heart in Daphnia, cockroach and chordates

- Structure of cardiac muscle.

### **Unit 3**

#### **Comparative Physiology 2:**

**(15 lectures)**

- Excretion and Osmoregulation
  - Categorization of animals on the basis of principal nitrogenous excretory products
  - Ornithine cycle, formation of urea, deamination and detoxification
- Control and Coordination:
  - Nerve net in hydra and Giant nerve in Earthworm
  - Structure of a neuron
  - Physiology of neuronal function.
- Reproduction:
  - Asexual and Sexual reproduction
  - Gametogenesis, structures of egg and sperm of mammal
  - Fertilization and *in vitro* fertilization
  - Oviparity, viviparity and ovoviviparity

#### **Recommended References:**

1. Principles and Techniques of Molecular biology by Wilson and Walker
2. Biochemical Methods by S.Sadasivam and A. Manickam
3. Animal Physiology by Arora
4. Principles of Anatomy and Physiology: G. J. Tortora and S.R. Grabowski, Harper Row Publishers
5. Vertebrate Zoology by Dhama and Dhama
6. Invertebrate Zoology by Dhama and Dhama

#### **Practical Course:**

1. Circulatory system: Heartbeat of Daphnia, study of heart of Cockroach, Frog, Fish and Mammal
2. Respiratory system: Gills, Lungs of frog and mammal, spiracles in cockroach
3. Study of Nutritional apparatus
4. Muscle slides-smooth muscle, Striated muscle, Cardiac muscles, ultra structure of cilia
5. Observation of Giant nerve fibre and spinal cord, nervous net in hydra
6. Observation of binary fission and conjugation
7. Mounting of Septal Nephridium of Earthworm
8. Urine analysis and detection of Ammonia
9. Chromatography: TLC and Paper Chromatography
10. Demonstration of cell counter using a Haemocytometer and numerical problems using the haemocytometer
11. Study of agarose and polyacrylamide gels

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# St. Xavier's College – Autonomous Mumbai

## Syllabus For III Semester Courses in Zoology (June 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.3.01- Ethology and Parasitology

S.Zoo.3.02 - Biostatistics and Evolution

S.Zoo.3.03 - Advanced Genetics and Bioinformatics

Practical Syllabus for Course: S.Zoo.3.PR

**S.Y.B.Sc. Zoology**

**S.ZOO.3.01**

## **ETHOLOGY AND PARASITOLOGY**

### **Learning Objectives:**

- To enable students understand animal strategies and interactions and emphasize the importance of behaviour for survival.
- To help students gain an in depth understanding of some disease causing protozoan and helminth parasites

**Number of lectures: 45**

### **Unit 1**

#### **Animal Learning:**

**(15 lectures)**

- Associative and instrumental learning
- Insight learning and Cognition
- Constraints of learning
- Animal interactions

### **Unit 2**

#### **Ethology:**

**(15 lectures)**

- Ontogeny of behaviour and sensitive periods during development
- Environmental influence on behaviour
- Communication in animals
- Adaptive strategies (ESS) and foraging strategies in animals

### **Unit 2**

#### **Parasitology:**

**(15 lectures)**

- Parasites (Ectoparasites, Endoparasites, Digenetic, temporary, Permanent, Facultative)
- Hosts (Definitive, Intermediate, paratenic, reservoir)
- Morphology , mode of infection, life cycle, pathogenicity, prophylaxis and treatment of
- Protozoan parasites – *Entamoeba histolytica*, *Leishmania donovani*, *Plasmodium vivax*, *Typanosoma gambiense*, *Giardia intestinalis*.
- Helminth Parasites – *Taenia solium*, *Ancylostoma duodenale*, *Wuchereria bancrofti*, *Ascaris lumbricoides*, *Dracunculus medinensis*

### **Recommended References:**

1. Animal Behaviour – Mechanism, Ecology, Evolution by Drickamer, Vessey, Jakob
2. Animal Behaviour – Its development, Ecology and Evolution by Robert A Wallace. Goodyear Publishing Company
3. Animal Behaviour by David McFarland. Pitman Publishing ltd
4. Textbook of Animal behaviour by F.B.Mandal. PHI
5. Behaviour by M. Dockery and M Reiss. Cambridge University press.
6. Introduction to Animal Behaviour by Manning and Dawkins. Cambridge Univ. Press
7. Animal Parasitology by JD Smyth. Cambridge University Press
8. Parasitology - Protozoology & Helminthology by K.D. Chatterjee
9. Essentials of Human Parasitology by Judith S Heelan, Frances W Ingersoll. Delmar Thomson Learning
10. Medical Parasitology - A Practical approach by S.H.Gillespie and P.M. Hawkey. Oxford Univ Press
11. Manson's Tropical Diseases – P.H. Manson. Bahr Cassell and Co. Ltd.

### **Practical Course:**

1. Identification of Protozoan parasites – Entamoeba, Leishmania, Trypanosoma, Plasmodium, Giardia
2. Identification of Helminth parasites – Taenia, Ancylostoma, Wuchereria, Ascaris, Dracunculus
3. Parasitic adaptations – Taenia (scolex, proglottid), Trypanosoma, Entamoeba, Ascaris, Giardia
4. Mounting of mouthparts of mosquito/bed bug and house fly
5. Demonstrate wing cleaning in housefly and observation of feeding behaviour
6. Study of animal interactions
  - a. Parasitism (Ecto and Endo)
  - b. Mutualism
  - c. Commensalism
7. To study antennal grooming in cockroach
8. Study of optimal foraging strategies and ideal free distribution using guppy

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**S.Y.B.Sc. Zoology**

**S.ZOO.3.02**

## **BIostatistics AND EVOLUTION**

### **Learning Objectives:**

- ❖ To learn basic concepts in statistics and their application in biology
- ❖ To understand basic framework of evolutionary biology

**Number of Lectures: 45**

### **Unit 1**

#### **Descriptive Statistics:**

**(15 lectures)**

- Introduction to Biostatistics
- Sampling
- Describing your data – Measures of central tendency and dispersion
- Depicting your data – graphical representation
- Different types of distributions- Normal, Binomial, Poisson distributions, Central limit theorem and confidence interval

### **Unit 2**

**(15 lectures)**

#### **Inferential Statistics:**

- Hypothesis testing – General framework, Idea of probability, Type I and II errors, Idea of Significant difference.
- Parametric tests - Z-test, t-test, G-test
- ANOVA
- Non-parametric tests – Wilcoxon test, Man-Whitney U test
- Regression and Correlation

### **Unit 3**

#### **Evolution:**

**(15 lectures)**

#### **Natural selection: The driving force in evolution??**

- Darwins idea of natural selection
- Do we really need fossils??
- The missing Link. Is anything missing???

#### **Neo Darwinism: Natural selection revisited**

- Natural selection revisited and remodified

#### **Evolution of genome/gene**

#### **Phylogenetic Analysis**

- Phylogenetics – Use of sequence to decipher distance
- Phylogenetic trees - Cladogram, Dendogram

**Recommended References:**

1. Biostatistics: A foundation for analysis: Daniel. Wiley Publishing House
2. Statistical Methods in Biology: Norman Bailey. Cambridge Low Price Edition
3. Choosing and Using Statistics: A Biologist's Guide: Calvin Dytham. Blackwell Publishing
4. Origin of Species – Charles Darwin.
5. Evolution: Mark Ridley. 3<sup>rd</sup> edition
6. Evolution: Douglas Futuyama. 3<sup>rd</sup> edition
7. What Evolution Is: Ernst Mayr

**Practical Course:**

1. Descriptive Statistics – Central Tendency Problems
2. Descriptive Statistics – Dispersion Problems
3. Graphical Representation
4. Computers in biostatistics – Use of Excel and other softwares
5. Evolution in Jaw and cranium: Fish, Amphibian, Reptile, Bird, Mammal
6. From water to land: the evolution of limb in animals
7. Constructing phylogenetic trees.

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**S.Y.B.Sc. Zoology**

**S.ZOO.3.03**

## **ADVANCED GENETICS AND BIOINFORMATICS**

### **Learning Objectives:**

- This course aims at a comprehensive understanding of genetics and its varied applications whilst shedding light on more fundamental concepts of sex determination and mutations affecting genes.
- In Bioinformatics students are exposed at a basic level to the exciting world of fusion between IT and Biology and the enormous advances and uses of this field.

**Number of Lectures: 45**

### **Unit 1**

**Genetics 1:**

**(15 lectures)**

#### **Population Genetics**

- Hardy-Weinberg equilibrium
- Proof of HW equilibrium
- Exceptions to the rule
- Problems on HW equilibrium

#### **Linkage Mapping**

- Proof of crossing over
- Two point cross
- Three point cross
- Use of linkage analysis in gene Mapping

### **Unit 2**

**Genetics 2:**

**(15 lectures)**

#### **Sex Determination in Man**

- Red herrings along the way
- The Sry story

#### **Sex determination in *Drosophila Melanogaster***

#### **Chromosomal aberrations**

- Deletion, Duplication, Translocation, Inversion, non-disjunction, fragile X

#### **DNA mutations**

- Transition, Transversion, Insertion, Deletion, Frame shift

#### **DNA Replication**

- Models of DNA replication, Hershey Chase experiment
- Molecules and Mechanism in Prokaryotes
- Molecules and Mechanism in Eukaryotes





# St. Xavier's College – Autonomous Mumbai

## Syllabus For IV Semester Courses in Zoology (November 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.4.01- Developmental Biology and Information Flow

S.Zoo.4.02 - Cell Biology

S.Zoo.4.03 – Biochemistry and Applied Zoology

Practical Syllabus for Course: S.Zoo.4.PR

## S.Y.B.Sc. Zoology

## S.ZOO.4.01

### DEVELOPMENTAL BIOLOGY AND INFORMATION FLOW

#### Learning Objectives:

- This course aims at laying strong foundation for developmental biology with regard to the principles and the study of model organisms.
- This course lays the basic framework for transcription and translation

Number of lectures: 45

#### Unit 1

##### Developmental Biology 1:

(15 lectures)

##### Introduction to developmental biology

- Early theories of Developmental biology
- Concept of model organisms

##### Model Organisms: A closer look

- Amphibians: *Xenopus laevis*
- Birds: Chicken
- Mammals: Mouse
- Invertebrate: *Drosophila melanogaster*
- Invertebrate: *Caenorhabditis elegans*

##### Regeneration: Remembering previous existence

- Limb regeneration: Salamander
- Regeneration in Hydra

#### Unit 2

##### Developmental Biology 2:

(15 lectures)

##### Body Plan: Setting up the vertebrate body axes

- Animal vegetal axis : Amphibians
- Dorsal ventral axis: Amphibians
- Antero-posterior axis: Chick

##### Fertilization: The Genesis

- Concept of fertilization
- Fertilizin, Resact, ZP3
- Slow and fast block to polyspermy

##### Morphogenesis

- Cleavage: Holoblastic and Meroblastic
- Blastulation: *Drosophila*, Frog, Chick
- Gastrulation: *Drosophila*, Frog, Chick

### **Unit 3**

#### **Information Flow:**

**(15 lectures)**

#### **DNA transcription:**

- RNA polymerase and Transcription Cycle
- Prokaryotic and Eukaryotic transcription
- Post-transcriptional modifications
- Regulation

#### **Translation:**

- Genetic Code
- Main players in translation
- Prokaryotic and Eukaryotic translation
- Regulation

### **Recommended References:**

1. Principles of developmental Biology: Lewis Wolpert. 3<sup>rd</sup> ed. Oxford University Press
2. Developmental Biology: Scott Gilbert. 10<sup>th</sup> ed. Sinauer associates
3. Molecular Biology of the Gene: Watson et al. Pearson International Ed.
4. Molecular Biology: Robert Weaver.
5. Mark's Basic Medical Biochemistry: A clinical Approach: Leiberman and Marks. 4<sup>th</sup> ed. Lippincott, Williams and Wilkins

### **Practical Course:**

1. Chick embryo permanent slides (18, 24, 36, 48, 72 hours)
2. Blastula of Frog, Gastrula of Frog
3. Egg of Frog, Bird, reptile, Fish
4. Temporary preparation of Chick embryo
5. Temporary preparation of Drosophila embryo
6. Regeneration in hydra
7. Understanding Transcription and Translation using presence and absence of antibiotic markers

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**S.Y.B.Sc. Zoology**

**S.ZOO.4.02**

## **CELL BIOLOGY**

### **Learning Objectives:**

- To learn fundamental biochemical and physiological concepts that governs cell function and its application to understand health and disease.

**Number of Lectures: 45**

### **Unit 1**

**Introduction Membranes and Endomembrane Systems: (15 lectures)**

- Introduction to basic cell structure
- Membrane structure, Transport through membranes Diffusion and Facilitated Diffusion
- Osmosis, Active transport, Bulk transport.
- Endo membrane systems-Endoplasmic reticulum Types of Endoplasmic reticulum and Functions
- Golgi-complex and cell secretion
- Lysosomes – types of lysosome and function

### **Unit 2**

**Cell Energetics And Regulation: (15 lectures)**

- Mitochondria: Structure and ATP Synthesis
- Nuclear structure-Nuclear envelope, Nuclear Pore complex, Nucleolus
- Chromatin structure and compaction
- Giant chromosomes - Polytene chromosomes and Lampbrush chromosomes

### **Unit 3**

**Cell Cycle and Cancer Biology: (15 lectures)**

- Cell cycle – regulation of cell cycle
- Cell division- Mitosis and Meiosis
- Cell culture - Primary cell culture, organ culture, cell lines, cell viability
- Cancer Biology: Cancer and Types of Cancer, Characteristics of Cancer Cells
- Carcinogens: Physical, Chemical and Biological
- Genes and Cancer: Oncogenes and Tumor Suppressor Genes

**Recommended References:**

1. Molecular cell Biology Harvey Lodish David Baltimore Arnold Berk et al Scientific American books
2. Cell Biology, Genetics and Evolution By Verma and Aggarwal S.Chand Publication
3. Cell Biology by Pollard
4. The World of Cell Wayne M. Becker, Lewis J. Kliensmith Jeff Hardin Pearson Publication
5. Principles of Anatomy and Physiology Gerald J Tortora and Sandra Reynolds Grabowski Harper and Row Publisher
6. Biology of Disease Jonathan Phillips and Paul Murray Published by Blackwell science Ltd

**Practical Course:**

1. Study of Osmosis using Erythrocytes
2. Electron micrographs of ER, Golgi Complex, Lysosomes and Mitochondria
3. Vital staining of Mitochondrion
4. Study of Mitosis using Onion Root Tip
5. Study of polytene chromosomes from Chironomous larvae
6. Shell less embryo culture
7. Characteristics of Cancer Cells – Slides / Electron Micrographs
8. Primary Cell Culture / Cell Line Culture

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**S.Y.B.Sc. Zoology**

**S.ZOO.4.03**

**BIOCHEMISTRY AND APPLIED ZOOLOGY**

**Learning Objectives:**

- To emphasize the commercial aspect of the pure science of zoology
- To learn the various commercial applications of zoology
- To learn concepts used in biochemistry and their applications

**Number of Lectures: 45**

**UNIT 1**

**Biochemistry**

**(15 lectures)**

Molecular structure of water: tetrahedral geometry, Hydrogen bond and flickering→ clusters, macromolecular association

- Physical and chemical properties of water: Density, specific heat, heat of vaporization,→ heat of fusion, surface tension. Hydrogen bonds with solutes. Interaction with non-polar compounds. Water as a reactant.
- Ionization of water, Kw ion product of water, pH scale.
- Dissociation of weak acids and weak bases, pKa,
- Henderson – Hasselbach equation.
- Titration curves of weak acids
- Buffers in biological system

**UNIT 2**

**Metabolism**

**(15 lectures)**

Physiologic regulation

- Carbohydrate metabolism
- Lipid metabolism
- Nitrogen and Amino Acid Metabolism
- Metabolic Integration, Adaptation and Disease

**UNIT 3**

**Applied Zoology**

**(15 lectures)**

- Introduction to fisheries – Types of fisheries and recent techniques- SONAR, GPS, Remote Sensing
- Fish uses and fish processing industries
- Dairy Science – including cattle diseases
- Aquaculture – Prawn culture, Pearl culture, Fish culture (including fish diseases)



**Recommended References:**

1. Biochemistry - Lehninger
2. Biochemistry – Harper
3. Biochemistry – Conn & Stumpf
4. Biochemistry – Deb
5. Biochemistry – Satyanarayan
6. A text book of Animal Husbandry – G.C. Banerjee. Oxford Publishers.
7. Wealth of India – VI: Livestock CSIR
8. Wealth of India – IV: Fish and Fisheries CSIR
9. General and Applied Ichthyology: Fish and Fisheries – SK Gupta & PC Gupta. S. Chand Publishers
10. Economic Zoology – Shukla, Upadhay. Rastogi Publications.

**Practical Course:**

1. Identification of: Crafts and gears.
2. Identification of: Fish, Crustaceans and Molluscs.
3. Estimation of total cholesterol from the given milk sample.
4. Estimation of total lipids from the given milk sample.
5. Estimation of reducing sugars from the given milk sample.
6. Estimation of calcium content in milk.
7. Study of cattle breeds.
8. pH metry
9. Preparation of Buffers and pKa
10. Titration curves
11. Biometric study in Fish
12. Field Trip for Applied Zoology

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# St. Xavier's College – Autonomous Mumbai

## Syllabus For V Semester Courses in Zoology (June 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.5.01 – Ontogeny of Vertebrates, Behavioural Ecology  
and Conservation Biology

S.Zoo.5.02 – Physiological Adaptations

S.Zoo.5.AC– Economic Entomology – I

Practical Course Syllabus for: S.Zoo.5. PR and S.Zoo.5.AC.PR

**T.Y. B.Sc. Zoology**

**S.ZOO. 5.01**

**ONTOGENY OF VERTEBRATES, BEHAVIOURAL ECOLOGY AND  
CONSERVATION BIOLOGY**

**Learning Objectives:**

- To comprehend the development and modifications of some vertebrate systems.
- To understand the behavioural and distribution patterns of animals and interpret formulation of conservation strategies.

**Number of lectures: 60**

**Unit 1**

**Ontogeny of Vertebrate systems: (15 Lectures)**

- A) Integumentary system
- B) Circulatory system
- C) Urinogenital system

**Unit 2**

**Behavioural Ecology: (15 Lectures)**

- A) Sexual selection
- B) Mating systems
- C) Parental care.

**Unit 3**

**Population and Community Ecology: (15 Lectures)**

- A) Population growth curves, factors affecting population growth.
- B) Life tables and survivorship curves, r and k strategies, Ecological succession.
- C) Social interactions, Parasitism and Predation

**Unit 4**

**Zoogeography and Conservation biology: (15 Lectures)**

- A) Zoogeographic realms, Biogeographic classification of the Indian subcontinent, Means of dispersal and Barriers to dispersal.
- B) Island Biogeography, Wildlife Tourism and Wildlife Forensics.
- C) History of Conservation Biology, Population Management and Restoration (case studies)

**Recommended References:**

1. Conservation Biology- Fred Van Dyke, Springer.
2. Wildlife Tourism- D.Newsome, R.Dowling, Susan Moore, Channel View Publication.
3. Conservation Biology- Scott P.Caroll and Charles Fox, Oxford University Press.
4. Comparative Anatomy of Vertebrates- George C.Kent, Mosby Year Book.
5. Elements of Chordate Anatomy- Charles K.Weichert, McGraw Hill Publication.
6. Behavioural Ecology- E.Danchin,L.A.Giraldeau, Frank Cezilly, Oxford University Press.
7. Atlas of World Wildlife- Sir J Huxley, Mitchell Beazely Publishers Limited
8. Behavioural Ecology- J.R. Krebs and N.B. Davies, Blackwell Scientific Publications
9. Animal Behaviour- John Alcock, Sinauer Associates, Inc.
10. Ecology- Eugene Odum.
11. Encyclopedia of Endangered Animals- A.J.Beer and P.Morris, Grange Books.
12. Ecology- Theories and Applications- Peter Stiling, Prentice-Hall of India.
13. Wildlife Forensics – Jane Huffman and John Wallace, Wiley-Backwell.
14. The wildlife detectives – Donna Jackson - Houghton Mifflin Harcourt Publishing Company

**Practical Course:**

1. Comparative study of the skull and girdles of frog, varanus, bird and rabbit.
2. Dissection of brain of chicken
3. Mountings of Columella of chicken, Hyoid of chicken
4. Identification of integumentary derivatives: feathers, scales (reptile), claw (bird/reptile/mammal), hooves (horse/cattle), horn, antler and teeth.
5. Mounting of epidermal derivatives (hair and fur)
6. Mounting of fish scales: placoid, cycloid, ctenoid.
7. Study of distinctive fauna of zoogeographic realms, and conservation status of the same
8. Study the response of housefly/cockroach to light.
9. Measure the Turbidity, and Conductivity of a given water sample.
10. Estimation of Population density (Sub-sampling of Daphnia and mark-recapture method).
11. Rapid field tests for sulphates, nitrates and base deficiency in different soil samples.
12. Calculation of life expectancy using life tables

❖ A long excursion to any National Park / Sanctuary for Unit 4

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## T.Y.B.Sc. Zoology

## S.ZOO. 5.02

### PHYSIOLOGICAL ADAPTATIONS

#### Learning Objectives:

- The aim of this module is to encourage an awareness of the physiological nature of life.
- To develop an understanding of form, function and adaptation in organ systems central to the maintenance of life and interaction with the environment.
- As an inter-disciplinary approach to the subject there is need to understand adaptations not only on the Earth but also in the space.

#### Unit 1:

#### Environment, adaptations and scaling

(15 Lectures)

#### A) Environment and physiological changes

##### Respiration

- Gas exchange across respiratory surfaces
- Diffusion
- Partial pressures
- Models of gas exchange in vertebrates
- Effects of diving and altitude

##### Blood

- Fluid composition of blood
- Solids
- Formed Elements
- Erythrocytes and haemoglobin
- Leucocytes
- Thrombocytes and clotting mechanism
- Coping with hypoxia and anoxia

#### B) Animal Adaptations and Scaling

- Adaptation at a molecular and genomic level
  - Controlling protein synthesis
  - Controlling protein action
- Physiological regulation of gene expression by proteins
  - Signals
  - Receptors
  - Mediators
- Scaling
  - Isometric and allometric
  - Scaling of metabolic rate and locomotion

**Unit 2:**

**Astrobiology and physiological adaptations in space conditions (15 lectures)**

**A) Basic Astrobiology**

- Introduction
- Basic Astronomy
- Early Earth Conditions
- Origin and Evolution of Life on the Earth
- Habitable zones
- Detection of exoplanets and SETI

**B) Space biology**

- Revision of human physiology
- Effect of space conditions on human physiology
- Problems faced by Astronauts and solutions

**Unit 3:**

**Osmoregulation and Thermoregulation (15 lectures)**

**A) Osmoregulation**

- Regulation in aquatic environments (marine and freshwater),
- Regulation in terrestrial environments
  - Evaporative water loss
  - Salt water ingestion and salt excretion
  - Metabolic water
  - Behavioral adaptations
- Hormonal control of water, osmotic, pH and ionic balance
- Osmoregulation in extreme environments
  - Aquatic: transient water bodies and osmotically peculiar environments
  - Terrestrial: hot and cold deserts

**B) Thermoregulation**

- Patterns of body temperature and temperature tolerance,
- Heat exchange
  - Conduction
  - Convection
  - Radiation
- Temperature regulation in ectotherms
- Temperature regulation in endotherms
  - Concept of critical temperatures
  - Heat gain
  - Heat Loss
- Life in temperature extremes

**Unit 4:**

**Physiology of reproduction (15 lectures)**

**A) Human Reproductive Systems**

- Male System

- Anatomy and histology of the testes
- Endocrine regulation of the male system
- Female System
  - Anatomy and histology of the ovary
  - Endocrine regulation of the female system

**B) Breeding cycles**

- Menstrual cycle
- Ovarian cycle
- Oestrous cycle in rats and dogs

**Recommended References:**

1. Molecular Biology of the Cell: Harvey Lodish, David Baltimore et al., Scientific American Books
2. Comparative Animal Physiology: P.C. Withers, Thomson Publishing Co.
3. Comparative Animal Physiology: Knut, Schmidt-Neilson, Cambridge
4. Principles of Anatomy and Physiology: G. J. Tortora and S.R. Grabowski, Harper Row Publishers
5. Human Physiology, Vol I: Chatterjee, Central Book Agency
6. Environmental Physiology of Animals: Pat Wilmer and Stone Graham, Blackwell publishers.
7. An Introduction to Astrobiology Edited by Iain Gilmour and Mark Sephton (2004). Cambridge University Press.

❖ **Field Trip for Unit 2:** It will be an overnight sky-observation session.





## T.Y. B.Sc. Economic Entomology

S.ZOO. 5.AC

### INSECT FORM AND FUNCTION, COMMERCIAL ENTOMOLOGY AND INSECT ADAPTATIONS

#### **Learning Objectives:**

- To understand insect classification and nomenclature of insects
- To study the working of insect systems
- To understand their adaptations to the environment
- To look into some commercial applications of entomology.

**Number of lectures: 60**

#### **Unit 1**

##### **Classification of common Insects:**

**(15 Lectures)**

A) General characteristics, with examples and economic importance of the following orders:

- Thysanura
- Lepidoptera
- Hemiptera
- Coleoptera
- Diptera
- Orthoptera
- Dictyoptera

#### **Unit 2**

##### **Morphology and Anatomy:**

**(15 Lectures)**

A) Morphology and modifications of Mouth-Parts, Antennae, Wings and Legs

B) An Outline of the Anatomy of Insects

- Digestive and Excretory system
- Circulatory and Respiratory system
- Nervous and Endocrine system
- Reproductive system and development of insects

C) Metamorphosis in insects

#### **Unit 3**

##### **Insects of Commercial importance:**

**(15 lectures)**

A) Honey Bee (Apiculture)

B) Silk Moth (Sericulture)

C) Lac Insect (Lac culture)

D) Government Agencies involved in research

E) Introduction to feasibility report and funding agencies

#### **Unit 4**

##### **Environmental factors and Special adaptations in Insects:**

**(15 Lectures)**

A) Environmental factors affecting insects – temperature, light and humidity

B) Sound Production and Chemical signaling

C) Mimicry

**Recommended References:**

- 1) A Textbook of Insect Morphology, Physiology and Endocrinology – Tembhare D.B. – S.Chand publication
- 2) Principles of Insect Morphology – Snodgrass R. E. –Tata McGraw Hill
- 3) Textbook of Entomology – Ross – John Wiley publication
- 4) General and Applied Entomology – David and Ananthakrishnan – Tata McGraw Hill publication
- 5) Economic Zoology – Shukla and Upadhyay, Rastogi Publication
- 6) Applied Entomology – Alka Prakash and Fennemore, New Age Publishers
- 7) A General Textbook of Entomology – A.D. Imms
- 8) Textbook of Entomology – Awasthi
- 9) Insects – Chapman, ELBS Publications
- 10) Entomology – Romoser, Macmillan Publishing Co.
- 11) Applied Agricultural Entomology – Lalit Kumar Jha New Central Book Agency
- 12) Natural History of the Insects of India – Westwood J.O. , Narendra Publishing House
- 13) Entomology – Novel approaches – P.C. Jain and M. C. Bhargava, New India Publishing House

**Practical Course:**

**1) Identification of specimens**

- Lepisma, Butterfly, Moth (Hawk Moth), Bed-bug, Giant water bug, Potter wasp, Carpenter ant, Lady bird beetle, Blister beetle, House-fly, Flesh-fly, Blue/Green bottle fly, Cricket, Grasshopper Praying Mantis.
- Metamorphosis of insects (Silkmoth, Mosquito, Flea, Beetle and housefly).
- Mimicry and Camouflage.
- Mouth-parts of butterfly and bed-bug.
- Types of antennae and legs.
- Identification of the parts of a bee box and apiculture equipment.

**2) Mountings**

- Halteres, Legs, Antennae and Mouth-parts of House-fly.
- Preservation of insect specimen.

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# St. Xavier's College – Autonomous Mumbai

## Syllabus For VI Semester Courses in Zoology (November 2016 onwards)

### **Contents:**

Theory Syllabus for Courses:

S.Zoo.6.01 – Basics of Enzymes, Toxicology and Histology

S.Zoo.6.02 – Immunology and DNA Recombinant Technology

S.Zoo.6.AC– Economic Entomology – II

Practical Course Syllabus for: S.Zoo.6. PR and S.Zoo.6.AC.PR

## T.Y.B.Sc. Zoology

S.ZOO. 6.01

### BASIC STUDY OF ENZYMES, TOXICOLOGY, HISTOLOGY AND NANOSCIENCE

#### Learning Objectives:

- To understand the classification and functions of enzymes.
- To study the various effects of toxic substances in our body.
- To understand the structure and function of some of the glands in our body.
- To learn basics of nano-particles.

**Number of lectures: 60**

#### Unit 1:

##### **Enzymes**

**(15 lectures)**

##### A) Introduction to enzymes

- Definition
- Structure of enzyme
- Mechanism of enzyme action
- Specificity of enzymes

##### B) Classification Of Enzymes

##### C) Factors affecting enzyme activity

- pH
- Temperature
- Substrate concentration
- Enzyme substrate
- Inhibitors:
  - Types of Inhibitors
  - Feedback Inhibition
  - Allosteric Regulation and Inhibition

##### D) Enzyme Kinetics – Michaelis Menten Equation and significance of $K_m$ and $V_{max}$

##### E) Enzyme Induction and Repression – Lac Operon Model

#### Unit 2:

##### **Basics of toxicology**

**(15 lectures)**

##### A) Introduction To Toxicology

- Definition of toxicology, toxicant, toxicity,  $LC_{50}$ ,  $LD_{50}$
- Measurements of toxicants and toxicity

##### B) Class of chemicals of toxic importance

- Sources of toxic compounds
- Absorption and distribution of toxicants
- Routes of absorption in mammals
- Distribution of a Toxicant

##### C) Toxicodynamics

##### D) Metabolism of toxicants

##### E) Applications of toxicology

##### F) Histology of Liver and its role in toxicity study

**Unit 3:**

**Histology of endocrine and exocrine glands**

**(15 lectures)**

- A) Embryological origin, histological structure, blood supply, nervous supply, functions and abnormalities of Pituitary, Adrenal, Thyroid, Parathyroid, Kidney and Pancreas.

**Unit 4:**

**Basics of nanoscience**

**(15 lectures)**

- A) Introduction to nanotechnology and nanoscience  
B) Types of nanoscale materials  
C) Techniques used in synthesis of nanoscale materials  
D) Stabilization of nanoparticles and capping agents  
E) Characterization methods to study nanomaterials  
F) Applications of nanomaterials

❖ **Recommended References**



1. Biochemistry - Lehninger
2. Biochemistry – Harper
3. Biochemistry – Conn and Stumpf
4. Biochemistry – Deb
5. Biochemistry – Satyanarayan
6. Histology – Baileys
7. Histology – Lange
8. Anatomy and Physiology – Tortora
9. Toxicology – Casarett and Doull's
10. Modern toxicology – Hodgson Levi
11. Fundamentals of toxicology – Pandey, Shukla, Trivedi
12. Diseases of the liver and biliary system – Blackwell
13. Nanoscale Science and Technology – Kelsall, Hamley and Georgehegan
14. A laboratory course in nanoscience and nanotechnology
15. Nanotechnology – Jeremy Ramsden
16. Nanotechnology application and markets – Lawrence Gasmen
17. Nanotechnologies Hazards and Resource Efficiency - Steinfeldt

**Practical Course:**

1. Estimation of proteins from the given tissue sample
2. Effect of varying pH on Acid Phosphatase activity.
3. Effect of Inhibitor (Competitive Inhibitor-  $\text{KH}_2\text{PO}_4$ ) on Acid Phosphatase activity.
4. Effect of varying Enzyme Concentration on Acid Phosphatase activity.
5. Effect of a given pesticide on the heart beat of Daphnia.
6. To find the activity of GOT in the liver of rat/mouse.
7. To find the activity of GPT in the liver of rat/mouse.
8. Identification of the histological structure of the following glands:
  - a) Pituitary
  - b) Adrenal
  - c) Thyroid
  - d) Parathyroid

- e) Liver
- f) Kidney
- g) Pancreas



**T.Y. B.Sc. Zoology**

**S.ZOO. 6.02**

## **IMMUNOLOGY AND RECOMBINANT DNA TECHNOLOGY**

### **Learning Objectives:**

- To understand the functioning of the immune system and to know the molecules of the immune system
- To understand how the immune system counters pathogens we come across on a daily basis
- To teach students the power of recombinant DNA and strategies that are used by modern science to create the same

**Number of lectures: 60**

### **Unit 1**

#### **Immunology 1:**

**(15 lectures)**

##### A) Structure of Antibodies

- Structure of different classes of Antibodies
- Hinge region, Light chain, heavy chain
- Proteolytic cleavage of an antibody by papain and pepsin

##### B) Hypersensitivity reactions (type I to IV)

- Type I (Allergic reaction)
- Type II
- Type III
- Type IV (DTH)

##### C) Antigens: Study of Antigenic properties

- Concept of antigens and immunogens, Haptens
- Properties of an antigen
- Properties of a host cell which helps in antigen detection
- Concept of Haptens and its uses in immunology

### **Unit 2**

#### **Immunology 2:**

**(15 lectures)**

##### D) Antigen – Antibody Interactions

- Precipitation reaction – Radial immunodiffusion, Double immunodiffusion
- Agglutination reaction – Hemagglutination reaction, Bacterial agglutination
- ELISA – Indirect, Sandwich and Competitive

##### E) Vaccines

- Active and Passive immunization
- Types of vaccines – Attenuated, Recombinant vaccines, DNA vaccines, multivalent subunit vaccines

##### F) Cells and Molecules of the immune system

- Phagocytes, Basophils, Eosinophils, Mast cells, Dendritic cells, T cells, B cells, Neutrophils
  - Interleukins, Interferons, Growth factors
- G) Immune Response to Protozoan diseases and Worms
- Malaria
  - Leishmaniasis
  - Ascariasis
  - Shistosomiasis

### **Unit 3**

#### **Recombinant DNA technology 1:**

**(15 lectures)**

- A) Restriction Enzymes and their types
- Concept of RE's
  - Type I, Type II, Type III
- B) Cutting and Joining DNA – Restriction/Modification system and ligation techniques
- Mechanism of Restriction (type II)
  - Restriction modification system
  - Ligation reactions and mechanisms of ligation
- C) Vectors used in RdT – Plasmids, Cosmids, BACs, YACs
- Plasmids: introduction, concept of copy number, properties of a cloning vector
  - Cosmids: introduction, creation of a cosmid, uses
  - BACs & YACs: introduction and its uses in cloning

### **Unit 4**

#### **Recombinant DNA technology 2:**

**(15 lectures)**

- D) Cloning strategies
- Blunt end ligation, Sticky end ligation
  - Homopolymer tailing, Adapter based ligation
  - Screening strategies: Insertional inactivation, gel mobility shift assay, PCR based screening
- E) Transformation strategies
- Introduction to transformation
  - CaCl<sub>2</sub> based transformation strategy
  - Electroporation based transformation strategy
  - Virus based transformation strategy
- F) Applications of RdT
- Generation of novel drugs and therapies
  - Use of sequence as a diagnostic tool



**Recommended References:**

1. Immunology 7ed. – Janis Kuby
2. Immunology – Janeway
3. Recombination DNA: Genes and genomes a short course – Watson, Myers. W.H.Freeman and Co.
4. Immunity to Parasites: How parasitic infections are controlled – Derek Wakelin. Cambridge University press
5. Roitt's Essential Immunology – Delves P, Martin S, Burton D, Roitt I. Blackwell Publishing
6. Immunology 2ed – C.V.Rao. Narosa Publication
7. Molecular Biology of the Cell – Alberts et al. Garland Science
8. Molecular cell Biology – Lodish et al. Freeman Publishers
9. Principles of RdT – Greenwood and Rai
10. Recombinant DNA technology – Ole and Primrose

**Practical Course:**

1. ELISA (Sandwich ELISA)
2. Agglutination and precipitation reactions (Blood grouping and Rheumatoid arthritis)
3. Plasmid Isolation (pUC 18/ pUC 19) and Electrophoresis
4. Electrophoresis of serum proteins
5. Study of various kinds of vectors used: Plasmids, Cosmids, BACs, YACs
6. Restriction mapping and problems on the same
7. Restriction digestion of plasmid DNA using any two restriction enzymes
8. Transformation
9. Identification of glands of immunological significance - Thymus, Lymph gland and Spleen

## T.Y.B.Sc. Economic Entomology

S.ZOO.6.AC

### FORENSIC ENTOMOLOGY AND PEST MANAGEMENT

#### Learning Objectives:

- To understand the role of insects in crime investigation.
- To study the various measures used to control pests.
- To understand the value of insects and the role they play in the lives of human beings.
- To appreciate the intricacies of the social life of insects.

**Number of lectures: 60**

#### Unit 1

##### **Forensic Entomology & Insect Plant interaction: ( 15 Lectures)**

- A) Brief mention of common insects of forensic importance (Flies and Beetles)
- B) Collection of entomological evidence (Preservation and handling of maggots) and other climatological data during crime investigation and analysis of entomological evidence and calculation of PMI (Post Mortem Index) using maggot age and insect succession
- C) Insect Plant interaction: Courier service, lodging, boarding, crime and deception

#### Unit 2

##### **Pest Management: (15 Lectures)**

- A) Origin of pests and pest control practices
- B) Chemical control and insecticide resistance
- C) Biological control and Integrated Pest Management

#### Unit 3

##### **Economic importance of Insects: (15 Lectures)**

- A) Insects useful to man (Insect products and other uses)
- B) Insects harmful to crops, animals, and stored grain (grasshopper, locust, cotton bug, ox warble, horse bots, green bottle fly, pea weevil, rice weevil, flour beetle, rice moth)
- C) Insects of medical importance (mosquitos, tsetse fly, sand fly, flea, horsefly)

#### Unit 4

##### **Social life of Insects: (15 Lectures)**

- A) Social organization in Termites, Bees and Ants
- B) Communication in Insects using
  - Sound
  - Light
  - Pheromones

**Recommended References:**

1. General and Applied Entomology-David and Ananthkrishnan, Tata McGraw Hill.
2. Applied Entomology-V.B.Awasthi, Scientific Publication.
3. Agricultural Pests and their control- V.B.Awasthi, Scientific Publication.
4. A manual of Practical Entomology- M.M Trigunayat, Scientific Publication.
5. Applied Entomology- Alka Prakash, and Fennemore, New Age Publishers.
6. Laboratory manual of Entomology- Alka Prakash, New Age Publishers.
7. Entomology and Pest Management- Larry.P.Pedigo and Rice, Pearson Education.
8. Destructive and Useful Insects- Metcalf and Flint, McGraw Hill Publication.
9. Insect Year Book of Agriculture- American Agriculture Department Publication.
10. Public Health Pests- N.R.H.Burgess, Chapman and Hall.

**Practical Course:**

1. Identification of insect products: Silk, Shellac, Honey and Beeswax.
2. Identification of harmful insects: Grasshopper, locust, Cotton bug, Oxwarble, Horsebot, green bottle fly, Pea weevil, Flour beetle, Rice Weevil, Rice Moth, Mosquitos- (anopheles, aedes, culex), Sandfly, Tsetse fly, horse bot, flea.
3. Identification of castes of social insects: Termite - queen, worker, soldier (nasute and mandibulate), Honeybee - queen, drone, worker, Ant - reproductives and worker.
4. Mounting of mouthparts, sting and legs of honeybee.
5. Identification of insects with respect to mode of communication: Cicada, Firefly and Moth.
6. Identification of insects of forensic importance: Fleshfly, Blowfly, Clown beetle, and Rove beetle, Hide beetle.
7. Forensic entomology- Case studies.
8. Study of LC<sub>50</sub> of Nicotine on a suitable organism (mosquito larvae, chironomous larvae or daphnia).
9. Identification and working of food lure and pheromone trap
10. Identification of biological control agents: Ichneumon wasp, Lady bird beetle and Red ant.

Field visit to Central Bee Research Institute Pune / Kokan Krishi Vidyapeeth Dapoli

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