

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

REGULATIONS AND SYLLABUS for B.Sc., Zoology Major

(This will come into force from the academic year 2018-2019 onwards)

1. Introduction of the Programme

B.Sc., DEGREE COURSE IN ZOOLOGY- Medium of instruction: English

This B.Sc., Zoology course is for a period of three years with six semesters and with

Part 1: Tamil 4 papers, Part 2: English 4 papers,

Part 3: Major (Zoology) Core Theory 10 papers, Skill based 6 papers, Non-Major Elective 2 papers, Environmental studies 1 paper, Value Education 1 paper, Practical 5 papers.

Ancillary I – Chemistry (I & II year only – 4 papers)

Ancillary II – Botany (II & III year only - 4 papers)

Each academic year shall comprise of two semesters viz. Odd and Even semesters

2. Eligibility for Admission:

Candidates should have passed the Higher Secondary(+2) Examination conducted by the board of higher secondary education, Government of Tamil Nadu with zoology or biology as one of the subjects and chemistry and botany subjects are essential.

3. Objectives of the programme

The B.Sc. Zoology programme is designed to help the students to:

1. To get basic skills in the observation and study of animals, plants, nature, biological techniques, chemical tech, experimental skills and scientific investigation
2. To study the invertebrate animals and vertebrate animals with interest in and love of nature with its myriad living creatures.
3. To get basic knowledge and skills in certain applied branches to enable them for self-employment in Apiculture, Sericulture, sericulture, poultry form and aquaculture.

4. To understand the awareness of the conservation of the biosphere and wild life.
5. To understand the unity of life with the rich diversity of organisms and their ecological and evolutionary significance
6. Impart basic knowledge of various branches of Zoology and General biology meant both for a graduate terminal course and for higher studies on M.Sc. M.Phil., and Research.

4. Outcome of the Programme

The graduate of this programme should be able to

1. Identify and list out common animals
2. Explain various physiological changes in our bodies
3. Analyze the impact of environment on our bodies
4. Understand various genetic abnormalities
5. Develop respect for nature
6. Explain the role and impact of different environmental conservation programmes
7. Identify animals beneficial to humans
8. Identify various potential risk factors to health of humans
9. Explain the importance of genetic engineering
10. Use tools of information technology for all activities related to zoology

5. Core subject papers

1. Invertebrata, 2. Chordata, 3. Developmental Biology, 4. Cell Biology, 5. Genetics, 6. Biochemistry, 7. Microbiology and Immunology–8. Biotechnology, 9. Animal Physiology, 10. Ecology and Evolution

6. Subject elective papers

1.Apiculture, 2.Sericulture, 3.Vermiculture, 4.Biostatistics & Computer Application, 5.Economic Zoology, 6.Applied Entomology

7. Non-subject elective papers

1. Ornamental fish culture, 2. Human Biology

8. Unitization

All papers are unitized with five units

9. Pattern of Semester exam

I B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
I	Part 1	Tamil paper 1	3	6	
	Part II	English paper 1	3	6	
	Part III Core -1	Invertebrata	4	4	
	Part IV Skill based -1	Apiculture	2	2	
	Skill based -2	Sericulture	2	2	
	Non-Major Elective-1	Ornamental Fish Culture		2	
	Allied -1	Chemistry -1			

I B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
II	Part 1	Tamil paper 2	3	6	
	Part II	English paper 2	3	6	
	Part III Core -2	Chordata	4	4	
	Part IV Skill	Vermiculture	2	2	

	based -3				
	Skill based -4	Biostatistics & Computer Application	2	2	
	Non-Major Elective-2	Human Biology		2	
	Allied -1	Chemistry -2			
Zoology	Major	Practical -1			
Chemistry	Allied	Practical -1			

II B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
III	Part 1	Tamil paper 3	3	6	
	Part II	English paper 3	3	6	
	Part III Core -3	Developmental Biology	4	4	
	Allied -1	Chemistry -3		4	
	Allied -2	Botany- 1		4	

II B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
IV	Part 1	Tamil paper 4	4	6	
	Part II	English paper 4	4	6	
	Part III Core -4	Cell Biology	4	4	
	Allied -I	Chemistry-4			
	Allied -II	Botany - 2			
Zoology	Major	Practical -2			
Chemistry	Allied	Practical -2			
Botany	Allied	Practical -1			

III B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
V	Part III Core -5	Genetics & Molecular Biology	4	4	
	Core -6	Biochemistry	4	4	
	Core -7	Microbiology & Immunology	4	4	
	Part IV Skill based -5	Economic Zoology		2	
		Environmental Studies			
	Allied -2	Botany -3			

III B.Sc., Zoology Major

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
VI	Part III Core -8	Biotechnology	4	4	
	Core -9	Animal Physiology	4	4	
	Core -10	Ecology & Evolution	4	4	
	Part IV Skill based -6	Applied Entomology	2	2	
		Value Education			
	Allied -2	Botany - 4			
zoology	Major	Practical -3			
zoology	Major	Practical -4			
zoology	Major	Practical -5			
Botany	allied	Practical -2			

I B.Sc., (Chemistry)– Ancillary Zoology

Semester	Part	Subject	No. of Credit	Contact hours per week	Subject code
I	Part III	Invertebrata -1		4	
II	Part III	Chordata -2		4	
	Allied	Practical -1 Invertebrate & Chordata			
III	Part III	Microbiology, Cellbiology, Genetics, Molecularbiology and Biotechnology -3		4	
IV	Part III	Developmentbiology , Biochemistry, Physiology, Immunologyand Evolution -4		4	
	Allied -	Practical -2			

10.Scheme for Internal Assessment: 25 marks

Internal test = 10 marks (average of the best two internal tests)

Assignment = 5 marks

Seminar / = 5 marks

Group discussion

Peer-team teaching = 5 marks

11.External Exam : Duration Three hours : 75 marks

12.Question paper pattern

Theory (External only)

Section-A (10 questions x 1 mark = 10 Marks)

Section-B (5 question x 7 mark = 35 Marks)

Answer all the questions choosing either (a) or (b) question.

Each unit comprises of one either (a) or (b) question.

11. (a) or (b)

12. (a) or (b)

13. (a) or (b)

14. (a) or (b)

15. (a) or (b)

Section-C (3 question x 10 mark = 45 Marks)

Answer any three out of five questions. One question should be asked from each unit. Answer not to exceed four pages. Questions 16 – 20

13. Scheme for evaluation

Based on the question marks given to introduction, definition, illustrations and diagrams.

14. Passing minimum

A) Theory:

40 marks of aggregate (Internal test + external exam)

No separate pass mark for internal test.

27 marks out of 75 is the pass minimum mark for the external.

B) Practical :

40 marks of aggregate (Internal test + external exam)

No separate pass mark for internal.

21 marks out of 60 is the pass minimum mark for the external.

15. Model questions

To refer University question papers

16. Teaching methodology

Using blackboard with chalk – colourful charts, models and with LCD projector

17.Text books and **18.** Reference books are mentioned in all theory papers.

INVERTEBRATA

(4 Credits)

<i>Contact classes per week</i>	-	<i>4 hours.</i>
<i>Contact classes per Semester</i>	-	<i>60 hours.</i>

OBJECTIVES:

- To understand the principles of classification.
- To acquire knowledge about the major invertebrate phyla.
- To know the diseases produced by the protozoan and helminthes parasites.
- To get an idea about the evolutionary significance of invertebrates.

UNIT – I TAXONOMY

- 12 hours

1. Definition.
2. Principles of classification – Symmetry and Coelom.
3. Units of Classification.
4. Binomial nomenclature.
5. Outline classification of Animal kingdom up to class level with example – Flow chart only.
6. General characters of the following phyla, i) Protozoa, ii) Porifera, iii) Coelenterata, iv) Platyhelminthes, v) Nematoda, vi) Annelida, vii) Arthropoda, viii) Mollusca, ix) Echinodermata.

UNIT – II PROTOZOA AND PORIFERA

- 12 hours

Phylum: Protozoa

Type Study – Paramecium: General organization, Cyclosis, Contractile vacuole and conjugation only – *Plasmodium vivax*: structure, pathology, prevention and control measures.

General Topic: Protozoan diseases of man – Amoebiasis, Leishmaniasis

Phylum: Porifera

Type Study – Leucosolenia: General organization, Histology, Spicules, Reproduction and Development only.

General Topic: Canal System in Sponges..

UNIT – III COELENTERATA AND HELMINTHES

- 12 hours

Phylum: Coelenterata

Type Study – Obelia: Structure of Obelia colony, Medusa and Nematocyst, Reproduction and Development (Metagenesis).

General Topic: Polymorphism in Coelenterates, Corals and coral reefs – Types – Ecological and Economic importance.

Phylum: Helminthes

Type Study – *Fasciola hepatica* (Liver fluke): External characters, Digestive System, Excretion, Reproduction and development (Life Cycle).

General Topic: Structure, Pathology and Control measures of Ascaris, Wuchereria.

UNIT – IV ANNELIDA AND ARTHROPODA

- 12 hours

Phylum: Annelida

Type Study – Earthworm: External Morphology, Setae, Nephridia, Nervous System and Reproductive System only.

General Topic: Metamerism in Annelids.

Phylum: Arthropoda

Type Study – Penaeus (Marine Prawn): External Morphology, Appendages, Respiratory System, Reproductive System and Development.

General Topic: Affinities of Peripatus.

UNIT – V MOLLUSCA AND ECHINODERMATA

- 12 hours

Phylum: Mollusca

Type Study – *Pila globosa*: External Morphology, Digestive System, Respiratory System, Osphradium only.

General Topic: Cephalopods as an advanced Mollusc.

Phylum: Echinodermata

Type Study – Star Fish: External Morphology, Pedicellaria, Water vascular system only.

General Topic: Larval forms in Echinodermata.

TEXT BOOKS:

1. A Text Book of Invertebrata – Arumugam. N *et al.*, 2017, SARAs Publication, Kottar, Nagercoil.
2. Invertebrate Zoology – Jordan. E.L. and Verma. P.S., 2010 (Reprint), S. Chand and Company Ltd., Ram Nagar, New Delhi.

REFERENCE BOOKS:

1. Manual of Zoology, Vol. I (Invertebrata), Ekambaranatha Ayyar. M and T.N. Ananthakrishnan, 2003 (Reprint), Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
2. Invertebrate Zoology: A functional Evolutionary Approach, 7th Edition, Edward E. Ruppert, Richard S. Fox and Robert D. Barnes, 2003, Brooks – Publisher Pvt. Ltd., United States.
3. Modern Text Book of Zoology Invertebrates, 11th Edition, Kotpal. R.L., 2014, Rastogi Publications, Meerut, India.
4. Biology of the Invertebrates, 7th Edition, Jan A Pechenik, 2014, McGraw-Hill Education, India.
5. Invertebrates, 3rd Edition, Richard C. Brusca, Wendy Moore, Stephen M. Shuster, 2016, Sinauer Associates, Oxford University Press, UK.

B.Sc., Zoology Major
Core Paper – 2

Part – III

Semester – II

CHORDATA

(4 Credits)

<i>Contact classes per week</i>	-	<i>4 hours.</i>
<i>Contact classes per Semester</i>	-	<i>60 hours.</i>

OBJECTIVES:

- To gain knowledge about the classification and general characters of vertebrates.
- To know the evolutionary significance of prochordates.
- To understand the structure and function of various systems in animals.
- To acquire knowledge on identifying the poisonous and non-poisonous snakes.
- To study the adaptations of birds and mammals.

UNIT – I TAXONOMY AND PROCHORDATA

- 12 hours

Chordates characteristics, Outline classification up to class level with examples.

Phylum Prochordata

Type Study – Amphioxus: External morphology, Digestive System and Excretory System only.

General Topics:

1. Retrogressive metamorphosis in Ascidian.
2. Affinities of Hemichordate.

UNIT – II PISCES AND AMPHIBIANS

- 12 hours

Classification of Fishes and Amphibians up to order level with examples.

Phylum :Pisces

Type Study – Shark: External Morphology, Digestive System and Reproductive System only.

General Topics:

1. Migration of Fishes.
2. Parental Care in Amphibians.

UNIT – III REPTILES

- 12 hours

Classification of Reptiles up to orders with examples.

Phylum : Reptiles

Type Study - Calotes: External Morphology, Digestive System and Circulatory System only.

General Topics:

1. Poisonous and non-poisonous snakes – Identification and biting mechanism.
2. Origin, Dominance and Decline of Mesozoic reptiles.

UNIT – IV AVES

- 12 hours

Classification of Aves up to orders with examples.

Phylum - Aves

Type Study – Pigeon: External Morphology, Respiratory System, Synsacrum, Pectoral and Pelvic girdles only.

General Topics:

1. Flight adaptation in birds.
2. Archaeopteryx and its evolutionary significance.

UNIT – V MAMMALS

- 12 hours

Classification of Mammals up to orders with examples.

Phylum - Mammals

Type Study – Rabbit: External Morphology, Excretory system and Reproductive System only.

General Topics:

1. Dentition in mammals.
2. Adaptation of aquatic mammals.

TEXT BOOKS:

3. A Text Book of Chordata – Arumugam. N *et al.*, 2017, Saras Publication, Kottar, Nagercoil.

4. Chordate Zoology – Jordan. E.L. and Verma. P.S., 2011, S. Chand and Company Ltd., Ram Nagar, New Delhi.

REFERENCE BOOKS:

6. A Manual of Zoology, Ekambaranatha Ayyar. M and T.N. Ananthakrishnan, 2003 (Reprint), Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
7. Modern Text Book of Zoology vertebrates, Kotpal. R.L., 2009, Rastogi Publications, Meerut, India.
8. Vertebrate Life, 9th Edition, Harvey Pough. F, Christine Janis, Heiser. J.B., 2013, Benjamin-Cummings Publishing House, San Francisco.
4. Comparative Vertebrate Zoology, Hyman. L.H., McGraw Hill Co., New York.

I B.Sc. Zoology Major

Part - III

Semester - II

Practical – 1

Invertebrata and Chordata

(2 Credits)

(to be done at the end of the II semester)

DISSECTION:

Earthworm: Nervous System

Cockroach: Digestive System and Nervous System

Pila: Digestive system

Frog: Arterial System and Venous System

Shark: Cranial nerves

MOUNTINGS:

Earthworm: Body Setae

Cockroach: Trachea

Honey bee: Mouth Parts

Pila: Radula

Shark: Placoid Scales

Frog: Brain

SPOTTERS: ANY THREE FROM EACH PHYLUM

Protozoa: Paramecium, Paramecium-conjugation, Euglena, Entamoeba, Plasmodium.

Porifera: Simple Sponge, Sponge-Gemmule, Sponge –Spicules.

Coelenterata: Obelia colony, Obelia medusa, Aurelia, Physalia, Sea anemone.

Helminthes: Liver fluke, Redia larva, Cercaria larva, Ascaris (Male and Female)

Annelida: Earthworm, Nereis, Heteronereis, Chaetopterus, Leech.

Arthropoda: Prawn, Peripatus, Centipede.

Mollusca: Pila, Fresh water mussel, Chiton, Sepia, Solen.

Echinodermata: Starfish, Sea-urchin, Sea-cucumber, Brittle Star.

Prochordata: Amphioxus, Amphioxus - T.S. through pharynx, Balanoglossus, Ascidian.

Agnatha: Petromyzon.

Pisces: Narcine, Echinops, Hippocampus, Eel, Catla, Tilapia.

Amphibian: Bufo, Rhacophorus, Ichthyophis. Salamander.

Reptilia: Poisonous Snakes: Cobra, Krait, and Viper.

Non-Poisonous Snakes: Dryophis and Ptyas.

Lizards - Chaemeleon and Draco.

Aves: Pectoral and Pelvic girdle of Pigeon, Archaeopteryx.

Mammals: Bat, Loris.

Animal collection / Field trip to visit places of biological importance and recorded.

B.Sc., Zoology Major
Core Paper – 3

Part – III

Semester – III

DEVELOPMENT BIOLOGY (4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

Objectives :

- To understand ontogenesis, the development of animals including parthenogenesis
- To study embryonic adaptations, human reproduction and reproductive technology in man.
- To know about test tube babies and twins
- To know about development of organs in frog

UNIT – I

Introduction

Gametogenesis – Spermatogenesis, spermiogenesis, structure and types of sperms, Oogenesis -Types of eggs and egg membranes ; Sperm – egg interaction, Fertilization types – physical, chemical, cytological and physiological changes in fertilization. Parthenogenesis definition and types.

UNIT-II

Cleavage

Types, planes, patterns and factors affecting cleavages; Types of blastula Blastulation and Gastrulation in frog, Fate maps in frog and Morphogenetic movements.

UNIT –III

Tubulation

Neurulation and organogenesis : Development of brain, eye, heart in frog : Extra-embryonic membranes in chick, Placentation in mammals –types, classifications and functions.

UNIT-IV

Genetic control of development – Organizer concept and embryonic induction. Concept of neotony and paedogenesis – Regeneration in Planarians and Amphibians. Metamorphosis in Amphibians.

UNIT –V

Assisted reproductive technology – Human Pregnancy and Gestation, infertility – Artificial Insemination – Cryo-preservation – *in-vitro* -fertilization – Embryo Transfer and its advantages – Concept of test-tube baby, Twins, Puberty, Menstrual cycle, Menopause

Text Books :

1. Chordate Embryology, Verma S. and Agarwal V.K., (2000) S. Chand & Co., New Delhi.
2. Text Bool of Embryology, Arumugam, N.A. (2008 Edition) Saras Publication, Kottar, Nagarcoil.

Reference Books :

1. An Introduction to Embryology, Balinsky, B.I. 1981. W.B. Saunders Company, Philadelphia.
2. Development Biology, Berrill, N.J. 1986, Mc Graw Hill, New Delhi.
3. Foundations of Embryology, Pattern B.M., 1958 Mc Graw Hill, New York.
4. Development Biology – Patterns and Principles, Saunders, J.W., 1982 Macmillan, New York.

5. Development Biology, Browder L.W. Erickson, C.A. & Williams, (1992) 3rd edition, R.J. Saunders College Publications, London.

**B.Sc., Zoology Major
Core Paper – 4**

Part – III

Semester – IV

CELL BIOLOGY

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

Objectives:

To learn the structure and functions of various cellular components.

To understand the principles of different Microscopes.

To know about Cancer and its types, causes and diagnosis

UNIT –I

History of cell biology – Cell theory – Cell as the basic unit of living organism, Difference between Prokaryotic and Eukaryotic cell, Ultra structure of an Animal Cell, Plasma membrane – Ultra Structure, models (Bilayer, Unit membrane, fluid mosaic) and functions.

Unit – II

Cell organelles – Ultra structure and functions of Endoplasmic reticulum, Ribosomes, Golgi complex, Lysosomes, Centrioles and Mitochondria.

Unit – III

Nucleus and Nucleolus – Structure, functions. Chromosomes – Structure, heterochromatin and Euchromatin, Giant chromosome – polytene and lambrush Cell Cycle – mitosis and meiosis.

Unit – IV

Microscopy:-, 1. Compound Microscope, 2. Phase contrast Microscope, 3. Electron Microscope, 4. Light and Dark field microscope
Cytological techniques: - fixation, staining, centrifugation and sedimentation coefficient.

Unit – V

Cancer:- Types, causes, diagnosis, characteristics and treatment. Genes responsible for aging. Stem cells : occurrence, concept, types and applications.

Reference Books :

1. Verma, P.S., and V.K. Agarwal, 1995, cell and Molecular Biology, 8th edition, S. Chand & Co., New Delhi – 110 055, 567.
2. De Robertis, E.D.P. and E.M.F. De Robertis, 2006, Cell & Molecular Biology, 8th Edition, Indian Reprint.
- Rastogi, S.C., 2010, Cell and Molecular Biology, Second Edition, New Age International (p) Ltd., New Delhi.
4. Powar, C.B., 1989 Essentials of Cytology, Himalaya Publishing House, Bombay,
5. Loewy, A.G. and P. Sickevitz, 1969, Cell structure and Function, Amerind Publishing Co., New Delhi – 110 020,

B.Sc., Zoology Major

PRACTICAL - II

DEVELOPMENTAL BIOLOGY & CELL BIOLOGY. (2 Credits)

(to be done at the end of the IV semester)

<i>Contact hours per week</i>	-	<i>2 hours</i>
<i>Contact hours per semester</i>	-	<i>30 hours</i>
<i>Contact hours per year</i>	-	<i>60 hours</i>

DEVELOPMENTAL BIOLOGY

Study the following prepared slides and Museum specimens.

1. Sections of testis and ovary showing the maturation stages of gametes (Mammalian)
2. Observation of egg and sperm (mammalian Sperm and ovum)
3. Early developmental stages of Frog. Cleavage, blastula, gastrula and neurula.
4. Different stages of chick embryo-24 Hours, 48 Hours, 72 Hours and 96 Hours.
5. Placenta of sheep / Man

CELL BIOLOGY

1. Microcopy : Handling of dissection and compound microscopes.
2. Mounting buccal epithelium and observing living cells using vital staining.
3. Mitosis in Onion root tip squash
4. Meiosis in grasshopper testis squash
5. Charts on – Mitochondria, Golgi apparatus, Endoplasmic reticulum, Ribosomes.

B.Sc. Zoology Major
Semester – V

Part – III

Core Paper - 5 Genetics & Molecular biology

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours (4 Credits)

- To understand Mendelian principle in plant cross
- To study human chromosomes and syndromes.
- To know about DNA as a genetic material
- To know about Eugenics: Positive and Negative- Euthenics

UNIT - I - 12 hours

1. Mendelian Principle: Mendel and his experiments and the laws of inheritance: Monohybrid cross and Dihybrid cross in pea , Law of Segregation, Law of Independent Assortment, back cross and test cross.
2. Gene interactions: Complementary genes: Flower colour in sweet peas, Epistasis: Plumage colour in poultry. Supplementary genes: Coat colour in mice.
3. Multiple alleles: ABO Blood groups and Rh factor in Human beings.
4. Multiple factors: Skin colour in Human beings.

UNIT-II - 12 hours

1. Sex determination: Chromosomal theory of sex determination- XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types, Genic balance theory of Bridges, Environment and Sex determination, Hormonal control of sex determination (free martin).
2. Linkage and Crossing Over: Coupling and repulsion hypothesis, Linkage in Drosophila- Linkage groups, Crossing over in Drosophila - Mechanism of crossing over-Types of crossing over, Sex Linkage: Sex-linkage in Man (Hemophilia and Colour blindness).

3. Chromosomal aberrations: Structural: Deletions, Duplications, Translocations and Inversions, Numerical: Euploidy (Monoploidy, Polyploidy), Aneuploidy (Monosomes, Nullisomes and Trisomes).

4. Extra Chromosomal Inheritance: Kappa particles in Paramecium, Plastid inheritance in Mirabilis.

UNIT–III

- 12 hours

1 Human Chromosomes: Normal human karyotype, inherited disorders: Allosomal (Klinefelter's syndrome and Turner's syndrome), Autosomal (Down syndrome).

2. Mendelian Traits: Strait hair, Curly hair, Widow's peak, Dimpled Cheeks, Mid digital hair, Hitchhiker's thumb, Clasp of hands and Hypertrichosis.

3. Pedigree studies: Symbols used in pedigree analysis- Pedigree analysis of important genetic disease like Hemophilia.

4. Eugenics: Positive and Negative- Euthenics and Genetic Counseling.

5. Genetics and Society: Human genome project.

UNIT–IV

- 12 hours

1. Nucleic Acids: DNA Structure, Types and Replication - RNA Types and Structure.

2. Chemical basis of Heredity: Experimental Proof of DNA and RNA as genetic material.

3. Gene Mutation: Types of gene mutations – substitution, insertion and deletion

4. Genetics of Bacteria: Recombination in bacteria: Transformation, Conjugation, Transduction and Sexduction.

UNIT–V

- 12 hours

1. Genetic Code: Features of genetic code.

2. Gene Action: Protein synthesis – Transcription and Translation in Prokaryotes.

3. Regulation of Gene expression: Regulation of Gene expression in Prokaryotes – Operon concept (Lac Operon).

4. Insertional elements and transposons: Transposable elements in Maize and Drosophila

REFERENCE:

1. Gardner, E.J., Michael J. Simmons, Peter Sunstad, D., (1991). Principles of Genetics. 8th edition John Wiley and Sons, INC.

2. Benjamin Lewin., (2004). Genes VIII. Pearson Prentice Hall, Pearson Education, Inc. Strickberger M.W., (1985). Genetics. 3rd Edition, Macmillan Publishing Co., New Delhi.

3. William D. Stansfield., (1991). Schaum's outline of theory and problems of genetics. 3rd edition, Schaum's Outline Series. Mcgraw-Hill. 9
4. Daniel L. Haartl., Elizabeth W. Jones., (2001). Genetics. 5th edition, Jones and Bartlett Publishers., Sudbury.
5. Charlotte J. Avers., (1980). Genetics. D.Van Nostrand and Company, New York.
6. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A., Weiner, A.M., (1988). Molecular biology of the gene. 4th edition. The Benjamin Cummings Publishing Company Inc, California.
7. Dhawkins, J.D., (1996). Gene structure and expression. 3rd edition Cambridge University press, New York.

B. Sc. Zoology Major	Part-III	Semester - V
Core Paper-6	Biochemistry	(4 credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To understand the principles of classification.
- To acquire knowledge about the major invertebrate phyla.
- To know the diseases produced by the protozoan and helminthes parasites.
- To get an idea about the evolutionary significance of invertebrates.

Unit – I

Carbohydrates: Outline classification, properties and biological importance.
Structure of Monosaccharide (Glucose) Disaccharide (Sucrose) and
Polysaccharide (Starch), Carbohydrate metabolism – Glycolysis, Glycogenolysis
and Citric acid cycle.

Unit - II

Amino acids-structure and classification. Protein structure-primary, secondary, and tertiary structure .Functions of proteins. Structure, function and significance of Collagen. Protein metabolism – Deamination, Transamination and Urea cycle.

Unit -III

Lipids – Structure, classification with examples – Simple lipids – Compound lipids – Derived lipid – Biological significance of lipids. Lipid metabolism – β oxidation of fatty acids.

Unit IV

Enzymes- properties and classification, mechanism of enzyme action – Factors affecting enzyme action. Enzyme inhibition types.

Unit V

Biochemical techniques : pH meter, paper chromatography, spectrophotometry, PAGE

Textbooks:

Textbook of Biochemistry – Arumugam . SARAS publication.

Reference Books:

1. Dr. J.L. Jain, Sunjaj Jain, Nitin Jain. (2010). - Fundamentals of biochemistry for university and College Students in India and Abroad S. Chand & Company Ltd., Ram Nagar, New Delhi-110 055.
2. Prem Prakash Gupta. (2009). Text book of biochemistry CBS Publishers & Distributors, New Delhi.
3. Ambika Shanmugam., (2001). Fundamentals of Biochemistry for Medical students. Kartik Offset Printers, Chennai.
4. T. Van Bruggen., (2004). Edward Staunton West, Wilbert R. Todd, Howard S. Mason, and John Text Book of Biochemistry. 4th edition, Oxford and IBH Publicity Co, PVT, LTD, New Delhi.
5. Geoffrey L. Zubay., (1996). Biochemistry. 4th edition, New Delhi.
6. Thomas M. Devlin., (2002). Text book of Biochemistry with Clinical Correlations. 4th edition, New Delhi.
7. David.L.Nelson and Michael.M.Cox (2008). Lehninger's Principles of Biochemistry. 4th edition, W.H. Freeman and CO., New York.
8. Christopher K.Mathews and K.E. Van Holde (1996). Biochemistry. 2nd edition, . The Benjamin Cummings Publishing Company Inc,Menlo Park.
9. Sawhney S.K., (1996). Introductory Practical Biochemistry. Narosa Publishing House, Mumbai
10. Leninger – Principles of Biochemistry
West and Todd – Biochemistry
Hames and Hooper – Biochemistry 2nd Edn, Viva Books Pvt. Ltd.

B.Sc., Zoology Major
Core Paper – 7

Part – III

Semester –V

MICROBIOLOGY AND IMMUNOLOGY (4 credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To understand the bacterial classification
- To acquire knowledge about the diseases caused by microbes
- To know the immune system of our body
- To get an idea about the Vaccines and Immunization

Unit I

Scope of Microbiology – Contribution of Alexander Flemming, Antony von Leeuwenhoek and Louis Pasteur -Preparation of Nutrient agar, broth, slant and stab. Sterilization methods, types of culture medium, bacterial growth curve, phases of curve and factors affecting growth curve -

Unit II

Prokaryotic cell: Classification of Bacteria and Virus. Structure of *E.coli*, Size, shape, arrangement, capsule, pili, flagella, cell wall of Gram Positive and Gram Negative, cell membrane, plasmids and mesosome.

Unit III

Food as a medium for the growth of microorganism - Food preservation by high and low temperature- Infections – Types, Methods of transmission of infections, Sources of Infections. Nosocomial infections -Bacterial infections- Cholera, Viral infections- AIDS. Fungal infections – Candidiasis, Antibiotics – penicillin and tetracycline.

UNIT IV

Organs of immune system : Thymus, Bone marrow, Bursa of Fabricius, Spleen and lymph node. Cells of Immune system – Stem cells, B cells and T cells. Antigen – Haptens, epitopes, paratopes. Antibodies- Structure and properties and functions – IgG

UNIT V

Antigen – antibody reactions – in vitro method, Precipitation, Agglutination. Antigen – Antibody interactions- humoral immune response - Cell mediated immune response.

Major Histocompatibility complex- autoimmune disorders.

Vaccines and Immunization

Text Books:

Textbook of immunology, – Arumugam, N. 2015 SARAS publication.

References:

1. Roitt, I.M Essential Immunology. (2000) Blackwell scientific publishers
2. William E.Paul Fundamental immunology, (1989) 2nd Edition Raven press, New York.
3. Prescott, L.M J.P. Harley and C.A. Klein, Microbiology 2nd edition (1995). Wm, C. Brown publishers.
4. Salle A.J.:Fundamental Principles of Bacteriology 7th Edition, Tata Mc Hill Publishing Company Ltd.,
5. William claus. G.W.1989. Understanding Microbes – A Laboratory textbook for Microbiology, W.H. Freeman and Co., New York.
6. Wilson. K and Goulding. K.H. 1986. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, ELBS, London. B.Sc., Microbiology (Colleges-revised) 2008-09 Annexure No. 33 A.

III B.Sc. Zoology Major

Part – III

Semester -VI

Core Paper - 8

Biotechnology

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

Objectives

- To know about the tools and methods of gene transfer.
- To understand the meaning of genetic engineering.
- To get an idea of transgenic animals and their importance.
- To acquire knowledge on tissue culture technology and transgenic plants
- To study about recent advancements in biotechnology

Unit – I

Recombinant DNA Technology

1. Tools for Gene cloning:

- i) DNA manipulative enzymes: Restriction enzymes and DNA ligases.
- ii) Gene cloning vectors: Plasmids, Bacteriophage (Lambda) and Cosmids.

2. Major steps involved in cloning of human insulin gene.

3. Molecular biology techniques:

- i) Microinjection
- ii) Electroporation,
- iii) Polymerase chain reaction (PCR).
- iv) Blotting techniques: Southern and Northern blots.

Unit – II Application of r-DNA technique in Human health

1. Recombinant DNA proteins and their uses:
 - i) Interferon, ii) Interleukin, iii) Factor VIII, and iv) Urokinase
 - v) Tissue plasminogen activator.
2. Recombinant vaccines: Hepatitis-B and Rabies and FMD Vaccine.
3. Commercial production of Penicillin.
4. DNA finger printing and its use in Forensic science.

Unit - III Animal Biotechnology

1. Hybridoma technology: Production and Applications of monoclonal antibodies.
2. Cloning of animals: Methods and uses.
3. Transgenic Animals: Transgenic fish and sheep.
4. Production of Elite cows.
5. Human genome project- basic knowledge only.
6. Sheep as a bioreactor

Unit – IV Plant Biotechnology

1. Plant tissue culture: Applications of plant tissue culture.
2. Protoplast culture: Protoplast fusion methods and uses.
3. Transgenic plants: Technique of transformation – Agrobacterium mediated and physical methods (electroporation). Applications of transgenic plants.
4. Bio-pesticides: Bt toxins- Transgenic “Killer cotton”.

Unit – V Environmental and Industrial Biotechnology

1. Super Bug to control oil pollution.
2. Single cell proteins (SCP): Technique of mass culture of Algae – Spirulina.
3. Enzyme immobilization: Methods and advantages.
4. Bio-electronics:
 - i) Biosensors: Principle and Applications of Glucose Biosensor only
 - ii) Biochips: Principle and uses.
5. Bioinformatics definition and applications

Text book:

Biotechnology Kumaresan. V, Saras Publications, Nagercoil-2010

Reference books:

1. DNA Technology – Alacama, L.D., 1996, The Awesome skill, WCB, Dubuque, I. A.
2. Biotechnology, Primrose, S.B., 1987, Blackwell Scientific Pub., London.
3. Principles of Gene manipulation, Primrose, S.B., R.Y.Twyman., and R.W.Old., 2001, Blackwell Scientific Pub., London
4. Gene Cloning and DNA Analysis an introduction, T.A.Brown., (2005) IV Edition, Blackwell Scientific Pub., London,
5. Principles and Applications of Recombinant DNA, Bernard, R. Glick., & Jack. J. Pasternak., (2003) III Edition, AMS Press Washington..Prentice of India Pvt. Ltd., New Delhi – 110 001.
6. Text book of Biotechnology. Dubey, R.C.2008.Chand & co., New Delhi.
7. Biotechnology B.D.Singh.2008 Kalyani Publishers Ludhiana.

Core Paper : 9

ANIMAL PHYSIOLOGY

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

Objectives

- to explaining various aspects of physiological activities in animals
- to know about the functions of kidney
- to study about the nervous coordination system
- to know about the functions of hormones

Unit –I :Nutrition :

Types of Nutrition, Food and feeding mechanisms, Digestive enzymes and their role in digestion.

Unit –II : Respiration:

Respiratory organs, Respiratory pigments and functions, Transport of Gases (Co₂ and O₂)- Chloride Shift, Haldane and Bohr's effect.

Circulation:

Composition, Properties and functions of Blood, Mechanism of blood clotting, Structure of human heart – Cardiac cycle, Origin of heart beat, Pace maker, Regulation of heart beat, ECG, Blood Pressure.

Unit –III Excretion :

Kidney, Nephron – structure and mechanism of urine formation in mammals, .. Hormonal control of excretion. Osmo ionoregulation and thermoregulation.

Muscle Physiology:

Types of muscles, Structure and chemical composition of skeletal muscle, Mechanism of muscle contraction. Properties of muscle contractions.

Unit –IV Nerve Physiology:

Neuron – Structure, types of neurons – Nerve impulse in myelinated and non-myelinated, action potential, Synapse, Synaptic transmission of Impulses, Neuromuscular junction and reflex arc.

Receptors: Photoreceptor – Structure of a mammalian eye, Retina – Visual pigments, Physiology of vision. Phonoreceptor – Structure of mammalian ear, Mechanism of hearing, Physiology of equilibrium, Chemoreceptors.

Unit –V

Endocrine physiology

Hypo and hyper activity disorders of Pituitary hormones, thyroid, parathyroid, Adrenal Islets of Langerhans, testes and ovary.

Text Book : Arumugam, N. 2015 Animal Physiology, Saras Publication, Nagercoil

Reference Books :

1. Sambasivaiah, Kamalakara Rao and Augustine Chellappa 1990. A Text book of Animal physiology and ecology, S. Chand & Co., Ltd., New Delhi – 110 005.
2. Parameswaran, Anantakrishnan and Ananta Subramaniam, 1975, Out lines of Animal Physiology.

Viswanathan (Printers & Publishers) Pvt. Ltd.,

3. William S. Hoar, 1976 General and comparative physiology, Prentice Hall of India Pvt. Ltd., New Delhi, 110 001.
4. Wood, D. W., 1983, Principles of Animal Physiology 3rd Ed.,
5. Prosser, C. L. Brown, 1985, Comparative Animal Physiology, Satish Book, Enterprise, Agra.

B.Sc., Zoology Major

Part III

Core Paper - 10

ECOLOGY AND EVOLUTION

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To gain knowledge about the Abiotic factors.
- To acquire knowledge on animal population and wild life.
- To know the evolutionary significance of Human
- To understand the mechanism of evolution.

Unit –I

ABIOTIC FACTORS

Soil : Pedogenesis – Soil texture – Soil profile – Soil fauna.

Water : Properties of water

Temperature : Range of temperature- Thermal Stratification – biological effects of temperature.

Light : spectral composition, Light on water – biological effects of light.

Unit –II

Animal Population

Characteristics of population – density, natality- mortality – regulation of population density. Animal relationship :Commensalism , Mutualism, Parasitism, predation.

Community:- definition, structure, ecotone and edge effect, niche, ecological succession and climax.

Animal Ethics : Animal rights, Animal law, Wild life conservation

UNIT-III

Biochemical origin of life, Urey and Miller's experiment, Geological time scale, Evidences of evolution:- Morphological, Homologous and Analogous structures – vestigial organs – connecting links. Embryological evidences, Biochemical evidences.

UNIT-IV Lamarckism and Neo-Lamarckism, Darwinism and Neo-Darwinism, supplementary theories of Darwin, HMS Beagle, Galapagos island and Darwin's Finches, Modern Synthetic theory of Evolution.

UNIT-V

Fossils : Types and Dating of fossils, Sources of Variations -
Isolating mechanism: Geographic isolation, Reproductive isolation -
Speciation types, mechanism of Allopatric and Sympatric speciation -
Human evolution: Organic evolution of man, important fossils of human evolution, Cultural and future evolution of man.

Books for Study :

1. Arumugam N. (2016) Concepts of ecology. Saras publication 114/35G, A.R.P. Camp Road, Periyavillai, Kottar Po, Nagercoil – 629 002, Kanyakumari.
2. Arumugam N. (2015) Organic Evolution Saras publication 1114/35G, A.R.P. Camp Road, Periyavillai, Kottar Po, Nagercoil – 629 002, Kanyakumari.

Books for Reference :

1. Odum E.P. (1971) Ist edition Fundamentals of ecology, W.B. Saunders Company, London.
2. Verma and Agarwal, (2003) 5th edition, Principles of Ecology, S.Chand & Company, Ltd. New Delhi, 110055.
3. Tomar and Singh, (2010) 8th edition, Evolutionary Biology – Rastogi Publication, Meerut. 250 002.
4. Saha, T.K. (2002) Ist edition. Life : Origin, evolution and adaptationm, Books and allied (P) Ltd. Kolkata – 700 010.
5. Stabbins. Process of Organic Evolution, 2. Mayr, E. Animal Species and Evolution,
6. Moody, P.A.,2002, An introduction to Evolution 3rd Edition, Kalyani Publishers, Ludhiana.
7. Simpson, G.G., Major features of Evolution,
8. Dobzhansky, Evolution, Genetics and Man, Oxford and IBH Publishing Co., New Delhi.

B.Sc., Zoology Major**Part – III****Semester – VI****PRACTICAL – III****GENETICS, MICROBIOLOGY & IMMUNOLOGY****(5 Credits)****(To be done at the end of the Sixth Semester)**

<i>Contact classes per week</i>	-	<i>3 hours.</i>
<i>Contact classes per Semester</i>	-	<i>45 hours.</i>

GENETICS:

1. Studies on Mendelian traits in Man.
2. Human Blood Grouping.

3. Study of Abnormal Karyotypes – Down Syndrome (Autosomal), Turner Syndrome and Klinefelters Syndrome (Sex Chromosomal) (*Pictures*)
4. Pedigree Analysis: Symbols used in Sex Chromosomal (X – linked) Disorders.
5. Observation of Wild and Mutant forms of *Drosophila* – Slide.

MICROBIOLOGY:

1. Gram Staining.
2. Isolation of Bacteria from soil and water.
3. Pure Culture Technique
 - a. Streak Method
 - b. Pour Plate Method
 - c. Spread Plate Method
 - d. Serial Dilution Method
4. Clinical analysis of following Diseases: Tuberculosis and Gonorrhea.
5. Symbiotic nitrogen fixation in *Rhizobium*.
6. Non-symbiotic nitrogen fixation in *Azotobacter*.
7. Biomanure – *Azolla*.

IMMUNOLOGY:

1. Lymphoid Organs in Rat – Chart.

B.Sc., Zoology Major

Part – III

Semester – VI

PRACTICAL – IV

BIOCHEMISTRY, ECOLOGY

(5 Credits)

(To be done at the end of the Sixth Semester)

Contact classes per week -2 hours.

Contact classes per Semester -30 hours.

BIOCHEMISTRY:

1. Qualitative analysis of Protein, Carbohydrate and Lipids.
2. Instrumentation – Principles and Uses of

- a. pH Meter
- b. Electrophoresis
- c. Chromatography
- d. Spectrophotometer / Colorimeter
- e. Centrifuges

ECOLOGY:

3. Estimation of Dissolved Oxygen in water samples.
4. Plankton Mounting – Fresh water and Marine Planktons.
5. Study of abiotic factors in aquatic environment – Dissolved Oxygen, pH and Turbidity.
6. Examples illustrating animal association.
7. Food Chain and Food Web in pond ecosystem.
8. Adaptations:
 - a. Parasitic adaptations - Ascaris, Taenia solium & Saculina.
 - b. Flight adaptations - Birds and Bat
 - c. Aquatic adaptations - Aquatic Mammals (Model or Paper cuttings)
 - d. Burrowing adaptations - Rat / Pangolin

B.Sc., Zoology Major

Part – III

Semester – VI

PRACTICAL – V

ANIMAL PHYSIOLOGY, BIOTECHNOLOGY & EVOLUTION (5 Credits)

(To be done at the end of the Sixth Semester)

<i>Contact classes per week</i>	-	<i>2 hours.</i>
<i>Contact classes per Semester</i>	-	<i>30 hours.</i>

PHYSIOLOGY:

1. Amylase activity in human saliva in relation to pH and Temperature.
2. Estimation of Oxygen consumption of fish with reference to body weight.

3. Effect of Temperature on ciliary activity of freshwater mussel.
4. Qualitative analysis of nitrogenous waste products in fish tank water, bird excreta and mammalian urine.
5. Use of Kymograph and B.P. apparatus.

BIOTECHNOLOGY:

1. Demonstration of P.C.R. technique and Southern Plot (Demo through C.D.)

EVOLUTION:

1. Homologous and Analogous Organs.
2. Vestigial Organs.
3. Fossils.
4. Examples of Evolutionary Importance: *Peripatus* and *Limulus*.
5. Animals with adaptive colouration: *Leaf Insect*, *Stick Insect* and *Chameleon*.
6. Variation – Finger Print.

I B.Sc., Zoology

Part – IV

Semester – I

Non Major Elective –1. **Ornamental Fish culture**

(2 Credits)

(For non- biology students)

Objectives

- To identify common ornamental fishes and their characteristics
- To know the art of fish keeping and setting up a fish tank
- To understand the collection and preparation of live and prepared feed
- To become familiar with breeding technique
- To gain knowledge about the common diseases of ornamental fishes and their control

Unit-1

Identification of popular Ornamental fishes:

Siamese fighting fish, Gold fish, Rosy barb, Black molly, Guppy, Koi carp, Arowana and Angel fish.

Unit -2

Construction of fish tank:

Size and shape of fish tank, bottom settings, stocking of fish, planting with aquarium plants, Accessories of fish Tank - aerators, types of filters, nets, lights and hood.

Unit-3

Transport of fishes: Oxygen packing

Food and feeding: Culture of live food organisms- Micro worms, vinegar eel, tubifex.

Artificial feed - Pellet feed formulation.

Unit -4

Breeding methods:

Siamese fighting fish, Gold fish, Black molly, Guppy and sword tail.

Unit-5

Common diseases and treatment of ornamental fishes: Nutritional diseases, White spot diseases, Fungal diseases, Bacterial diseases, Dropsy diseases and ecto-parasites.

TEXT BOOK:

1. Jameson J.D., and Santhanam R., Manual of Ornamental Fishes and Farming Technologies, Fisheries College and Research Institute, Tamilnadu Veterinary and Animal Sciences, Tuticorin, 1996

2. REFERENCES:

1. Felix S., Sundaraj V., and Thilakar S., Manual of Tropical Fish Diseases Diagnosis, Tamilnadu Veterinary and Animal Sciences University, Chennai, 1999.
2. Ramanathan N., and Francis T., Manual of Breeding and Larval Rearing of Cultivable Fishes, Tamilnadu Veterinary and Animal Sciences University, Chennai, 1996.
3. Santhanam,R. Sukumaran,N. and Natarajan,P Oxford and IBH Publishing Co pvt. NewDelhi 1990.

I B.Sc., Zoology

Part – IV

Semester - II

Non Major Elective – 2

Human Biology

(2 Credits)

(For non- biology students)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours

Unit – I Human Embryology

- 6 hours

Structure of Human sperm and ovum - Menstrual cycle – Menopause – Pregnancy - Parturition -Twins - Test tube Baby.

Unit – II Human Physiology

- 6 hours

Respiration - Oxygen and Carbon di oxide transport; Blood: Blood Composition ; Structure and function of heart , Electrocardiogram (ECG), Blood pressure , Blood urea; Structure of kidney nephron - Formation of urine .

Unit – III Human Genetics

- 6 hours

Sex determination in Man - Chromosomal abnormalities (Down, Turner's, Klinefelter's syndromes) - Human Blood groups.

Unit – IV Human health and Hygiene

- 6 hours

Composition of food, Digestion and absorption of food, Balanced diet, Vitamin deficiencies, Calorie value of food, Malnutrition and Obesity,

Unit – V Human History

- 6 hours

Human origin – Diversification, Biological and cultural evolution - Human future.

Text Book:

1. Developmental Biology Arumugam. N.,Saras Publications, Kottar, Nagercoil-2012.
2. Animal physiology- N. Arumugam Saras Publication Nagercoil-2011
3. Organic Evolution by. Arumugam N, Saras Publications Nagercoil-2009.
4. Mani, A., Narayanan, Fatima , D L.M., Selvaraj, A.M. and Arumugam, N. Immunology and Microbiology(2010), Saras Publication, Nagercoil.

References Books

1. P.S.Verma and V.K. Agarwal- Animal physiology
2. Verma, P.S. and Agarwal V.K. 2005 Chordate Embryology S,Chand &Company Ltd., New Delhi.
3. Dobzhansky, Evolution, Genetics and Man, Oxford and IBH Publishing Co., New Delhi.
4. Gordon S. Maleon et al., Animal Function –Principles and Adaptations. The Macmillan Company –collier- Mamillan Ltd. Hen 5.. Hoar S.William-General, Comparative Physiology, prentice hall of Indian pvt ltd, New delhi,
5. Philip H. Mitchel – A Text book of General Physiology, Mc Graw Hill Book - 2013 Syllabus

B.Sc., Zoology Major
Skill Based Elective Paper: 1

Part – IV

Semester – I

APICULTURE

(2 Credits)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours.

OBJECTIVES:

- To inculcate importance of Bee keeping and Honey processing.
- To encourage young learners to take up the small-scale industries after graduation.
- To teach techniques of construction of Bee Hives and its maintenance.
- To disseminate information on economic aspects of honey bee.

UNIT – I

- 6 hours

History of Bee keeping – Scope and importance – Classification of honey bee species – Apiculture development in India – Institutions involved – Role of Central Honey Bee Research and Training Institute.

UNIT – II

- 6 hours

Basic concepts of morphology, mouth parts and sting of Honey bees – Social organization in honey bees: Colony life – Queen, drone, worker – Life cycle of the honey bee.

UNIT – III

- 6 hours

Bee hives – Traditional bee hives – Modern bee hive: Newton hive. Bee dances, Flora for apiculture – selection of bees for apiculture – tools and extraction of honey.

UNIT – IV

- 6 hours

Modern appliances for Apiaries, Products: Honey, Bee wax, Bee venom, Pollen,

Royal jelly, Propolis – Chemical composition, nutritional and medical value of honey.

UNIT – V

- 6 hours

Diseases of Honey bee – Symptoms and control measures - Bacterial: American foul brood, European Foul brood – Viral: Thai sac brood, Sac brood virus – Fungal: Chalk brood, Stone brood and Nosemosis,– Bee enemies: Wax moth, Ants, Wasp and birds.

TEXT BOOKS:

1. Apiculture – Sunithira. C, 2016, Divya Jothi Publication, Kanyakumari, Tamil Nadu.
2. Fundamentals of Bee keeping – Sathe. T.V., 2006, Daya Publishing House Pvt. Ltd., New Delhi.

REFERENCE BOOKS:

1. Honey Bee Pests, Predators and Diseases, 3rd Edition, Roger A. Morse, Kim Flottum, 1998, Wicwas Press.
2. Bee Keeping in India, Ghosh. G.K., 1998, APH Publishing, New Delhi.
3. Honey – A Comprehensive Survey – International Bee Research Association for house –
CNRC [England].
4. Honey Bee Biology and Bee keeping, Dewey M. Caron, 2013, Wicwas Press, Kalamazoo.
5. The Backyard Bee keeper, 3rd Edition, Kim Flottum, 2014, Quarry Books, Quayside Publishing Group, Beverly.

B.Sc. Zoology Major

Part - IV

Semester - I

Skill Based Elective Paper-2

SERICULTURE

(2 Credits)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours.

OBJECTIVES:

- To know about the Mulberry and Non – mulberry silkworm types

- To understand the mulberry cultivation and silkworm rearing
- To acquire knowledge about silk reeling
- To know about the diseases of silkworm.

UNIT I

Introduction to Sericulture - History of Sericulture - Sericulture organization in India, By products of silk industry.

UNIT II

Mulberry and Non - mulberry silkworm types- Mulberry cultivation and its tools, Morphology and Life cycle of *Bombyx mori*, Structure and function of silk gland. Chemical composition of silk fibre - sericin and fibroin

UNIT III

Votivism and races of silkworm, rearing of silkworm - Rearing Appliances - rearing operation.

Unit IV

Mounting and spinning - Types of Mounting - harvesting and marketing of cocoons . Cocoon processing and reeling - Appliances used for reeling .

Unit V

Diseases of silkworm –Pebrine Protozoan, Flacherie bacterial, Nuclear Polyhedrosis viral and Muscardine fungal diseases. Pests of Silkworm.

Text Books:

1. Ganga G., Sulochana chetty. J. An Introduction of Sericulture. Oxford, New Delhi – 1977.
2. Johnson M., and Kesary M., Sericulture, CSI Press, Marthandam, 2008.

REFERENCES:

1. Krisnamoorthy S., Improved Method of Rearing Young Age Silk Worms: Reprinted by CSB, Bangalore, 1986.
2. Tanaka Y., Sericology, CSB, Pub., Bangalore, 1964.
3. Text Book of Tropical Sericulture, Pub., Japan Overseas Volunteers, 1975.
4. Ullal S.R., and Narasimhan M.N., Hand Book of Practical Sericulture, CSB, Bangalore, 1987.
5. Hisao Aruga, Principles of sericulture, Oxford and IBH Publishing Company, 1994.

Skill Based Elective Paper – 3 VERMICULTURE (2 Credits)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours.

OBJECTIVES:

- To know the earthworm species and its importance
- To create awareness among students on organic vermicomposting.
- To motivate the students for self-employment
- To understand the production of organic fertilizer. .

Unit I –

Vermiculture – definition, scope and importance. Outline classification and types of earthworms used in vermin-culture. Biology of *Perionyx excavatus* and *Endriclus eugeniae* earthworms.

Unit II –

Culture methods – small scale methods, and large scale (commercial) methods- window and raised bed methods- harvesting. Essential parameters for vermiculture : bedding, worm food, moisture, aeration and temperature control.

Unit III-

Vermicomposting- microbes associated earthworms -Role of microbes in vermicomposting. Factors affecting vermicomposting .

Unit IV –

Applications of vermiculture in Agriculture and horticulture . Organic farming- biofertilizers, vermicast and vermiwash.

Unit V –

Applications of vermiculture in pollution management –vermicompost as an ecotool for sustainable solid waste management.

Text Book: Arumugam, Economic Zoology, Saras Publications

Sultan Ahmed Ismail . The Earthworm Book, 2nd revised edn. Other India Press. Goa, India.

Reference Books:

Bhatnagar and Patla- Earthworm-vermiculture and vermicomposting.

Peter Davis. Vermiculture and vermicomposting.

Skill Based Elective Paper - 4 **Biostatistics and Computer Applications (2 Credits)**

<i>Contact classes per week</i>	-	<i>2 hours.</i>
<i>Contact classes per Semester</i>	-	<i>30 hours.</i>

Unit – I

. Collection of Data – Primary and Secondary data.

Classification and Tabulation of data.

Diagrammatic representations of data –line, bar, pie, pictogram and cartograms

Graphic representations.

Unit – II

. Measures of Central tendency – Mean, median, and mode – definition and calculation in Individual discrete and continuous series.

Unit – III

Measures of Dispersion – Range, quartile and standard deviation- definition and formula.

Correlation types - Karl-Pearson's coefficient of correlation.

Unit -IV

Characteristics of computer, Computer and its applications- **MS Word:** Basic File Operations: New, Open, Save & Print. **Editing:** Cut, Copy, Paste, Find & Replace, **Insert:** Page numbers & Pictures. **Format:** Font, Bullet & Numbering, Paragraph & Background. **Tools:** Spelling & Grammar. **Data:** sort, Power point presentation.

Unit –V

Communication networks types, communication media, network topologies, Internet connections, search engines, web pages and email. Applications of Internet. MS Excel: components and features of excel.

Text Books:

1. Biostatistics and Computer application, Arumugam N Saras Publications, Kottar, Nagarcoil 2010.

References Books:

1. Statistical methods, Gupta S.P, (2006) Sultan Chand & Sons Educational Publishers, New Delhi.
2. Fundamental of Biostatistics, Khan A.S, & Khanum A, (2004) Ukaas Publishers, Hyderabad.
3. Methods of Biostatistics, Baskararao T, (2001) PARAS Publications, Hyderabad.
4. Biostatistics- P.Ramakrishnan, 2015 Saras Publications.
5. Statistical Methods for Biologists. S. Palanichamy, M. Manoharan. Publisher, Palani Paramount, 1990.
6. Fundamentals of Computer, V.Rajaraman

III B.Sc., Zoology Major Skill Based Subject Paper – 5

Part – IV

Semester – V

ECONOMIC ZOOLOGY (4 Credits)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours.

OBJECTIVES:

- To encourage young learners for self – Employment.
- To impart knowledge on useful animals to Mankind.
- To emphasize the importance of economic values of animals.
- To disseminate information on modern techniques of Animal culture.

UNIT – I

- 6 hours

Economics of Poultry Farming: Importance of poultry farming – Important breeds of Poultry: Desi, Chittagong and Leghorn – Practical aspects of chick rearing - sexing in one day old chick –deep litter system - Role of egg in human nutrition – Processing of Egg, Meat and By-products of Poultry – management of Ranikhet and Coccidiosis disease – Role of government / private agencies in poultry development.

UNIT – II

- 6 hours

Economics of Dairy Farming: Dairy breeds of India: Cattle and Buffaloes – Native and Exotic breeds – Nutritive value of Milk and Meat – Composition of Milk – Nutritional characteristics of by products: Whey, Buttermilk, Ghee residue.

UNIT – III

- 6 hours

Economics of Aquaculture: Definition and Scope – Culturable fishes: Indian major carps, Exotic carps – Different aquaculture system: Polyculture, Integrated culture – Live feed organisms and their culture – By-products of fishes and its commercial values.

UNIT – IV

- 6 hours

Pearl and Edible Oyster culture: Importance of Pearl culture – Biology of *Pinctada fucata* – formation of Natural Pearls – Culture of Pearl: Collection, preparation of graft tissue and nucleus, Insertion of nucleus, Post-operative culture – Techniques of edible oyster culture: Spat collection, Induced breeding, Culture methods (*on bottom* and *off bottom*), Harvesting.

UNIT – V

- 6 hours

Economic importance of Leather, Wool and Fur industries in India – Future plan for Livestock improvement – Transgenic Animal Technology – Genetic improvement for valuable breeds.

TEXT BOOK

- 1.Economic Zoology, Shukla. G.S. and V.B. Upadhy, 2006, Rastogi Publications, Meerut, India.
- 2.Applied Zoology, Arumugam. N. *et al.*, 2015, Saras Publication, Kottar, Nagercoil.

REFERENCE BOOKS:

- 1.Aquaculture Principles and Practices, Pillay. T.V.R., 1990, Fishing New (Book) Ltd., London.
2. Santhanakumar, G, and A.M. Selvaraj, 1995, Concepts of Aquaculture, Meenam Publications,, Nagarkovil ...
- 3.Handbook of Poultry Science and Technology, Isabel Guerrero – Legarreta, 2010, John Wiley and Sons Ltd., U.K.
- 4.Economic Zoology, Vinita Jaiswal and K.K. Jaiswal, 2014, PHI Learning Pvt. Ltd., New Delhi.
- 5.Commercial Dairy Farming, 2015, Engineers India Research Institute (EIRI Board), New Delhi.

III B.Sc. Zoology Major

Part - IV

Semester – VI

Skill based Elective paper: 6 **Economic Entomology**

(2 Credits)

Contact classes per week - 2 hours.

Contact classes per Semester - 30 hours.

Objectives

To become familiar with various developmental stages of insects

To understand the role of beneficial insects

To know about the principle and methods of pest control

To study on household insects and insects vectors of human diseases

Unit-I

Insect development and metamorphosis: types, hormonal control, types of Larvae and pupae.

Unit-II

Beneficial insects as Scavengers, Pollinators, Predators and Parasites effecting biological control and weed killers.

Unit – III

Outline classification and identification of Insect orders. Life cycle and control measure of Cotton pest-*Helicoverpa armigera*, Sugarcane pest- *Scirpophaga nivella*, Paddy pest-*Hieroglyphus daganensis* and Coconut pest – *Oryctes rhinoceros*

Unit – IV

Insect pest -definition, kinds of pests, causes that make the insect as pest, factors causing pest outbreaks, Methods of Pest control – Physical, Chemical, Mechanical, Biological, and Integrated pest management –

Unit – V

Disease causing vectors and their control measures. : House fly, Sand flies, Mosquito, Lice. Fleas, Tsetse fly, - Pest of cattles.

Text Book:

Study material prepared by the Department.

References Books:

1. Vasantharaj David,B.2016 Elements of Economic Entomology. 8th Edition
2. Metcalf. Flint & Metcalf. (1998) Destructive and Useful insects. IV Edition.
3. Mani. M.S. 1958, Text book of Entomology.
- 4.Ramakrishna Ayyar T.V.1992, Hand book of Economic Entomology for South India.
- 5.Imms, A.D. 1978, Outlines of Entomology

I B.Sc. Zoology, Ancillary

Part - III

Semester - I

Core paper -1

Invertebrata

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

Objectives

- i. To study the levels of organization and outline classification of animals.
- ii. To know the salient features and examples of invertebrate phyla.
- iii. To understand the biology and parasitic adaptations of invertebrates.
- iv. To trace the economic importance of invertebrate groups.
- v. To study the method of oyster culture.

Unit - I

Taxonomy and Protozoa

-12 hours

1. Types of classification and nomenclature
2. General characters of Phylum Protozoa
3. **Amoeba - Type study**-Externals, Nutrition, Locomotion, excretion and reproduction
4. **Plasmodium**: Life history, transmission, prevention and control.

Unit – II Porifera and Coelenterata

-12 hours

1. General characters of **Phylum Porifera and Coelenterata**.
2. **Obelia - Type study**-Structural organization of Obelia colony, Medusa and Life cycle of Obelia(Metagenesis)
3. Canal system and spicules of Sponges

Unit - III Helminthes

- 12 hours

1. General characters of **Platyhelminthes and Nematoda**.
2. **Fasciola - Type study**- External characters, Excretion, Reproduction and Development (Life cycle).
3. **Wuchereria**: Life history, transmission, prevention and control
4. Parasitic adaptations of helminthes worms

Unit - IV Annelida and Arthropoda

- 12 hours

1. General characters of Annelida and Arthropoda.
2. **Earth worm - Type study**. External characters, Digestive system, nervous system, Excretion, Reproduction and development
3. i) pest of Paddy - Tryporyza, Leptocorisa,
ii) pest of coconut - *Oryctes rhinoceros* and *Nephantis*.

Unit - V Mollusca and Echinodermata

-12 hours

1. General characters of Mollusca and Echinodermata.
2. **Star fish** – Type Study - External Morphology, Digestive System, and Water vascular System, Bipinnaria larva and its significance
3. **Pearl Culture**: Structure of Pearl oyster-formation of pearl-types of culture
4. **Oyster Culture**: Structure of edible oyster-types of culture and its food value

TEXT BOOKS:

1. A Text Book of Invertebrata – Arumugam. N et al., 2017, SARAs Publication, Kottar, Nagercoil.
2. Invertebrate Zoology – Jordan. E.L. and Verma. P.S., 2010 (Reprint), S. Chand and Company Ltd., Ram Nagar, New Delhi.

REFERENCE BOOKS:

1. Manual of Zoology, Vol. I (Invertebrata), Ekambaranatha Ayyar. M and T.N. Ananthakrishnan, 2003 (Reprint), Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
2. Invertebrate Zoology: A functional Evolutionary Approach, 7th Edition, Edward E. Ruppert, Richard S. Fox and Robert D. Barnes, 2003, Brooks – Publisher Pvt. Ltd., United States.
3. Modern Text Book of Zoology Invertebrates, 11th Edition, Kotpal. R.L., 2014, Rastogi Publications, Meerut, India.
4. Biology of the Invertebrates, 7th Edition, Jan A Pechenik, 2014, McGraw-Hill Education, India.
5. Invertebrates, 3rd Edition, Richard C. Brusca, Wendy Moore, Stephen M. Shuster, 2016, Sinauer Associates, Oxford University Press, UK.

I B.Sc., Ancillary Zoology,

Part - III

Semester - II

Core paper -2

Chordata

(4 Credits)

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To gain knowledge about the classification and general characters of vertebrates.
- To understand the structure and function of various systems in animals.
- To acquire knowledge on identifying the poisonous and non-poisonous snakes.
- To study the adaptations of birds and mammals.

Unit - I: Phylum Prochordates and Chordata - 12 hours

1. General characters of Phylum Chordata and classification upto class level
2. General characters of prochordates- Salient features of Hemichordata / Urochordata / Cephalochordata with one example each.
3. **Amphioxus** - Type Study - External features, Mode of feeding, Digestive system, excretory system and Reproductive system.
4. Affinities of prochordates

Unit - II: Pisces and Amphibia - 12 hours

1. General characters of Class Pisces and Amphibia.
2. **Shark** - Type study. External features, Digestive system, Respiratory system, structure of Brain,
3. Accessory respiratory organs in fishes
4. Parental care in amphibia

Unit - III: Reptilia

- 12 hours

1. General characters of Class Reptilia.
2. Identification of poisonous and non - poisonous snakes.
3. Biting mechanism of poisonous snake, Venoms of snake, first - aid and treatment for snake bite.
4. Extinction of dinosaurs-Classification of dinosaurs-causes of extinction

Unit: V: Aves - 12 hours

1. General characters of Class Aves.
2. Modification of beak and feet.
3. Migration of birds.
4. Flight adaptations in birds.

Unit - V: Mammalia - 12 hours

1. General characters of Class Mammalia.
2. **Rabbit** - Type study - Digestive system, Respiratory system, Brain and eye and excretory system.
3. Dentition in mammals.
4. Adaptations of aquatic mammals.

TEXT BOOKS:

- 1.A Text Book of Chordata – Arumugam. N *et al.*, 2017, Saras Publication, Kottar, Nagercoil.
- 2.Chordate Zoology – Jordan. E.L. and Verma. P.S., 2011, S. Chand and Company Ltd., Ram Nagar, New Delhi.

REFERENCE BOOKS:

- 1.A Manual of Zoology, Ekambaranatha Ayyar. M and T.N. Ananthakrishnan, 2003 (Reprint), Viswanathan Printers and Publishers Pvt. Ltd., Chennai.
- 2.Modern Text Book of Zoology vertebrates, Kotpal. R.L., 2009, Rastogi Publications, Meerut, India.
- 3.Vertebrate Life, 9th Edition, Harvey Pough. F, Christine Janis, Heiser. J.B., 2013, Benjamin-Cummings Publishing House, San Francisco.
4. Comparative Vertebrate Zoology, Hyman. L.H., McGraw Hill Co., New York.

II B.Sc Ancillary Zoology Part - III Semester - III

Microbiology, Cell biology, Genetics, Molecular biology, and Biotechnology

Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To gain knowledge about the bacterial and viral structure and diseases
- To understand the structure and function of various cell organelles.
- To acquire knowledge on sex linked inheritance in man
- To study the biotech applications.

Unit - I Microbiology - 12 hours

1. Structure of a prokaryotic cell (E.Coli).
2. Structure of T4 Phage.
3. Morphology of Bacteria i) coccus type: - Micrococcus, Diplococcus, Streptococcus, and Staphylococcus. ii) Bacillus type: - Micro bacillus, Diplobacillus, Streptobacillus, and Staphylobacillus. iii) Spirochetes, and iv) Comma shaped.
4. Bacterial and Viral disease - Gonorrhea and AIDS (Pathogenesis, Symptoms, Prevention, and Control).

Unit - II Cell biology - 12 hours

Structure and functions of the following cell components:

1. Cell membrane
2. Mitochondria
3. Endoplasmic reticulum and Ribosomes
4. Golgi body

Unit - III Genetics - 12 hours

1. Mendel's Laws – Mono and Dihybrid crosses.
2. Linkage and Crossing over
3. Multiple Allele and polygene inheritance
4. Sex linked inheritance in Man

Unit - IV Molecular biology - 12 hours

1. Structure and functions of DNA.
2. Structure and functions of RNAs (t RNA, m RNA, and r RNA).
3. DNA replication.
4. Protein synthesis.

Unit - V Biotechnology - 12 hours

1. Recombinant DNA -Construction and applications
2. Stem Cell Culture- Methods and applications
3. Transgenic animals-Methods and applications
4. DNA finger printing-Methods and applications.

Text Book:

1. Cell and Molecular Biology Arumugam.N, Saras Publications, Kottar, Nagercoil-2011
2. Biotechnology Kumaresan. V, Saras Publications, Nagercoil-2010

References Books:

1. De Robertis, E.D.P. and E.M.F. De Robertis 1987. Cell and Molecular Biology.
2. Power, C.B., 1989. Essentials of Cytology. Himalaya Publishing House.
3. Mani, A., Narayanan, Fatima, D L.M., Selvaraj, A.M. and Arumugam, N. Immunology and Microbiology(2010), Saras Publication, Nagercoil.
4. Genetics, Meyyan R.P. Saras Publication Nagercoil. 2008.
5. Principles of Genetics (VIII Edition) by Eldon John Gardener, Michael J. Simmons, D. Peter Snustad (2006) Published by John Wiley & Sons Inc., Canada. (2005 Reprint)
6. Text book of Biotechnology. Dubey, R.C. 2008. Chand & co., New Delhi.
7. Biotechnology B.D. Singh. 2008 Kalyani Publishers Ludhiana.

II B.Sc. Ancillary Zoology

Part - III

Semester - IV

Developmental biology, Biochemistry, Physiology, Immunology, and Evolution
Contact hours per week – 4 hours

Contact hours per Semester - 60 hours

OBJECTIVES:

- To gain knowledge about the test tube babies
- To understand the function of various metabolic cycles.
- To acquire knowledge on kidney function
- To study the human evolution.

Unit - I: Developmental biology - 12 hours

1. Structure of sperm and ovum in Frog.
2. Fertilization, Blastulation and Gastrulation in Frog.
3. Placentation in Mammals-Formation, Classification and functions
4. Test tube baby methods

Unit - II: Biochemistry - 12 hours

1. Classification and structure of Carbohydrates. (Mono, Di, Polysaccharides with one example each).
2. Classification and structure of proteins with examples (primary, secondary, tertiary, and quaternary structure).
3. Classification and Structure of Lipids with examples.
4. Metabolism: Glycogenesis, Glycolysis, Deamination and Transamination-
Beta oxidation

Unit - III: Physiology (Human) - 12 hours

1. Digestion of Carbohydrates, Protein, and Lipids.
2. Mechanism of respiration and Transport of gases
3. Structure of Nephron and Formation of urine
4. Structure of Neuron and conduction of impulse

Unit - IV: Immunology. - 12 hours

1. Types of Immunity (Innate and Acquired immunity).
2. Lymphoid organs. (Primary and secondary)
3. Immunoglobulin – Types and structure.
4. Antigen – antibody reactions.

Unit - V: Evolution - 12 hours

1. Lamarckism and De veries theory of Mutation.
2. Darwin's theory and Modern synthetic theory.
4. Speciation – Allopathic and Sympatric.
5. Human Evolution-Fossils and Genomic studies only.

Text Book:

1. Developmental Biology Arumugam. N.,Saras Publications, Kottar, Nagercoil-2012.
2. Animal physiology- N. Arumugam Saras Publication Nagercoil-2011
3. Organic Evolution by. Arumugam N, Saras Publications Nagercoil-2009.
4. Mani, A., Narayanan, Fatima , D L.M., Selvaraj, A.M. and Arumugam, N. Immunology and Microbiology(2010), Saras Publication, Nagercoil.

References Books

1. P.S.Verma and V.K. Agarwal- Animal physiology
2. Verma, P.S. and Agarwal V.K. 2005 Chordate Embryology S,Chand &Company Ltd., New Delhi.
3. Dobzhansky, Evolution, Genetics and Man, Oxford and IBH Publishing Co., New Delhi.
4. Gordon S. Maleon et al., Animal Function –Principles and Adaptations. The Macmillan Company –collier- Mamillan Ltd. Hen 5.. Hoar S.William-General, Comparative Physiology, prentice hall of Indian pvt ltd, New delhi,
5. Philip H. Mitchel – A Text book of General Physiology, Mc Graw Hill Book - 2013 Syllabus

Invertebrata and Chordata

Practical – I

Contact hours per week - 2 hours

(1 Credit)

Contact hours per Semester – 30 hours

1. Identifying the virtual specimen exposed in monitor / dissect the virtual specimen and label it and comment on it with suitable diagram.

- (1) Cockroach (2) Earthworm (3) Calotes

2. SPOTTERS

A. Classify giving reasons :

- 1) Paramecium
- 2) Taenia solium
- 3) Penaeus
- 4) Sea star
- 5) Amphioxus
- 6) Calotes
- 7) Pigeon
- 8) Rabbit

B. Draw Labeled Sketch :

- 1) Obelia Colony
- 2) Taenia Solium – Scolex
- 3) Frog – Pectoral girdle
- 4) Calotes – Brain
- 5) Snake – Poison apparatus
- 6) Pigeon – Quill feather
- 7) Rabbit – Dentition

C. Biological significance :

- 1) Obelia Medusa
- 2) Balanoglossus
- 3) Honey bee
- 4) Culex mosquito
- 5) Earth worm
- 6) Kangaroo

D. Write descriptive notes :

- 1) Paramecium – conjugation only
- 2) Gold fish
- 3) Sea horse
- 4) Peripatus
- 5) Owl

6) Bat

3. Identification of fauna and report submission

4. Record

II B.Sc. Ancillary Zoology

Part - III

Semester - IV

Practical - II

Microbiology, Cell biology, Genetics, Molecular biology, and Biotechnology, Developmental biology, Biochemistry, Physiology, Immunology, and Evolution

List of practicals:

1. Simple staining of non- pathogenic bacteria and observe the morphological structure.
2. Preparation of Onion root tip and observe the Mitotic stages.
3. Mendelian Monohybrid ratio with beads.
4. Self observation and recording of some common Mendelian traits.
5. Quantitative test for ammonia, urea, and uric acid.
6. Quantitative test for Carbohydrates, protein, and lipid.
7. Antigen – antibody reaction (in blood grouping)

List of Spotters:

1. Different morphological appearance of Bacteria.
2. Mitochondria, Golgi body, Endoplasmic reticulum, Lysosome and Ribosome.
3. Mitotic stages identification.
4. Meiotic stages identification.
5. Mendelian traits in Human population.
6. DNA – Model / paper cutting.
7. t RNA – Model / paper cutting.
8. Following stages of Frog embryo: i) Egg, ii) Sperm, iii) Blastula, iv) Gastrula.
9. Frog embryo – Section through optic cup.
10. Sheep placenta.
11. Paper cutting of zebra neck growth to explain Lamarckism.