# Undergraduate Programme
# B. Sc. Zoology (Honours)
# 4- year Degree Course

# Dr. BHIM RAO AMBEDKAR UNIVERSITY, AGRA
# (Formerly: Agra University, Agra)

# SUBJECT: ZOOLOGY

## Members, Experts and Convenor

### Convenor

**Prof. J Andrew,**
**Department of Zoology,**
**St. John's College, Agra**

**Members**

**1- Prof. Rajvir Singh,**
**Department of Zoology, R.B.S. College, Agra.**

**2- Prof. Vinod Kumar Khandelwal,**
**Department of Zoology, K.R.P.G. College, Mathura.**

**3- Prof. Ravi Kumar Yadav,**
**Department of Zoology, Narain College, Shikohabad.**

**4- Prof. Suman Kapoor,**
**Department of Zoology, Agra College, Agra**

**5- Prof. Vishwakant,**
**Department of Zoology, Agra College, Agra**

**6- Prof. Dharmendra Pratap Singh,**
**Department of Zoology, Agra College, Agra.**

**EXPERTS**

**1. Prof. Alok Kumar Panday,**
**Department of Zoology, DAV (PG) College, Kanpur**

**2. Prof. Ravikant Upadhyay,**
**Department of Zoology, Gorakhpur University, Gorakhpur**

# Undergraduate Programme: B. Sc. Zoology (Honours) 4- year Degree Course

| Year | Course | Semester | Paper Title | Course Code | Theory/Practical/Project | Credits | Teaching Hours |
|---|---|---|---|---|---|---|---|
| 1 | Certificate Course in Medical Diagnostics & Public Health | I | Cytology, Genetics, and Infectious Diseases | B050101T | Theory | 4 | 60 |
| | | | Cell Biology and Cytogenetics Lab | B050102P | Practical | 2 | 60 |
| | | II | Biochemistry and Physiology | B050201T | Theory | 4 | 60 |
| | | | Physiological, Biochemical &Haematology Lab | B050202P | Practical | 2 | 60 |
| 2 | Diploma in Molecular Diagnostics and Genetic Counselling. | III | Molecular Biology, Bioinstrumentation &Biotechniques | B050301T | Theory | 4 | 60 |
| | | | Bioinstrumentation& Molecular Biology Lab | B050302P | Practical | 2 | 60 |
| | | | Project work/ Dissertation | Research Project: Methodology | | | 60 |
| | | IV | Gene Technology, Immunology and Computational Biology | B050401T | Theory | 4 | 60 |
| | | | Genetic Engineering and Counselling Lab | B050402P | Practical | 2 | 60 |
| | | | Project work/ Dissertation | B050403R | Research Project | 4 | 60 |
| 3 | B.Sc. Degree of Bachelor of Science in Zoology | V | Diversity of Non-Chordates, Parasitology and Economic Zoology | B050501T | Theory | 4 | 60 |
| | | | Protochordata, Diversity of Chordates and Comparative Anatomy | B050502T | Theory | 4 | 60 |
| | | | Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology | B050503P | Practical | 2 | 60 |
| | | VI | Evolution and Developmental Biology | B050601T | Theory | 4 | 60 |
| | | | Ecology, Ethology, Environmental Science and Wildlife | B050602T | Theory | 4 | 60 |
| | | | Lab on Environmental Science, Behavioural Ecology, Developmental Biology, Wildlife and Ethology | B050603P | Practical | 2 | 60 |

| Year | Course | Semester | Paper Title | Course Code | Theory/Practical/Project | Credits | Teaching Hours |
|---|---|---|---|---|---|---|---|
| 4 | B.Sc. (Hons.) Degree of Bachelor of Science with Honours in Zoology | VII | Systematics, Structure and Function of invertebrates | B050701T | Theory | 4 | 60 |
| | | | Molecular and Cell Biology | B050702T | Theory | 4 | 60 |
| | | | Biological Techniques and Instrumentation | B050703T | Theory | 4 | 60 |
| | | | Micro Biology and Immunology | B050704T | Theory | 4 | 60 |
| | | | Practical | B050705P | Practical | 4 | 60 |
| | | VIII | Chordate Anatomy | B050801T | Theory | 4 | 60 |
| | | | Genetics and Biotechnology | B050802T | Theory | 4 | 60 |
| | | | Animal Physiology and Biochemistry | B050803T | Theory | 4 | 60 |
| | | | Developmental Biology | B050804T | Theory | 4 | 60 |
| | | | Practical | B050805P | Practical | 4 | 60 |
| 4 | B.Sc. (Hons.) Degree of Bachelor of Science with Honours and Research in Zoology<br><br>*Any 3 of the Theory papers & Research Project | VII | Systematics, Structure and Function of invertebrates* | B050701T | Theory | 4 | 60 |
| | | | Molecular and Cell Biology* | B050702T | Theory | 4 | 60 |
| | | | Biological Techniques and Instrumentation* | B050703T | Theory | 4 | 60 |
| | | | Micro Biology and Immunology* | B050704T | Theory | 4 | 60 |
| | | | Practical | B050705P | Practical | 4 | 60 |
| | | | Research Project | Research Project: Methodology | | | 60 |
| | | VIII | Chordate Anatomy* | B050801T | Theory | 4 | 60 |
| | | | Genetics and Biotechnology* | B050802T | Theory | 4 | 60 |
| | | | Animal Physiology and Biochemistry* | B050803T | Theory | 4 | 60 |
| | | | Developmental Biology* | B050804T | Theory | 4 | 60 |
| | | | Practical | B050805P | Practical | 4 | 60 |
| | | | Research Project | B050806R | Research Project | 8 | 60 |

# Certificate Course in Medical Diagnostics & Public Health

# SEMESTER- I

| Programme /Class: B.Sc. / Certificate | **Course** B.Sc. **Subject:** ZOOLOGY **Year:** First **Semester:** I<br>**Course Title:** Cytology, Genetics, and Infectious Diseases | **Course code** B050101T |
|---|---|---|
| **Credits:** 4 | **Marks:** 25 Internal+75 External=100 | **Lectures/ week:** 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Contribution of the following scientists as introduction and part of the Continuous Internal Evaluation-(CIE)**<br>a. Sir C.V. Raman in Spectroscopy and biomolecules<br>b. Har Govind Khorana in Genetics<br>c. M.S. Swaminathan in Green Revolution<br>d. Verghese Kurien in White revolution<br>e. Venkatraman Ramakrishnan in Atomic structure of Ribosome<br>f. Sir. Salim Ali in Ornithology<br>g. Sir. J.N Tata- Modernising silk industry in India<br>**Structure and Function of Cell Organelles I**<br>· Plasma membrane: chemical structure—lipids and proteins<br>· Cell-cell interaction: cell adhesion molecules, cellular junctions<br>· Endomembrane system: protein targeting and sorting, endocytosis, exocytosis. | 6 |
| II | **Structure and Function of Cell Organelles II**<br>· Cytoskeleton: microtubules, microfilaments, intermediate filaments<br>· Mitochondria: Structure, oxidative phosphorylation<br>· Peroxisome and ribosome: structure and function | 6 |
| III | **Nucleus and Chromatin Structure**<br>· Structure and function of nucleus in eukaryotes<br>· Chemical structure and base composition of DNA and RNA<br>· DNA supercoiling, chromatin organization, structure of chromosomes<br>· Types of DNA and RNA | 8 |
| IV | **Cell cycle, Cell Division and Cell Signalling**<br>· Cell division: mitosis and meiosis<br>· Cell cycle and its regulation, apoptosis<br>· Signal transduction: intracellular signalling and cell surface receptors,<br>via G-protein linked receptors, JAK-STAT pathway | 8 |
| V | **Mendelism and Sex Determination**<br>· Basic principles of heredity: Mendel's laws, monohybrid and dihybrid crosses<br>· Complete and Incomplete Dominance | 8 |

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|---|---|---|
| | · Penetrance and expressivity<br>· Genic Sex-Determining Systems, Environmental Sex Determination, Sex Determination in *Drosophila,* Sex Determination in Humans<br>· Sex-linked characteristics and Dosage compensation | |
| VI | **Extensions of Mendelism, Genes and Environment**<br>· Extensions of Mendelism: Multiple Alleles, Gene Interaction<br>· The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics<br>· Cytoplasmic Inheritance, Genetic Maternal Effects<br>· Genomic Imprinting, Anticipation<br>· Interaction Between Genes and Environment: Environmental Effects on Gene Expression, Inheritance of Continuous Characteristics | 8 |
| VII | **Human Chromosomes and Patterns of Inheritance**<br>· Human karyotype<br>· Chromosomal anomalies: Structural and numerical aberrations with examples<br>· Pedigree analysis<br>· Patterns of inheritance: autosomal dominant, autosomal recessive, X-linked recessive, X-linked dominant | 8 |
| VIII | **Infectious Diseases**<br>· Introduction to pathogenic organisms: viruses, bacteria, fungi, protozoa, and worms.<br>· Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: *Trypanosoma, Giardia and Wuchereria* | 8 |
| | **Suggested Readings:**<br>1. De Robertis: Cell and Molecular Biology, Saunders Pub.<br>2. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).<br>3. Alberts et al: Molecular Biology of the Cell: Garland (2002).<br>4. Cooper: Cell: A Molecular Approach: ASM Press (2000).<br>5. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).<br>6. Lewin B. Genes VIII. Pearson (2004).<br>7. Watson et al. Molecular Biology of the Gene. Pearson (2004).<br>8. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby Kuby Immunology. W H Freeman (2007).<br>9. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).<br>10. Shetty Nandini Immunology Introductory Textbook. New Age International. (2005) | |
| **Certificate Course in Medical Diagnostics and Public Health** | | |

| Programme /Class: B.Sc. / Certificate | **Course** B.Sc. **Subject:** ZOOLOGY **Year:** First **Semester:** I<br>**Course Title:** Cell Biology and Cytogenetics Lab | **Course code** B050102P |
|---|---|---|
| **Credits:** 2 | **Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical Classes (60) | **Practical** |
| I | 1. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue.<br>2. To study the different stages of Mitosis in root tip of onion.<br>3. To study the different stages of Meiosis in grasshopper testis.<br>4. To prepare molecular models of nucleotides, amino acids, dipeptides<br>using bead and stick method.<br>5. To check the permeability of cells using salt solution of different concentrations. | 15 |
| II | 1. Study of parasites (e.g. Protozoans, helminths *etc.*) from permanent slides.<br>2. To learn the procedures for preparation of temporary and permanent<br>stained/unstained slides. | 15 |
| III | 1. Study of mutant phenotypes of *Drosophila.*<br>2. Preparation of polytene chromosomes.<br>3. Study of sex chromatin (Barr bodies) in buccal smear and hair bud cells (Human).<br>4. Preparation of human karyotype and study the chromosomal aberrations with respect to number, translocation, deletion etc. from the pictures provided.<br>5. To prepare family pedigrees. | 15 |
| IV | **Virtual Labs (Suggestive sites)**<br>https://www.vlab.co.in<br>https://zoologysan.blogspot.com<br>www.vlab.iitb.ac.in/vlab<br>www.onlinelabs.in<br>www.powershow.com<br>https://vlab.amrita.edu<br>https://sites.dartmouth.edu | 15 |

**Suggested Readings:**


1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis KubyKuby Immunology. W H Freeman (2007).
6. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi

# SEMESTER-II

| Programme /Class: B.Sc. / Certificate | Course B.Sc. Subject: ZOOLOGY Year: First Semester: II<br>Course Title: Biochemistry and Physiology | Course code B050201T |
|---|---|---|
| Credits: 4 | Maximum Marks: 25 Internal+75 External=100 | Lectures/ week: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Structure and Function of Biomolecules**<br>· Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates)<br>· Lipids (saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids)<br>· Structure, Classification and General properties of α-amino acids; Essential and non-essential α-amino acids, Levels of organization in proteins; Simple and conjugate proteins. | 8 |
| II | **Enzyme Action and Regulation**<br>· Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action<br>· Isozymes; Mechanism of enzyme action<br>· Enzyme kinetics; Factors affecting rate of enzyme-catalysed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition;<br>· Allosteric enzymes and their kinetics; Regulation of enzyme action | 8 |
| III | **Metabolism of Carbohydrates and Lipids**<br>· Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway<br>· Glycogenolysis and Glycogenesis<br>· Lipids --- Biosynthesis of palmitic acid; Ketogenesis<br>β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms | 8 |
| IV | **Metabolism of Proteins and Nucleotides**<br>· Catabolism of amino acids: Transamination, Deamination, Urea cycle<br>· Nucleotides and vitamins<br>· Review of mitochondrial respiratory chain, Oxidative phosphorylation, and its regulation | 6 |
| V | **Digestion and Respiration**<br>· Structural organization and functions of gastrointestinal tract and associated glands<br>· Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins;<br>Histology of trachea and lung | 7 |

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| | · Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood Respiratory pigments, Dissociation curves and the factors influencing it; Control of respiration | |
| VI | **Circulation and Excretion**<br>· Components of blood and their functions<br>· Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN<br>· Structure of mammalian heart<br>· Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation<br>· Structure of kidney and its functional unit; Mechanism of urine Formation | 8 |
| VII | **Nervous System and Endocrinology**<br>· Structure of neuron, resting membrane potential<br>· Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers<br>· Types of synapses<br>· Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them<br>· Classification of hormones; Mechanism of Hormone action | 8 |
| VIII | **Muscular System**<br>Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus | 7 |


1. Nelson & Cox: Lehninger's Principles of Biochemistry: McMillan (2000)
2. Zubay*et al:* Principles of Biochemistry: WCB (1995)
3. Voet & Voet: Biochemistry Vols 1 & 2: Wiley (2004)
4. Murray *et al:* Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press

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5. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company. (2006).
6. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
7. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
8. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee C C Human Physiology Volume 1 & 2. 11th edition. CBS Publishers(2016).


**Certificate Course in Medical Diagnostics and Public Health**

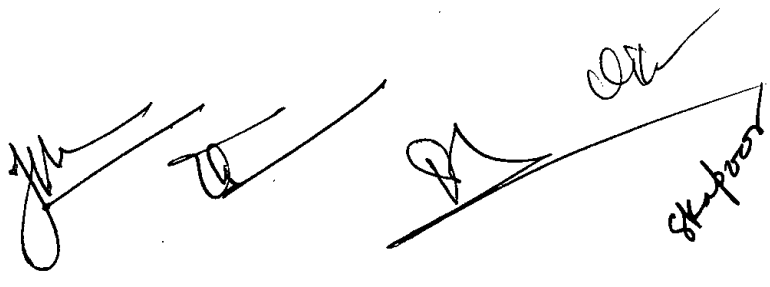
| Programme /Class: B.Sc. / Certificate | Course B.Sc. Subject: ZOOLOGY Year: First Semester: II<br>Course Title: Physiology, Biochemistry and Haematology Lab | Course code B050202P |
|---|---|---|
| Credits: 2 | Marks: 100 External | Practical/ week 4 |
| **Unit** | **Topics**<br>Total Number of Practical Classes (60) | **Practical** |
| I | 1. Estimation of haemoglobin using Sahli's haemoglobinometer<br>2. Preparation of haemin and haem chromogen crystals<br>3. Counting of RBCs and WBCs using Haemocytometer<br>4. To study different mammalian blood cell types using Leishman stain.<br>5. Recording of blood pressure using a sphygmomanometer<br>6. Recording of blood glucose level by using glucometer | 20 |
| II | 1. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid<br>2. Recording of simple muscle twitch with electrical stimulation (or Virtual)<br>**3.** Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex) | 15 |
| III | 1. Ninhydrin test for ·-amino acids.<br>2. Benedict's test for reducing sugar and iodine test for starch.<br>3. Test for sugar and acetone in urine.<br>4. Qualitative tests of functional groups in carbohydrates, proteins and lipids.<br>5. Action of salivary amylase under optimum conditions. | 10 |
| IV | **Virtual Labs (Suggestive sites)**<br>1. https://www.vlab.co.in<br>2. https://zoologysan.blogspot.com<br>3. www.vlab.iitb.ac.in/vlab<br>4. www.onlinelabs.in<br>5. www.powershow.com<br>6. https://vlab.amrita.edu<br>7. https://sites.dartmouth.edu | 15 |

**Suggested Readings:**


1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. /W.B. Saunders Company.
4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons .
5. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott
W. & Wilkins.
6. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.
7. Kesar, Saroj and Vashishta N. (2007). Experimental Physiology: Comprehensive Manual. Heritage Publishers, New Delhi


**Certificate Course in Medical Diagnostics and Public Health**

# Diploma in Molecular Diagnostics and Genetic Counselling



# SEMESTER- III

| Programme /Class: B.Sc. / Diploma | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Second **Semester**: III<br>**Course Title**: Molecular Biology, Bioinstrumentation and Biotechniques | **Course code** B050301T |
|---|---|---|
| **Credits**: 4 | **Marks**: 25 Internal+75 External=100 | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Process of Transcription**<br>· Fine structure of gene<br>· RNA polymerases<br>· Transcription factors and machinery<br>· Formation of initiation complex<br>· Initiation, elongation and termination of transcription in prokaryotes and eukaryotes | 7 |
| II | **Process of Translation**<br>· The Genetic code<br>· Ribosome<br>· Factors involved in translation<br>· Aminoacylation of tRNA, tRNA-identity, Aminoacyl tRNA synthetase<br>· Initiation, elongation and termination of translation in prokaryotes and eukaryotes | 7 |
| III | **Regulation of Gene Expression I**<br>· Regulation of gene expression in prokaryotes: *lac* and *Trp* operons in *E. coli*<br>· Regulation of gene expression in eukaryotes: Role of chromatin in gene expression<br>· Regulation at transcriptional level, post-transcriptional modifications: Capping, Splicing, Polyadenylation<br>· RNA editing. | 8 |
| IV | **Regulation of Gene Expression II**<br>· Regulation of gene expression in eukaryotes:<br>· Regulation at translational level, post-translational modifications: protein folding etc.<br>· Intracellular protein degradation<br>· Gene silencing, RNA interference (RNAi) | 8 |
| V | **Principles and Types of Microscopes**<br>· Principle of Microscopy and Applications<br>· Types of Microscopes: light microscopy, dark field microscopy, phase-contrast microscopy, | 7 |

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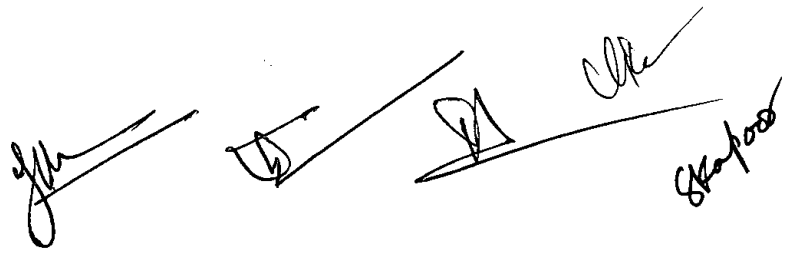
|---|---|---|
| | · Fluorescence microscopy, confocal microscopy, electron microscopy | |
| VI | **Centrifugation and Chromatography**<br>· Principle of Centrifugation<br>· Types of Centrifuges: high speed and ultracentrifuge<br>· Types of rotors: Vertical, Swing-out, Fixed-angle etc.<br>· Principle and Types of Chromatography: paper, ion exchange, gel filtration, HPLC, affinity | 7 |
| VII | **Spectrophotometry and Biochemical Techniques**<br>· Biochemical techniques: Measurement of pH, Preparation of buffers and solutions<br>· Principle of Colorimetry/Spectrophotometry: Beer-Lambert law<br>· Measurement, applications and safety measures of Radio tracer techniques | 8 |
| VIII | **Molecular Techniques**<br>· Detection of nucleic acid by gel electrophoresis<br>· DNA sequencing DNA fingerprinting, RFLP<br>· Polymerase Chain Reaction (PCR)<br>· Detection of proteins, PAGE, ELISA, Western blotting | 8 |
| | **Suggested Readings:**<br>1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).<br>2. Alberts et al: Molecular Biology of the Cell: Garland (2002).<br>3. Cooper: Cell: A Molecular Approach: ASM Press (2000).<br>4. Karp: Cell and Molecular Biology: Wiley (2002).<br>5. Watson et al. Molecular Biology of the Gene. Pearson (2004).<br>6. Lewin. Genes VIII. Pearson (2004).<br>7. Pierce B. Genetics. Freeman (2004).<br>8. Sambrook*et al. Molecular* Cloning Vols I, II, III. CSHL (2001).<br>9. Primrose. Molecular Biotechnology. Panima (2001).<br>10. Clark & Switzer. Experimental Biochemistry. Freeman (2000) | |
| Diploma in Molecular Diagnostics and Genetic Counselling. | | |

| Programme /Class: B.Sc. / Diploma | **Course** B.Sc. **Subject:** ZOOLOGY **Year:** Second **Semester:** III<br>**Course Title:** Bioinstrumentation and Molecular Biology Lab | **Course code** B050302P |
|---|---|---|
| **Credits:** 2 | **Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical Classes (60) | **Practical** |
| I | 1. To study the working principle and Simple, Compound and Binocular microscopes.<br>**2.** To study the working principle of various lab equipment such as pH Meter, Electronic balance, use of glass and micropipettes, Laminar flow, Incubator, Water bath, Centrifuge,<br>Chromatography apparatus, etc. | 15 |
| II | 1. To prepare solutions and buffers.<br>2. To measure absorbance in Colorimeter or Spectrophotometer.<br>3. Demonstration of differential centrifugation to fractionate different components in a mixture. | 15 |
| III | 1. To prepare dilutions of Riboflavin and verify the principle of spectrophotometry.<br>2. To identify different amino acids in a mixture using paper chromatography.<br>3. Demonstration of DNA extraction from blood or tissue samples.<br>4. To estimate amount of DNA using spectrophotometer. | 15 |
| IV | **Virtual Labs (Suggestive sites)**<br>www.labinapp.com<br>www.uwlax.edu<br>www.labster.com<br>www.onlinelabs.in<br>www.powershow.in<br>https://vlab.amrita.edu<br>info@premiereducationaltechnologyies.com<br>https://li.wsu.edu | 15 |
| Suggested Readings:<br>1. Sambrook *et. al. Molecular* Cloning Vols I, II, III. CSHL (2001).<br>2. Primrose. Molecular Biotechnology. Panima (2001).<br>3. Clark & Switzer. Experimental Biochemistry. Freeman (2000) | | |
| Preparation for the Diploma in Molecular Diagnostics and Genetic Counselling. | | |

# SEMESTER- IV



| Programme /Class: B.Sc. / Diploma | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Second **Semester**: IV<br>**Course Title**: Gene Technology, Immunology and Computational Biology | **Course code** B050401T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks**: 25 Internal+75 External=100 | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Principles of Gene Manipulation**<br>· Recombinant DNA Technology<br>· Selection and identification of recombinant cells<br>· Restriction Enzymes, DNA modifying enzymes, Cloning Vectors, Ligation<br>· Gene transfer techniques, Gene therapy | 10 |
| II | **Applications of Genetic Engineering**<br>· Single cell proteins<br>· Biosensors, Biochips<br>· Crop and livestock improvement, development of transgenics<br>· Development of DNA drugs and vaccines | 8 |
| III | **DNA Diagnostics**<br>· Genetic analysis of human diseases, detection of known and unknown mutations<br>· Concept of pharmacogenomics and pharmacogenetics | 4 |
| IV | **Immune System and its Components**<br>· Historical perspective of Immunology, Innate and Adaptive Immunity, clonal selection, complement system<br>· Structure and functions of different classes of immunoglobulins, Hypersensitivity<br>· Humoral immunity and cell mediated immunity<br>· HLA complex: organization, class I and II HLA molecules | 10 |
| V | **V Biostatistics I**<br>· Calculations of mean, median, mode, variance, standard deviation<br>· Concepts of coefficient of variation, Skewness, Kurtosis<br>· Elementary idea of probability and application | 7 |
| VI | **Biostatistics II**<br>· Data summarizing: frequency distribution, graphical presentation—bar, pie diagram, histogram<br>· Tests of significance: one and two sample tests, t-test and Chi-square Test | 7 |

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|---|---|---|
| VII | **Basics of Computers**<br>· Basics (CPU, I/O units) and operating systems<br>· Concept of homepages and websites, World Wide Web, URLs, using search engines | 6 |
| VIII | **Bioinformatics**<br>· Databases: nucleic acids, genomes, protein sequences and structures, Bibliography<br>· Sequence analysis (homology): pairwise and multiple sequence alignments-BLAST, CLUSTALW<br>· Phylogenetic analysis | 8 |
| | **Suggested Readings:**<br>1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).<br>2. Hartl& Jones. Genetics: principles & Analysis of Genes & Genomes. Jones & Bartlett (1998).<br>3. S6mbrook *et al. Molecular* Cloning Vols I, II, III. CSHL (2001).<br>4. Primrose. Molecular Biotechnology. Panima (2001).<br>5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)<br>6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).<br>7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).<br>8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).<br>9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.<br>10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell<br>11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley<br>12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott J. Meiners<br>13. Westhead *al* Bioinformatics: Instant Notes. Viva Books (2003). | |
| Diploma in Molecular Diagnostics and Genetic Counselling. | | |

| Programme /Class: B.Sc. / Diploma | **Course** B.Sc. **Subject:** ZOOLOGY **Year:** Second **Semester:** IV<br>**Course Title:** Genetic Engineering and Counselling Lab | **Course code** B050402P |
|---|---|---|
| **Credits:** 2 | **Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical (60) | **Practical** |
| I | 1. Measure the pre and post clitellar lengths of earthworms and calculate mean, median, mode, standard deviation etc.<br>**2.** 2. Measure the height and weight of all students in the class and apply statistical measures. | 10 |
| II | 1. Determination of ABO Blood group<br>2. To perform bacterial culture and calculate generation time of bacteria.<br>3. To study Restriction enzyme digestion using teaching kits.<br>4. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits.<br>5. Demonstration of agarose gel electrophoresis for detection of DNA.<br>6. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins.<br>7. To calculate molecular weight of unknown DNA and protein fragments from gel pictures. | 20 |
| III | 1. To learn the basics of computer applications<br>2. To learn sequence analysis using BLAST<br>3. To learn Multiple sequence alignment using CLUSTALW<br>4. To learn about Phylogenetic analysis using the programme PHYLIP.<br>**5.** To learn how to perform Primer designing for PCR using available software etc. | 15 |
| IV | **Virtual Labs (Suggestive sites)**<br>1. Gel Documentation Systemhttps://youtu.be/WPpt3-FanNE<br>2. Colorimeter- https://youtu.be/v4aK6G0bGuU<br>3. PCR Part 1- https://youtu.be/CpGX1UFSl4A<br>4. PCR Part 2- https://youtu.be/6IcHAYPTAEw<br>5. DNA isolation Part 1-https://youtu.be/QE7Ul0JnY9A<br>6. DNA isolation part 2- https://youtu.be/-efr_HFeHxM<br>7. DNA curve- https://youtu.be/ubL8QxTeuG4<br>8. Spectrophotometerhttps://youtu.be/ubL8QxTeuG4<br>9. Agarose Part 1- https://youtu.be/7gvHPFww--g<br>10. Agarose part 2- https://youtu.be/j_bOZCHNsSg<br>11. Use software like Primer3, NEB cutter<br>12. NCBI, BLAST, CLUSTAL W, PHYLIP | 15 |

**Suggested Readings:**

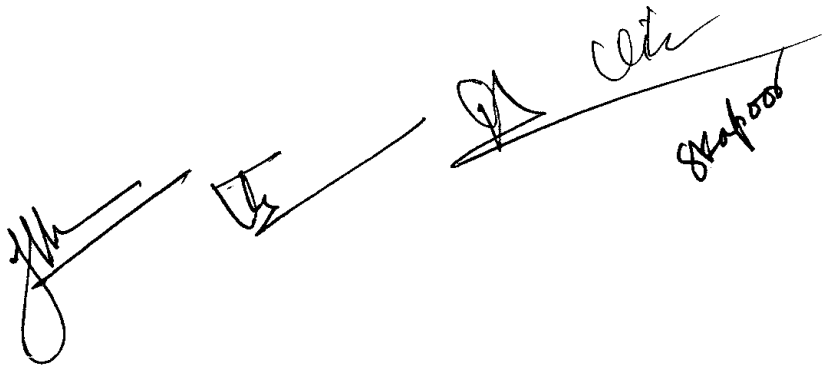

1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook *et al.* Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).


Diploma in Molecular Diagnostics and Genetic Counselling.

| Programme /Class: B.Sc. / Diploma | **Course** B.Sc. (Diploma) **Subject**: ZOOLOGY **Years**: 2 **Semesters**: 3,4 | **Course code** B050403R |
|---|---|---|
| | **Course Title**: Research Project: Methodology | |
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External= 100 | **Lectures/ Practical /Week**: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | Teaching Research Methodology for doing a Research Project. Learning how to identify a research work, do and Present a Research Project Report. | 10 |
| II | Learning the literature which forms the base for identifying a research problem Identifying the lacuna (Need for a study/work) available in the existing knowledge. | 10 |
| III | Formulating the methodology to do the work and identifying the tools and techniques involved in doing the research Project | 10 |
| IV | Doing the work under the guidance of the Research Supervisor and documenting the observations, results, and findings. | 10 |
| V | Collecting the observations of the Research work done in the form of data, Pictures or recordings and arranging them in the proper form of Results or observations or findings presentable as a Research Project. The data collected can be analyzed using the needful statistical analysis and expressed in the form of graphs. | 10 |
| VI | In writing the discussion, findings of the Research work should be correlated with the available literature to justify the findings. The relevant literature related to the work quoted in the Project work should be arranged in the form of References. Finally, the Research Project work can be organised and submitted in the Presentable form to the University. | 10 |
| | Diploma in Molecular Diagnostics and Genetic Counselling | |

# B.Sc. Degree of Bachelor of Science in Zoology

# SEMESTER- V



| Programme /Class: B.Sc. / Degree | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Third **Semester**: V<br>**Course Title**: Diversity of Non- Chordates and Economic Zoology | **Course code** B050501T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External=100 | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Protozoa to Coelenterate**<br>· Protozoa – *Paramecium* (Morphology and Reproduction)<br>· Porifera – *Sycon* (Canal System)<br>· Coelenterata – *Obelia* (Morphology and Reproduction) | 7 |
| II | **Ctenophora to Nemathelminthes**<br>· Ctenophora - Salient features<br>· Platyhelminthes - *Taenia* (Tape worm) (Morphology and Reproduction)<br>· Nemathelminthes –*Ascaris lumbricoides* (Morphology and Reproduction) | 7 |
| III | **Annelida**<br>· Annelida –*Hirudinaria* (Leech) (Morphology and Reproduction) | 8 |
| IV | **Arthropoda**<br>· Arthropoda – *Palaemon* (Prawn) (Morphology, Appendages, Nervous System and Reproduction) | 8 |
| V | **Mollusca, Echinodermata**<br>· Mollusca – *Pila* (Morphology, Shell, Respiration, Nervous System and Reproduction)<br>· Echinodermata –Star fish (Morphology and Water Vascular System) | 8 |
| VI | **Vectors and pests**<br>Life cycle and their control of following pests: Gandhi bug, Sugarcane leafhopper, Rodents. Termites and Mosquitoes and their control | 8 |
| VII | **Economic Zoology-1**<br>Animal breeding and culture: Pisciculture | 7 |
| VIII | **Economic Zoology- 2**<br>Sericulture, Apiculture, Lac-culture, Vermiculture | 7 |
| | **Suggested Readings:**<br>1. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Backwell 17<br>2. Hunter: Life of Invertebrates (1979, Collier Macmillan)<br>3. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)<br>4. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)<br>5. Brusca and Brusca (2016) Invertebrates. Sinauer<br>6. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill | |

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|---|---|---|
| | 7. Neilsen (2012). Animal Evolution: Interrelationships amongst living Phyla. Oxford<br>8. Parasitology- Chatterjee<br>9. Parasitology- Chakraborty<br>10. Thomos C. Chung. General Parasitology. Hardcourt Brace and Co. Ltd. Asia, New Delhi.<br>11. Gerard D. Schmidt and Larry S Roberts. Foundations of Parasitology. McGraw Hill.<br>12. Bisht. D.S., *Apiculture*, ICAR Publication.<br>13. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.<br>14. Jhingran. V.G. Fish and fisheries in India.,<br>15. Khanna. S.S, An introduction to fishes<br>16. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management,<br>17. Biswas.K.P, Fish and prawn diseases,<br>18. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.<br>19. Lee, Earthworm Ecology<br>20. Stevenson, Biology of Earthworms<br>21. Destructive and Useful Insects by C. L. Metcalf<br>22. Sericulture for Rural Development: Hanumappa (1978), Himalaya Publication,<br>23. Sriculture in India Sarkar, D.C. (1988), CSB, Bangalore. | |
| Degree in Bachelor of Science. | | |

| Programme /Class: B.Sc. / Degree | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Third **Semester**: V<br>**Course Title**: Protochordata, Diversity of Chordates and Comparative Anatomy | **Course code** B050502T |
|---|---|---|
| **Credits**: 4 | **Marks:** 25 Internal+75 External=100 | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Origin of Chordates & Hemichordata**<br>· Origin of Chordates. Classification of Phylum Chordata Up to the class.<br>· Hemichordata: General characteristics, classification and detailed study of *Balanoglossus* (Habit and Habitat, Morphology, Anatomy, Physiology and Development). | 6 |
| II | **Cephalochordata and Urochordata**<br>· Cephalochordata: General characteristics, classification and detailed study of *Branchiostoma* (*Amphioxus*) (Habit and Habitat, Morphology, Anatomy, Physiology).<br>· (ii) Urochordata: General characteristics, classification and detailed study of *Herdmania* (Habit and Habitat, Morphology, Anatomy, Physiology and Post Embryonic Development). | 6 |
| III | **Classification and General Characteristics of Vertebrates**<br>· General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) up to the order with examples.<br>· Poisonous and Non-Poisonous Snakes and biting mechanism.<br>· Neoteny and Paedogenesis<br>· Migration in birds<br>· Dentition in Mammals | 8 |
| IV | **Comparative Anatomy and Physiology of Vertebrates**<br>**Integumentary System**<br>Structure, functions and derivatives of integument<br>**Skeletal System**<br>Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches | 8 |
| V | **Digestive System**<br>Alimentary canal and associated glands, dentition | 8 |
| VI | **Respiratory System**<br>Skin, gills, lungs and air sacs; Accessory respiratory organs | 8 |
| VII | **Circulatory System**<br>General plan of circulation, evolution of heart and aortic arches<br>**Urinogenital System**<br>Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri | 8 |
| VIII | **Nervous System**<br>Comparative account of brain<br>Autonomic nervous system, Spinal cord, Cranial nerves in mammals<br>**Sense Organs**<br>Classification of receptors | 8 |

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| | Brief account of visual and auditory receptors in man | |
| | **Suggested Readings:**<br>1. Harvey et al: The Vertebrate Life (2006)<br>2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time<br>(5th ed 2002, Wiley - Liss)<br>3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)<br>4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill<br>5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing)<br>6. Parker and Haswell: Text Book of Zoology, Vol. II (1978, ELBS)<br>7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)<br>8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)<br>9. Weichert C.K and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills | |
| Degree in Bachelor of Science. | | |

| Programme /Class: **B.Sc. / Degree** | Course B.Sc. Subject: ZOOLOGY Year: Third Semester: V<br>**Course Title**: Lab on Virtual Dissection, Anatomy, Economic Zoology and Parasitology | Course code B050503P |
|---|---|---|
| **Credits**: 2 | **Maximum. Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical classes (60) | **Practical** |
| I | Study of animal specimens of various invertebrate phyla.<br>1. To prepare permanent stained slide of septal nephridia of earthworm.<br>2. To take out the nerve ring of earthworm.<br>3. To take out hastate plate from *Palaemon*. | 15 |
| II | 1. Study of animal specimens of various Chordate phyla<br>2. Study on use and ethical handling of model organisms (Mice, rats, rabbit, and pig).<br>3. To prepare stained/unstained slide of placoid scales.<br>4. Comparative study of bones of different vertebrates.<br>5. Comparative study of histological slides of different tissues of vertebrates. | 15 |
| III | 1. Permanent Preparation of: *Euglena, Paramecium*<br>2. Study of prepared slides/specimens of *Entamoeba, Giardia, Leishmania, Trypanosoma, Plasmodium, Fasciola, Cotugnia, Taenia, Rallietina, Polystoma Schistosoma, Echinococcus, Enterobius, Ascaris and Ancylostoma*<br>3. Permanent Preparation of *Cimex* (bed bug)/ *Pediculus* (Louse), *Haematopinus* (cattle louse), fresh water annelids, arthropods; and soil arthropods.<br>4. Larval stages of helminths and arthropods.<br>5. Permanent mount of wings, mouth parts and developmental stages of mosquito and house fly.<br>Permanent preparation of ticks/ mites, abdominal gills of aquatic insects viz. Chironomus larva, dragonfly and mayfly nymphs, preparation of antenna of housefly.<br>6. Identification of pests.<br>7. Life history of silkworm, honeybee, and lac insect.<br>8. Different types of important edible fishes of India.<br>9. Slides of plant nematodes.<br>10. Study of an aquatic ecosystem, its biotic components and food chain.<br>11. Project Report/ model chart making.<br>12. **Dissections**: through multimedia / models<br>13. **Cockroach**: Central nervous system<br>14. ***Wallago/Scoliodon***: Afferent and efferent branchial vessels, Cranial nerves, Weberian ossicles. | 15 |
| IV | **Virtual Labs (Suggestive sites)**<br>https://www.vlab.co.in<br>https://zoologysan.blogspot.com<br>www.vlab.iitb.ac.in/vlab<br>https://www.vlab.co.in<br>https://zoologysan.blogspot.com<br>www.vlab.iitb.ac.in/vlab | 15 |

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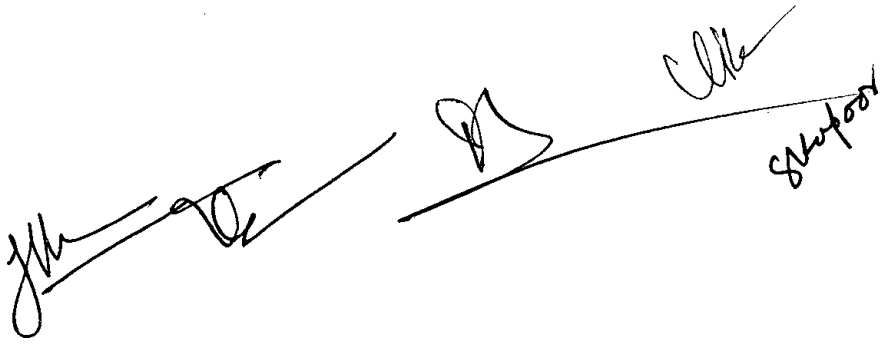
| | www.onlinelabs.in<br>www.powershow.com<br>https://vlab.amrita.edu<br>https://sites.dartmouth.edu | |

**Suggested Readings:**


1. Harvey et al: The Vertebrate Life (2006)
2. Colbert et al: Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2002, Wiley - Liss)
3. Hildebrand: Analysis of Vertebrate Structure (4th ed 1995, John Wiley)
4. Kenneth V. Kardong (2015) Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill
5. McFarland et al: Vertebrate Life (1979, Macmillan Publishing)
6. Parker and Haswell: Text Book of Zoology, Vol. II (1978, ELBS)
7. Romer and Parsons: The Vertebrate Body (6th ed 1986, CBS Publishing Japan)
8. Young: The Life of vertebrates (3rd ed 2006, ELBS/Oxford)
9. Barnes et al (2009). The Invertebrates: A synthesis. Wiley Blackwell 17
10. Marshall: Parker &Haswell Text Book of Zoology, Vol. I (7th ed 1972, Macmillan)
11. Moore: An Introduction to the Invertebrates (2001, Cambridge University Press)
12. Brusca and Brusca (2016) Invertebrates. Sinauer
13. Jan Pechenik (2014) Biology of the invertebrates. McGraw Hill
14. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home
15. Robert Leo Smith Ecology and field biology Harper and Row publisher
16. Handbook of Practical Sericulture: Ullal, S. R. and Narasimhanna, M.N. (1987), Central Silk Board Publication, Bangalore.
17. Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
18. Bisht. D.S., *Apiculture*, ICAR Publication.
19. Singh S., *Beekeeping in India*, Indian council of Agricultural Research, New Delhi.
20. Ullal S.R. and Narasimhanna, M.N. Handbook of Practical Sericulture: CSB,Bangalore
21. Jolly. M. S. Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
22. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co.
23. Santanam, B. *et al,* A manual of freshwater aquaculture
24. Boyd. C.E. &Tucker.C.S, Pond aquaculture water quality management
25. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
26. Ranganathan L.S, Vermicomposting technology- soil health to human health


Degree in Bachelor of Science

# SEMESTER- VI



| Programme /Class: B.Sc. / Degree | Course B.Sc. **Subject**: ZOOLOGY **Year**: Third **Semester**: VI | Course code B050601T |
|---|---|---|
| | **Course Title**: Evolution and Developmental Biology | |
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | **Theories of Evolution**<br>· Origin of Life<br>· Historical review of evolutionary concept: Lamarckism, Darwinism (Natural, Sexual and Artificial selection)<br>· Modern synthetic theory of evolution<br>· Patterns of evolution (Divergence, Convergence, Parallel, Coevolution) | 8 |
| II | **Population Genetics**<br>· Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy- Weinberg equilibrium and conditions for its maintenance<br>· Forces of evolution: mutation, selection, genetic drift | 8 |
| III | **Direct Evidences of Evolution**<br>Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse | 7 |
| IV | **Species Concept and Extinction**<br>· Biological species concept (Advantages and Limitations);<br>Modes of speciation (Allopatric, Sympatric)<br>Mass extinction: Causes, Names of five major Extinctions | 7 |
| V | **Gametes, Fertilization and Early Development**<br>· Gametogenesis, Fertilization<br>· Cleavage pattern<br>· Gastrulation, fate maps<br>· Developmental mechanics of cell specification<br>· Morphogenesis and cell adhesion | 6 |
| VI | **Developmental Genes**<br>· Genes and development<br>· Molecular basis of development<br>· Differential gene expression | 8 |
| VII | **Early Vertebrate Development**<br>· Early development of vertebrates (fish, birds & mammals)<br>· Metamorphosis, regeneration, and stem cells<br>· Environmental regulation of development | 8 |
| VIII | **Late Developmental Processes**<br>· The dynamics of organ development<br>· Development of eye, kidney, limb<br>· Metamorphosis: the hormonal reactivation of development in amphibians, insects | 8 |

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|---|---|---|
| | · Regeneration: salamander limb, mammalian liver, Hydra<br>· Aging: the biology of senescence | |
| | **Suggested Readings:**<br>1. Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing<br>2. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold<br>Spring, Harbour Laboratory Press.<br>3. Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers<br>4. Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.<br>5. Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.<br>6. Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi<br>(2013).<br>7. Essential Developmental Biology: Jonathan M. W. Slack, (3rd ed.), Wiley-Blackwell. (2012).<br>8. Developmental Biology: From a Cell to an Organism (Genetics & Evolution) eBook: Russ Hodge,<br>Infobase Publishing. (2009).<br>9. Current Topics in Developmental Biology: Roger A. Pedersen, Gerald P. Schatten, Elsevier. (1998).<br>10. Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012).<br>11. Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences.<br>(2018).<br>12. Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019). | |
| Degree in Bachelor of Science. | | |

| Programme /Class: B.Sc. / Degree | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Third **Semester**: VI<br>**Course Title**: Ecology, Ethology, Environmental Science and Wildlife. | **Course code** B050602T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Introduction to Ecology**<br>· History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors | 4 |
| II | **Organization of Ecosystem**<br>· Levels of organization, Laws of limiting factors, Study of physical factors,<br>· Population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential, and logistic growth,<br>· Types of ecosystems with one example in detail.<br>Food chain: Detritus and grazing food chains, Food web, Energy flow through the ecosystem,<br>· Ecological pyramids and Ecological efficiencies,<br>Nutrient and biogeochemical cycle with one example of Carbon cycle | 12 |
| III | **Community Ecology**<br>Community characteristics: species richness, dominance, diversity, abundance, Ecological succession with one example. | 7 |
| IV | **Environmental Hazards**<br>· Sources of Environmental hazards<br>· Climate changes<br>· Greenhouse gases and global warming<br>· Acid rain, Ozone layer destruction | 7 |
| V | **Effects of Climate Change**<br>· Effect of climate change on public health<br>· Sources of waste, types, and characteristics,<br>Sewage disposal and its management, Solid waste disposal, Biomedical waste handling and disposal,<br>· Nuclear waste handling and disposal, Waste from thermal power plants.<br>· Case histories on Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident and their aftermath. | 6 |
| VI | **Behavioural Ecology and Chronobiology**<br>· Origin and history of Ethology,<br>· Instinct vs. Learnt Behaviour<br>· Associative learning, classical and operant conditioning, Habituation, Imprinting,<br>· Circadian rhythms; Tidal rhythms and Lunar rhythms<br>· Chrono medicine | 8 |

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|---|---|---|
| VII | **Introduction to Wild Life**<br>· Values of wild life - positive and negative;<br>Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies. | 8 |
| VIII | **Protected areas**<br>· National parks & sanctuaries, Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserves. | 8 |
| | **Suggested Readings:**<br>1. Ecology: Theories & Applications. Peter D. Stiling, 2001, Prentice Hall.<br>2. Ecological Modeling. 2008. Grant, W.E. and Swannack, T.M., Blackwell.<br>3. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.<br>4. Elements of Ecology. T.M. Smith and R.L. Smith, 2014, Pearson Education Inc.<br>5. Environmental Chemistry. 2010. Stanley and Manahan, E. CRC, Taylor & Francis. London.<br>6. Environment. Raven, Berg, Johnson, 1993, Saunders College Publishing.<br>7. Essentials of Ecology. G.T. Miller, Jr. & Scott. E. Spoolman, 2014, Brooks/Cole, Cengage Learning.<br>8. Freshwater Ecology: A Scientific Introduction. 2004. Closs, G., Downes, B. and Boulton, A. Wiley-Blackwell publisher, Oxford.<br>9. Fundamental Processes in Ecology: An Earth system Approach. 2007. Wilkinson, D.M. Oxford | |
| Degree in Bachelor of Science. | | |

| Programme /Class: B.Sc. / Degree | **Course** B.Sc. **Subject**: ZOOLOGY **Year**: Third **Semester**: VI<br>**Course Title**: Lab on Ecology, Developmental Biology, Behavioural Ecology and Wild Life. | **Course code** B050603P |
|---|---|---|
| **Credits**: 2 | **Maximum. Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical Classes (60) | **Practical** |
| I | 1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.<br>2. Study of an Ecosystem: Pond/Grass Land<br>3. Study of population dynamics through numerical Problems.<br>4. Study of circadian functions in humans (daily eating, sleep, and temperature patterns).<br>5. Study of permanent slides on Embryology: Stages of cleavage, Gastrula, and Chick embryo at various stages of development:18, 24, 48, 72 hours. | 26 |
| II | Report on a visit to National Park/Biodiversity Park/Wild life Sanctuary | 4 |
| III | 1. Demonstration of basic equipment needed in wildlife studies, their use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of Cameras and lenses)<br>2. Familiarization and study of animal evidences in the field; Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.<br>3. Demonstration of different field techniques for flora and fauna. | 15 |
| IV | **Virtual Labs (Suggestive sites)**<br>https://www.vlab.co.in<br>https://zoologysan.blogspot.com<br>www.vlab.iitb.ac.in/vlab | 15 |

**Suggested Readings:**

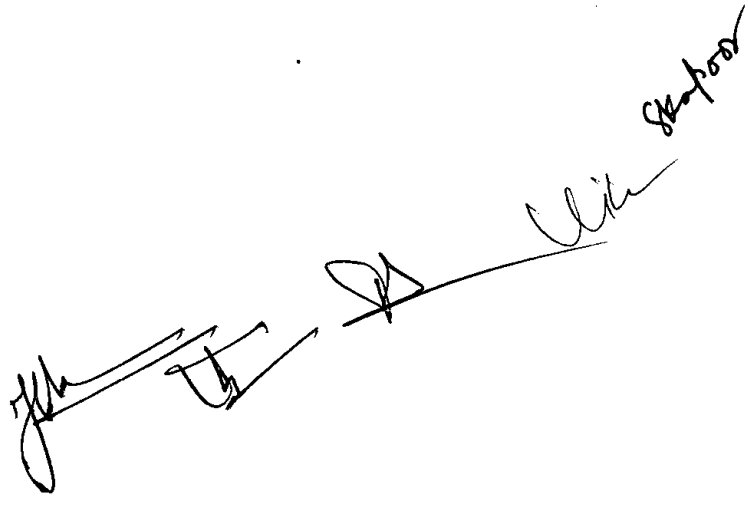

1. Ecology: The Experimental Analysis of Distribution and Abundance. Charles J. Krebs, 2016, Pearson Education Inc.
2. Fundamentals of Ecology. E.P. Odum& Gray. W. Barrett, 1971, Saunders.
3. Robert Leo Sith Ecology and field biology Harper and Row publisher
4. Bookhout, T.A. (1996). Research and Management Techniques for Wildlife and Habitats, 5th edition. The Wildlife Society, Allen Press.
5. Methods and Practice in biodiversity Conservation by David Hawks worth, Springer publication.


Degree in Bachelor of Science.

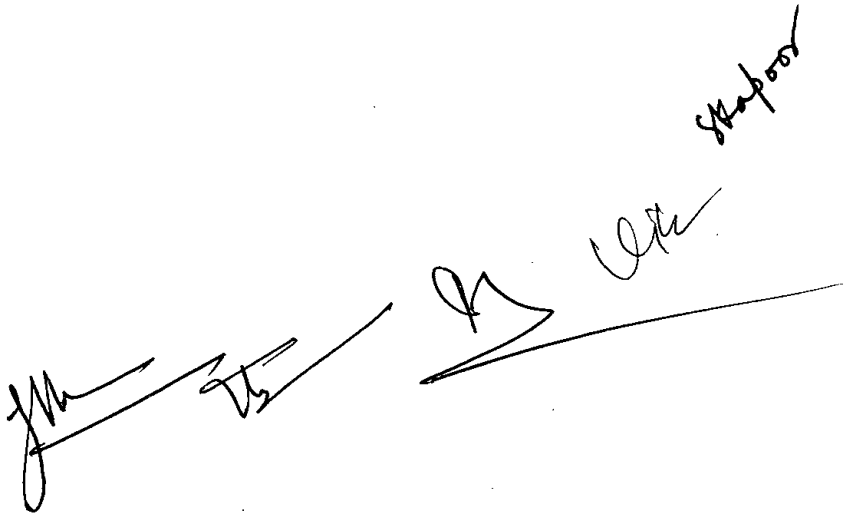
# B.Sc. (Hons.)

# Degree of Bachelor of Science in Zoology

# (Honours)



# SEMESTER- VII



| Programme /Class: B.Sc. / Honours | Course B.Sc. (Hons.) Subject: ZOOLOGY Year: Fourth Semester: VII | Course code B050701T |
|---|---|---|
| | Course Title: Systematics, Structure and Function of Invertebrates. | |
| Credits: 4 | Maximum. Marks: 25 Internal+75 External | Lectures/ week: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | **Principles of animal taxonomy and the basic concepts of . biosystematics**:<br>• Species concept, International Code of Zoological Nomenclature.<br>• Taxonomic procedures: new trends in taxonomy<br>• Taxonomy collections, preservations, and curetting process of identification.<br>• different kinds of taxonomy keys and their merits and demerits | 10 |
| II | **Organization of Coelom**:<br>• Acoelomates<br>• Pseudocoelomates<br>Coelomates: Protostomia and Deuterostomia | 10 |
| III | **Nutrition and Digestion:**<br>• Patterns of feeding and digestion in lower metazoan<br>• Filter feeding in Polychaeta, Mollusca, and Echinodermata. Parasitic mode of feeding. | 10 |
| IV | **Excretion and Respiration**:<br>Structural and functional organization of excretory systems in various invertebrates (Coelomoducts, Nephridia and Malpighian tubules) and various excretory products produced within them.<br>• Osmoregulation.<br>Structural and functional organization of respiratory organs (gills, lungs and trachea) in invertebrates. | 10 |
| V | . **Parasitic protozoans, helminths and Invertebrate Larvae**:<br>Larval forms of free-living Invertebrates.<br>Strategies and evolutionary significance of larval forms.<br>Description of protozoan and helminth parasites | 10 |
| VI | **Minor Phyla in Classification:**<br>Concept and significance.<br>• Organization and general characters.<br>Affinities of Rotifera and Hemichordata | 10 |
| Degree in Bachelor of Science (Honours) Zoology. | | |

Suggested Readings for **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth: Paper: Systematic and Structure and Function of Invertebrate


1. Barnes, R. D. (1987). *Invertebrate zoology* (5th ed.). Saunders College Publishing.
2. Barrington, E. J. W. (1979). *Structure and function of invertebrates*. Thomas Nelson and Sons Ltd.
3. Hyman, L. H. (1940–1967). *The invertebrates* (Vols. 1–6). McGraw-Hill.
4. Mayr, E., & Ashlock, P. D. (1991). *Principles of systematic zoology* (2nd ed.). McGraw-Hill.

| Programme /Class: B.Sc. / Honours | Course B.Sc. (Hons.) Subject: ZOOLOGY Year: Fourth Semester: VII<br>Course Title: Molecular and Cell Biology | Course code B050702T |
|---|---|---|
| Credits: 4 | Maximum. Marks: 25 Internal+75 External | Lectures/ week: 4 |
| Unit | Topics<br>Total Number of Lectures (60) | Lectures |
| I | **History and scope of molecular Biology**:<br>Structure of DNA and types of DNA<br>• DNA replication: prokaryotic and eukaryotic DNA replication, DNA damage and DNA repair<br>Nucleosome and structure of chromatin | 10 |
| II | **DNA- Transcription and Translation**:<br>• Transcription: Pro and Eukaryotic transcription, RNA polymerases<br>• Three-dimensional structure of t-RNA, clover leaf model, L type model.<br>• Regulation of gene expression: Prokaryotic organisms, Lac operon, Trp. operon.<br>Role of ribosomes in protein synthesis, operon model. | 10 |
| III | **Cell Biology:**<br>• Modern Concepts of Structure and functions of bio membranes.<br>• Transport across the Plasma Membrane: Diffusion, Active transport and Pumps<br>• Membrane Potential. | 10 |
| IV | **Cell Organelles:**<br>Structural and functional organization of Cell Organelles (Mitochondria, Lysosomes, Golgi Apparatus and Endoplasmic Reticulum)<br>• Molecular structure of chromosome, Heterochromatin and Giant Chromosomes.<br>Cilia and flagella. | 10 |
| V | **Cell Cycles**:<br>Cellular differentiation and cell cycle.<br>• Mitosis and Meiosis.<br>• Significance of cell cycles. | 10 |
| VI | **Cellular Origin of Diseases**:<br>• Cellular origin of diseases: cancer, glycogen storage disease, lipid storage disease<br>Inborn errors of metabolism Phenyl Ketonuria, Galactosaemia, Thalassemia, and Sickle cell anaemia | 10 |
| | Suggested Readings: | |

**Degree in Bachelor of Science (Honours) Zoology.**

Suggested Readings for **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth: Paper: Molecular and Cell Biology


1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2001). *Molecular biology of the cell* (4th ed.). Garland Science.
2. Freifelder, D. (1998). *Molecular biology* (2nd ed.). Jones and Bartlett Publishers.
3. Gardner, E. J. (1975). *Principles of genetics*. Wiley Eastern Pvt. Ltd.

4. Giese, A. C. (1973). *Cell physiology* (5th ed.). W.B. Saunders Company.
5. Karp, G. (1996). *Cell and molecular biology: Concepts and experiments*. John Wiley & Sons.
6. Karp, G. (1999). *Cell and molecular biology: Concepts and experiments* (2nd ed.). John Wiley & Sons.
7. Kleinsmith, L. J., & Kish, V. M. (1995). *Principles of cell and molecular biology* (2nd ed.). Harper Collins College Publishers.
8. Lodish, H., Berk, A., Zipursky, S. L., Matsudaira, P., Baltimore, D., & Darnell, J. (1995). *Molecular cell biology* (3rd ed.). Scientific American Books.
9. Sinnott, E. W., Dunn, L. C., & Dobzhansky, T. (1960). *Principles of genetics* (5th ed.). McGraw-Hill.
10. Swanson, C. P. (1957). *Cytology and cytogenetics*. Macmillan & Co. Ltd.
11. Waddington, C. H. (1956). *An introduction to modern genetics*. George Allen & Unwin Ltd.
12. White, M. J. D. (1973). *Animal cytology and evolution* (3rd ed.). Cambridge University Press.

| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth **Semester**: VII | **Course code** B050703T |
|---|---|---|
| | **Course Title**: Biological Techniques and Instrumentation | |
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | **Fixation:** Principles of chemical basis of fixation. Fixation by formaldehyde, glutaraldehyde, chromium salts, mercury salts, Osmium tetroxide, alcohol, and acetone. Freeze drying, freeze fracturing and substitution techniques | 10 |
| II | **Cytology and Hematology techniques**: Measurement of cell size • Hematological methods: Total Leucocyte Count, Total Erythrocytes Count, Differential Leucocyte Count, Hb concentration, PCV, ESR and Red cell indices. | 10 |
| III | **Chemical basis of staining for Histology and Histochemistry:** Processing a tissue, Embedding, sectioning by a Microtome, and staining for observation. Special Staining Methods for Carbohydrates, Proteins, Lipids and DNA contents like PAS, Feulgen and other methods. Metachromasia. | 10 |
| IV | **Tools for Histology, Cytology and Histochemistry:** Various types of microscopes. Compound, Binocular and Trinocular Microscopes • Phase contrast, interference, fluorescence, and polarized microscopes. Transmission and scanning Electron microscopes. | 10 |
| V | **Techniques of separation I**: Types of Centrifuges and their applications. Types of Electrophoresis techniques and their applications | 10 |
| VI | **Techniques of separation II**: Types of Chromatography techniques and their applications. Autoradiography and its applications. X-ray diffraction method and its applications. | 10 |
| | Suggested Readings: | |

**Degree in Bachelor of Science (Honours) Zoology.**

Suggested Readings for **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth: Paper: Biological Techniques and Instrumentation


1. Bisen, P. S., & Mathur, S. (2010). *Tools and techniques in life sciences*. CBS Publishers & Distributors.
2. Braun, R. D. (1987). *Introduction to instrumental analysis*. McGraw-Hill Book Company.
3. Brouss, R. (1982). *Introduction to instrumental analysis*. McGraw-Hill International Editions.
4. Caspersson, T. O., & Schultz, W. E. (1950). *Cell growth, cell function and cytochemical study*. W. W. Norton & Co.

5. Cowdry, E. V. (1950). *Laboratory techniques in biology and medicine*. Williams & Wilkins Co.
6. Sluder, G., & Wolf, D. E. (Eds.). (2008). *Techniques in microscopy for biomedical applications*. Tata McGraw-Hill Education.
7. Wilson, K., & Goulding, K. H. (1986). *A biologist's guide to principles and techniques of practical biochemistry* (3rd ed.). Edward Arnold.
8. Wilson, K., & Walker, J. (2010). *Principles and techniques of biochemistry and molecular biology* (7th ed.). Cambridge University Press.

| Programme /Class: B.Sc. / Honours | Course B.Sc. (Hons.) Subject: ZOOLOGY Year: Fourth Semester: VII<br>Course Title: Microbiology and Immunology | Course code B050704T |
|---|---|---|
| Credits: 4 | Maximum. Marks: 25 Internal+75 External | Lectures/ week: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **History and scope of Microbiology:**<br>• Recognition of microbial role in diseases.<br>• Microbial effects on organic and inorganic matter, the composition of microbial world and scope and relevance of microbiology.<br>Virus - Concept, general properties, cultivation, purification, Assay, structure, and structural properties | 10 |
| II | **Microbial Taxonomy**:<br>Morphological, Physiological, metabolic.<br>• Ecological and molecular characteristics.<br>Aerobic, motile, and non-motile gram-negative bacteria, anaerobic gram negative and gram-positive bacteria. | 10 |
| III | **Basic concepts of immunology**:<br>• Basic concepts of immunity, Types of immunity, Phagocytosis, Inflammation<br>• Cells and molecules of the immune system, functions of immune response.<br>The adaptive immune response- T cell immunity properties, cytotoxicity. | 10 |
| IV | **Nature of symbiotic microbial association:**<br>• Types of interactions: Symbiosis, Commensalism, Mutualism and Host parasite relationships.<br>• Microbiota of human body.<br>• Microorganisms as components of environment<br>Microorganisms in Aquatic Ecosystems . | 10 |
| V | **Microbial Diseases and Immunology:**<br>Viral- Air borne, Direct contact, Food borne and water borne diseases.<br>• Bacterial- Air borne and direct contact.<br>• Fungal and Protozoan diseases.<br>Deficiencies of immune system, autoimmune diseases, allergy, and hypersensitivity | 10 |
| VI | **Antibodies**:<br>• Antibody production and their function.<br>• Structure of antibody molecules and immunoglobulin genes. Antibody with specific | 10 |

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| | antigens.<br>• Antigen recognition by T lymphocyte and Antibody production by B lymphocyte. | |

**Degree in Bachelor of Science (Honours) Zoology**

Suggested Readings for **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth: Paper: Microbiology and Immunology


1. Banwart, G. J. (1989). *Basic food microbiology* (2nd ed.). Van Nostrand Reinhold.
2. Campbell, R. (1983). *Microbial ecology*. Blackwell Scientific Publications.
3. Kuby, J. (1997). *Immunology* (3rd ed.). W.H. Freeman and Company.
4. Laskin, A. I. (Ed.). (2005). *Advances in applied microbiology* (Vol. 57). Academic Press.
5. Prescott, L. M., Harley, J. P., & Klein, D. A. (2005). *Microbiology* (6th ed.). McGraw-Hill.
6. Wistreich, G. A., & Lechtman, M. D. (1988). *Microbiology* (5th ed.). Macmillan Publishing Company.

| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject:** ZOOLOGY **Year:** Fourth **Semester:** VII<br>**Course Title:** Practical | **Course code** B050705P |
|---|---|---|
| **Credits:** 4 | **Marks:** 100 External | **Practical/ week** 4 |
| **Unit** | **Topics**<br>Total Number of Practical Classes (60) | **Practical** |
| I | **(I): Specimens and Slides (Invertebrates)**<br>**(a)** Protozoa:<br>Entamoeba histolytica, Entamoeba gingivalis. Trypanosoma, Leishmania, Trichomonas, Plasmodium.<br>**(b)** Porifera:<br>Euplectella, Spongilla, Cliona, Euspongia.<br>Prepared Sides: LS of Sycon, Gemmule, Amphiblastula Larva.<br>**(c)** Coelenterata:<br>Tubularia, Campanularia, Sertularia, Millipora, Physalia, Porpita, Tubipora, Alcyonium, Adamsia, Madrepora, Fungia.<br>Medusa of Obelia, Ephyra and Scyphistoma larvae of Aurelia.<br>**(d)** Platyhelminthes:<br>Planaria, Polystoma, Schistosoma, Echinococcus Granulosus, Fasciola hepatica, Taenia solium<br>Sporocyst, Miracidium, Redia and Cercaria larvae of F. hepatica<br>Scolex, Gravid proglottid and Cysticercus larva of T. solium. | **12** |
| II | **(e)** Aschelminthes:<br>Ancylostoma, Wuchereria bancrofti, Trichinella spiralis, Trichuris, Enterobius vermicularis<br>T.S. through the body of Ascaris Male and Female.<br>(f) Annelida:<br>Nereis, Heteronereis, Glycera, Chaetopterus, Arenicola, Amphitrite, Pontobdella, Hirudinaria,<br>T. S. of Pheretima through Pharynx and Typhlosolar regions,<br>Parapodium of Nereis and Heteronereis,<br>Trochophore Larva of Nereis,<br>T. S. of Hirudinaria through Crop with/without diverticula.<br>(g) Mollusca:<br>Snail, Chiton, Dentalium, Aplysia, Doris, Mytilus, Pinctada, Teredo, Loligo, Octopus, Nautilus | 12 |

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| | Radula of Pila, TS through gill Lamina of Unio,<br>Glochidium Larva of *Unio.* | |
| III | **(h) Arthropoda:**<br>Balanus, Sacculina on Crab, Eupagurus, Scolopendra, Julus, Peripatus, Limulus, Lepisma, Collembola, Melanopus, Gryllotalpa, praying Mantis, Pediculus, Termite, Dragon Fly, Belostoma, Cicada, Butterfly, Moth, Xenopsylla,<br>Head and Mouth Parts of Male and Female Anopheles and Culex.<br>Head and mouth parts of Butterfly<br>Mouth parts and Sting apparatus of honey bee.<br>**(i) Echinodermata:**<br>Antedon, Cucumaria, Holothuria, Asterias, Ophiothrix, Echinus, Clypeaster ,<br>Bipinnaria, Brachiolaria, Ophiopluteus and Echinopluteus larvae.<br>**(j) Hemichordata:**<br>Balanoglossus,<br>T.S. of Balanoglossus through Proboscis and collar regions, Tonaria larva of Balanoglossus.<br>**(k) Minor Phyla:**<br>Echiura, Bonellia, Sipunculus, Bugula and Sagitta | 12 |
| IV | **Dissections: Major and Minor**<br>1. Pheretima posthuma (Earthworm): External Features, General Anatomy, Septal Nephridia, Ovary and Nervous System<br>2. Unio/Mytilus: External Features, General anatomy and Nervous System<br>3. Sepia/ Loligo: Nervous System<br>4. Pila: External Features, General Anatomy and Nervous System.<br>5. Palaemon: External features, Appendages and Nervous System | 12 |

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| | 6. Cockroach: External Features, General anatomy, Reproductive System and Nervous System<br><br>**SELECTED MOUNTINGS:**<br>1. Phylum Protozoa: Amoeba, Paramecium, Euglena, Balantidium.<br>2. Phylum Porifera: Spicules, Spongin fibre, Gemmules<br>3. Phylum Coelenterata: Hydra, Obelia<br>4. Phylum Platyhelminthes: Planaria<br>5. Nematodes.<br>6. Phylum Annelida (a) Earthworm-Ovary, septal nephridia,<br>Nereis: Parapodia.<br>7. Phylum Arthropoda:<br>Palaemon- Hastate Plate, Statocyst<br>Cyclops, Daphnia, and other Crustacean Larvae.<br>Cockroach-Salivary Glands, Trachea,<br>Mouth parts of insects.<br>8. Phylum Echinodermata: Tube Feet and pedicellariae of starfish | |
| V | **(II) Molecular Biology**<br>1. Study of polytene Chromosomes<br>2. Study and interpretation of Electron Micrographs or Photographs showing DNA replication and Transcription<br>**(III) Cell Biology:**<br>1. Study of Human karyotype (normal and abnormal).<br>2. Study of buccal epithelial cells, neurons, striated muscles using Methylene blue.<br>3. Study of different stages of Mitosis using onion root tip.<br>**(IV) Techniques and Instrumentation:**<br>1. To study the working principle of various laboratory equipment such as pH Meter, Electronic balance<br>2. Use of glass and micropipettes, Laminar flow, Incubator, Water bath, Centrifuge, Chromatography apparatus etc. | 6 |
| VI | **(V) Microbiology:**<br>1. To study the different phases of bacterial growth and to plot standard growth curve of Staphylococcus | |

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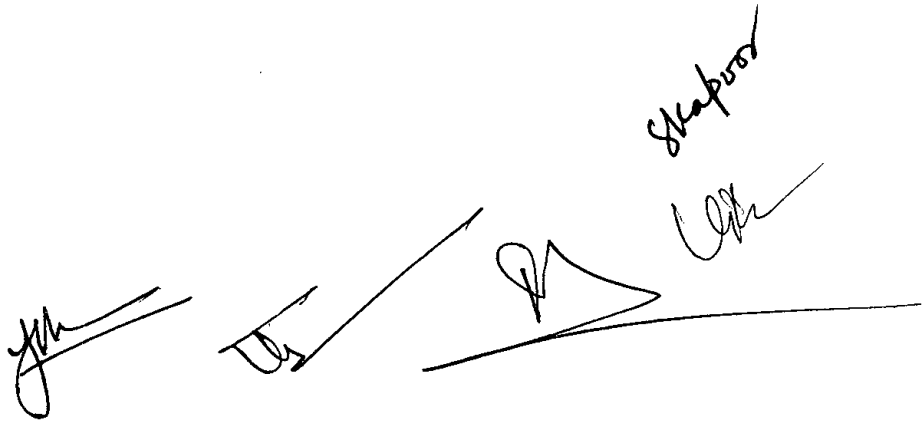
| | aureus.<br>2. Gram Stain Technique.<br>Staining of Bacterial smear<br>**(VI) Immunology:**<br>1. Determination of ABO Blood group<br>2. To study primary and secondary immune organs of rat<br>3. Histological study of spleen, thymus, and lymph nodes through slides/ photographs<br>**4.** Preparation of stained bIood fiIm to study various types of blood cel Is | 6 |
| Suggested Readings: | | |
| **Degree in Bachelor of Science (Honours) Zoology** | | |

# SEMESTER- VIII



| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth **Semester**: VIII | **Course code** B050801T |
|---|---|---|
| | **Course Title**: Chordate Anatomy | |
| **Credits**: 4 | **Maximum. Marks**: 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | • Outline classification of various classes of chordates<br>Concept of Protochordates | 10 |
| II | • General organization and affinities of Cephalochordata, Cyclostomata, Holocephali and Dipnoid<br>Origin, Evolution, adaptation, and parental care in amphibia | 10 |
| III | • Characters and affinities of Rhynchocephalia<br>• Characters and affinities of Ratitae, palate in birds, migration and aerial adaptation in birds<br>• Characters and affinities of Prototheria and Metatheria<br>Adaptive radiation in Mammals | 10 |
| IV | • Chordate integuments and its derivatives<br>• Evolution of heart, aortic arches and portal systems<br>Comparative account of respiratory organs of Chordates | 10 |
| V | • Comparative account of jaw suspensorium, vertebral column of Chordates<br>Evolution of Urinogenital systems in Chordates | 10 |
| VI | • Organs of olfaction and taste<br>• Lateral line systems, electroreception<br>Comparative anatomy of brain and spinal cord in relation to its functions in Chordates | 10 |
| Suggested Readings:<br>**Books Recommended:**<br>**Ali Salim, 1995.The** Book of Indian Birds. Bombay Nat. His. Soc. Bombay.<br>**Berrill, N. J. 1955.** The Origin of Vertebrates. London<br>**Colbert E. H. 1955.** Evolution of The Vertebrates. New York **Goodrich E.S. 1958.** Studies on the Structures and Development of Vertebrates. vol I&II. New York<br>**Hegnar R. W. & Steiles K. A. 1963.** College Zoology. Oxford & IBH | | |
| **Degree in Bachelor of Science (Honours) Zoology.** | | |

Suggested Readings for **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth:

| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth **Semester**: VIII<br>**Course Title**: Genetics and Biotechnology | **Course code** B050802T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Basics concepts and Mendelism**<br>• Genetic terms and concepts<br>• Mendel's laws of inheritance<br>• Limitations of Mendelism (incomplete dominance, codominance, epistasis, polygenes, lethal genes)<br>Linkage and crossing over | 10 |
| II | **Chromosomal basis of inheritance**<br>• Gene and chromosome mapping<br>• Variations in chromosome number and structure<br>• Human genetic disorders<br>• Concept of gene<br>. Basic concepts of bacterial genetics | 10 |
| III | **Molecular Basis of Inheritance**<br>• Genetic material<br>• Experiments to support DNA as genetic material<br>• Structures of nucleic acids<br>• Replication of DNA<br>• DNA repair mechanisms | 10 |
| IV | **Gene Expression**<br>• Concept of modem central dogma and flow of genetic information<br>• Genetic codes<br>• Transcription and translation in prokaryotes and eukaryotes<br>• Operon model and gene regulation in bacteria<br>Gene regulation in eukaryotes | 10 |
| V | **Biotechnology and basics of DNA recombination**<br>• Scope of biotechnology<br>• DNA Recombination Technology<br>• PCR<br>• Gel Electrophoresis<br>• Southern, Northern and Western Blotting | 10 |

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| | • Gene guns<br>• Autoradiography | |
| VI | **Biotechnology and its applications**<br>• Biotechnical waste water and sewage treatment<br>• New medicines using biotechnical `methods<br>• Single cell proteins and bio-fortified food<br>• Genetically modified organisms<br>Biotechnology and environment | 10 |

Suggested Readings:


1. Snustad and Simmons., Principals of genetics. John Wiley & Sons, Inc.
2. Robert H. Tamarin., Principals of genetics. Robert H. Tamarin, WCB Publishers.
3. D.L. Hartl, E.W. Jones., Genetics - Principles and Analysis. Bartlett Publishers, Massachusetts.
4. John E. Smith., Biotechnology. Cambridge University Press.
5. A. J. Nair., Introduction to biotechnology and genetic engineering.

   Infinity science press, Massachusetts New Delhi, India.


**Degree in Bachelor of Science (Honours) Zoology.**

| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth **Semester**: VIII<br>**Course Title**: Animal Physiology and Biochemistry | **Course code** B050803T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | **Biochemical setup**<br>• Carbohydrates- structure, and functions<br>• Amino acids and protein structure<br>• Fatty acids, lipids, and steroids<br>Nucleotides and nucleic acids | 10 |
| II | **Biomolecules of physiological importance**<br>• Enzymes, classification, action mechanism, inhibition<br>• Hormones, types, and mechanism of action<br>bioenergetics (Glycolysis, Kreb's cycle, Beta oxidation, Pentose Phosphate Pathway (PPP) and Electron Transport System (ETS) | 10 |
| III | **Digestion and respiration**<br>• Alimentary canal and associated glands<br>• Digestive juices, enzymes and their action<br>• Absorption and assimilation of food<br>• Structure of lungs and thoracic cavity<br>• Inhalation and exhalation mechanism<br>Transport of gases within the body | 10 |
| IV | **Neural and chemical control**<br>• Neurons, types, and impulse conduction<br>• Synaptic transmission<br>• Structure and functions of Brain, spinal cord and associated nerves<br>• Reflex actions and their types<br>• Autonomic control<br>• Structure of eye and ear<br>Important endocrine glands and their secretion | 10 |
| V | **Muscles, Skeleton and Excretion**<br>• Various types of muscles<br>• Detailed structure of skeletal muscle and the mechanism of contraction<br>• Details of human skeleton (Axial and | 10 |

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| | appendicular skeleton).<br>• Pectoral girdles in different vertebrates<br>• Pelvic girdles in different vertebrates<br>• Modes of excretion in different vertebrates<br>• Mechanism of urine formation and urine concentration mechanism<br>RAAS and hemodialysis | |
| VI | **Cardiovascular system and reproduction**<br>• Heart in different vertebrates<br>• Detailed structure and functioning of human heart<br>• Blood pressure, Arteries, and veins<br>• Human male and female reproductive system<br>• Menstruation and pregnancy<br>• Human and chick embryology.<br>Foetal membranes and placenta | 10 |

Suggested Readings: **Suggested Reading** -


1. Denis e R. Ferrier, Lippincott's Illustrated Reviews : Biochemistry.Lippicott Williams and Wilikins
2. David L. Nelson, Michael M. Cox. . Lehninger Principles of Biochemistry
3. Harper's Illustrated Biochemistry. Lange Medical Books
4. Guyton, Hall. Text book of Medical Physiology. Elsevier Sounders
5. Lauralee Sherwood. Human Physiology - From Cells to Systems.Brooks/Cole
6. Agrawal P. K. Simplified Biochemistry. Pragati Prakashan. Meerut
7. Ganong's Review of Medical Physiology. Lange Medical book


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**Degree in Bachelor of Science (Honours) Zoology.**

| Programme /Class: B.Sc. / Honours | **Course** B.Sc. (Hons.) **Subject**: ZOOLOGY **Year**: Fourth **Semester**: VIII<br>**Course Title**: Developmental Biology | **Course code** B050804T |
|---|---|---|
| **Credits**: 4 | **Maximum. Marks:** 25 Internal+75 External | **Lectures/ week**: 4 |
| **Unit** | **Topics**<br>Total Number of Lectures (60) | **Lectures** |
| I | • Theories of Development: Preformation of Epigenesis<br>• Gametogenesis: Spermatogenesis and Oogenesis<br>Fertilization: Significance of Fertilization for development, Pre and Post Fertilization and Biochemistry of Fertilization | 10 |
| II | • Biochemistry of Semen: Semen composition and formation, assessment of sperm function and sperm structure<br>• Different types of eggs in Chordates<br>Different types of cleavage | 10 |
| III | • Early embryonic development: Patterns of cleavage, Blastulation and Gastrulation in Chordates (Tunicates to Mammals), fate maps, morphogenic movements, mechanics and significance of gastrulation<br>• Casual basis of development: primitive embryonic induction, •• concepts of potencies, prospective fates , progressive determination, Speman's primary organization, nature and regionally specific properties of inductor | 10 |
| IV | • Organogenesis: Brain, aortic arches, hearts, eyes in mammals<br>• Development and physiology of extraembryonic membranes (foetal membranes) in amniotes | 10 |
| V | • Development types and physiology of mammalian placenta<br>• Metamorphosis in amphibian: Structural and physiological changes during metamorphosis, endocrine control of metamorphosis.<br>Environmental regulations of animal development | 10 |
| VI | • Competence, determination, differentiation, and regeneration<br>• Regeneration: types of regeneration (physiological, reparative and compensatory, hypertrophy),<br>• regenerative ability in Chordates morphological and histological process in amphibian limb regeneration, origin of cells for regeneration and differentiation | 10 |

**Books Recommended:**

**Balinsky, B.I.** *Introduction To Embryology.* Saunders, Philadelphia **Berril, N. J.& Karp, G.** *Development Biology.* McGraw Hill, New York

**Gilbert, S. F.** *Developmental Biology.* 10th Edition, Sinauer Associated Inc., Massachusetts

**Hamburger, V& Hamilton, H.L.** *Handbook of Chick development stages.* Saunders Publications

**Degree in Bachelor of Science (Honours) Zoology.**

| Programme /Class: B.Sc. / Honours | Course B.Sc. (Hons.) Subject: ZOOLOGY Year: Fourth Semester: VIII<br>Course Title: Practical | Course code B050805P |
|---|---|---|
| Credits: 4 | Marks: 100 External | Practical/ week 4 |
| Unit | Topics<br>Total Number of Practical Classes (60) | Practical |
| I | **Study of Museum specimens and a field Visit**<br>(a) Study of various Chordate specimens from Protochordata and class Cyclostomata to class Mammalia.<br>(b) A Field visit and study of Biodiversity of animals. | **12** |
| II | **Histology, Osteology and Embryology**<br>(a) Histological slides of various organ systems from Protochordata and class Cyclostomata to class Mammalia.<br>(b) Osteology of Vertebrates from Amphibia to Mammals.<br>(c) Embryology slides: Blastula and Gastrula.<br>(d) Study of Chick Embryo Development after 18, 24, 48 and 72 hours of incubation of Egg. | 12 |
| III | **Dissection: Major And Minor**<br>Major dissections:<br>1. Afferent Branchial Arteries of (dogfish) Scoliodon.<br>2. Efferent Branchial Arteries of (dogfish) Scoliodon.<br>3. Cranial nerves of Scoliodon<br>4. Minor dissection:<br>Exposure of internal ear of Scoliodon in situ.<br>**Permanent mounting:**<br>1. Preparation of permanent slides from animal tissues like amphioxus-oral hood/wheel organ/pharyngeal wall.<br>12. Preparation of permanent slide of placoid scales from scoliodon. | 12 |
| IV | **Genetics and Biotechnology Exercise:**<br>Genetics Exercises based on basic principles of heredity:<br>1. Incomplete Dominance<br>2. Law Of independent Assortment<br>3. Multiple Alleles<br>4. Sex-Linked Inheritance.<br>5. Pedigree Analysis.<br>Biotechnological exercises (on the basis of | 12 |

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|---|---|---|
| | availability)<br><br>1. Cell culture study<br>2. Primary cell line and Secondary cell line culture study<br>3. Vermiculture<br>4. Transgenic animals and their models. | |
| V | **Physiology and Biochemistry Exercise:**<br>1. Counting of RBC and WBC's using Hemocytometer.<br>2. A study of mammalian blood (cell types) by making Leishman's stain blood smear.<br>3. Monitoring of muscle activity by electromyography.<br>4. Separation of amino acids by paper chromatography and the calculation of Rf value.<br>5. identification of lipids/Amino acids in a given sample by thin layer Chromatography | 12 |
| **Degree in Bachelor of Science (Honours) Zoology.** | | |

| Programme /Class: B.Sc. / Honours | Course B.Sc. (Hons.) Subject: ZOOLOGY Years: 4 Semesters: 7,8 | Course code |
|---|---|---|
| | Course Title: Research Project: Methodology | B050806R |
| Credits: 8 | Maximum. Marks: 25 Internal+75 External= 100 | Lectures/ Practical /Week: 4 |
| **Unit** | **Topics** Total Number of Lectures (60) | **Lectures** |
| I | Teaching Research Methodology for doing a Research Project. Learning how to identify a research work, do and Present a Research Project Report. | 10 |
| II | Learning the literature which forms the base for identifying a research problem Identifying the lacuna (Need for a study/work) available in the existing knowledge. | 10 |
| III | Formulating the methodology to do the work and identifying the tools and techniques involved in doing the research Project | 10 |
| IV | Doing the work under the guidance of the Research Supervisor and documenting the observations, results, and findings. | 10 |
| V | Collecting the observations of the Research work done in the form of data, Pictures or recordings and arranging them in the proper form of Results or observations or findings presentable as a Research Project. The data collected can be analyzed using the needful statistical analysis and expressed in the form of graphs. | 10 |
| VI | In writing the discussion, findings of the Research work should be correlated with the available literature to justify the findings. The relevant literature related to the work quoted in the Project work should be arranged in the form of References. Finally, the Research Project work can be organised and submitted in the Presentable form to the University. | 10 |

**Degree in Bachelor of Science (Honours) Zoology.**

**Information for those Opting Zoology as a Minor Subject**

Any one of the Following courses of **SWAYAM Portal** is recommended as Minor Subject in Zoology.

**Course No: 1- NOC 25 MG 74: Applied and Economic Zoology**

**Course No. 2- NOC 25 GE 14 Fundamentals of Ecology**