

D DEPARTMENT OF ZOOLOGY

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To impart an education that promises an integrated growth of knowledge, skills and values and enables the students to have confidence and positive outlook.

Objectives

1. To develop an in-depth knowledge in the subject.
2. To enable the students to pursue higher studies.
3. To create an awareness on environment.

Courses Offered

Semester	Course	Subject Code	Paper	Hours / Week	Credits
I	Part I	TL1711	Language: Tamil	6	3
		FL1711	French		
	Part II	GE1711	General English: A Stream	6	3
		GE1712	B Stream		
	Part III	ZC1711	Major Core I: Invertebrate Zoology	4	4
		ZC17P1	Major Practical I	2	-
		CA1711	Allied I: Theory	4	4
		CA17P1	Allied I: Practical	2	-
	Part IV	AEC171	Ability Enhancement Compulsory Course (AECC): English Communication	2	2
		ZNM171	Non Major Elective Course (NMEC): Public Health and Hygiene	4	2
		VEC172	Foundation Course I: Values for Life	-	-
Part V	SDP172	Skill Development Programme (SDP): Certificate Course	-	-	
	STP174	Student Training Programme (STP): Clubs & Committees / NSS	-	-	
II	Part I	TL1721	Language: Tamil	6	3
		FL1721	French		
	Part II	GE1721	General English: A Stream	6	3
		GE1722	B Stream		
	Part III	ZC1721	Major Core II: Chordate Zoology	4	4
		ZC17P1	Major Practical I	-	2
		ZC17P2	Major Practical II	2	2
		CA1721	Allied I: Theory	4	4
CA17P1		Allied I: Practical	2	2	
	AEC172	Ability Enhancement Compulsory Course (AECC): Environmental Studies	2	2	

	Part IV	ZNM172	Non Major Elective Course (NMEC): Common Ailments and Simple Remedies	4	2
		VEC172	Foundation Course I: Values for Life	-	1
	Part V	SDP172	Skill Development Programme (SDP): Certificate Course	-	1
		STP174	Student Training Programme (STP): Clubs & Committees / NSS	-	-
	Part I	TL1731 FL1731	Language: Tamil French	6	3
	Part II	GE1731 GE1732	General English: A Stream B Stream	6	3

III	Part III	ZC1731	Major Core III: Cell Biology	4	4	
		ZC1732 ZC1733 ZC1734	Elective I: (a) Biochemistry and Biophysics (b) Clinical Laboratory Technology (c) Bioinstrumentation	4	4	
		ZC17P3	Major Practical III	2	-	
		ZA1731	Allied II: General Zoology	4	4	
		ZA17P1	Allied II: Practical	2	-	
		Part IV	SBC173/ SBC174	Skill Based Course (SBC): Meditation and Exercise / Computer Literacy	2	2
	VEC174		Foundation Course II: Personality Development	-	-	
	Part V	STP174	Student Training Programme (STP): Clubs & Committees / NSS	-	-	
		SLP173	Service Learning Programme (SLP): Extension Activity (RUN)	-	1	
	IV	Part I	TL1741 FL1741	Language: Tamil French	6	3
		Part II	GE1741 GE1742	General English: A Stream B Stream	6	3
Part III		ZC1741	Major Core IV: Genetics	4	4	
		ZC1742 ZC1743 ZC1744	Elective II: (a) Biostatistics and Computer Applications (b) Bioinformatics (c) Apiculture	4	4	
		ZC17P3	Major Practical III	-	2	
		ZC17P4	Major Practical IV	2	2	
		ZA1741	Allied II: Theory: Applied Zoology	4	4	
		ZA17P1	Allied II: Practical	2	2	
		SBC173/ /	Skill Based Course (SBC): Meditation and Exercise /	2	2	

	Part IV	SBC174	Computer Education		
		VEC174	Foundation Course II: Personality Development	-	1
	Part V	STP174	Student Training Programme (STP): Clubs & Committees / NSS	-	1
		ZC1751	Major Core V: Physiology	6	5
V	Part III	ZC1752	Major Core VI: Developmental Zoology	6	5
		ZC1753	Major Core VII: Ecology and Toxicology	5	4
		ZC1754 ZC1755 ZC1756	Elective III: (a) Aquaculture (b) Sericulture (c) Marine Biology	5	5
		ZC17P5	Major Practical V: (Physiology & Developmental Zoology)	4	-
		ZC17P6	Major Practical VI (Ecology and Toxicology & Evolutionary Biology)	2	-
		ZSK175	Skill Based Course (*SBC): Vermitechnology	2	2
	Part IV	HRE175	Foundation Course III: Human Rights Education (HRE)	-	1

VI	Part III	ZC1761	Major Core VIII: Biotechnology	6	5
		ZC1762	Major Core IX: Immunology and Microbiology	6	5
		ZC1763	Major Core X: Evolutionary Biology	5	5
		ZC1764 ZC1765 ZC1766	Elective IV: (a) Applied Zoology (b) Poultry Science (c) Pest Management	5	4
		ZC17P5	Major Practical V: (Physiology & Developmental Zoology)	-	2
		ZC17P6	Major Practical VI: (Ecology and Toxicology & Evolutionary Biology)	2	2
		ZC17P7	Major Practical VII (Biotechnology & Immunology and Microbiology)	4	2
	Part IV	ZSK176	* SBC - Project	2	2
		WSC176	Foundation Course IV: Women's Studies (WS)	-	1
			TOTAL	180	140 + 3

With effect from the academic year 2017 - 2020

Semester I
Major Core I – Invertebrate Zoology
Sub. Code: ZC1711

No. of hours/ week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To know the difference between protozoa and metazoa, and to study the structure, functional organization, adaptations and the economic importance of invertebrates.
2. To enable the students to recognize the invertebrates and to obtain jobs in museum, consultancy firms and educational institutions.

Unit I

Classification of Animal Kingdom. Levels of organization: Grades of organization, symmetry and coelom. **Protozoa:** General characters and classification up to classes with names of examples only. Type study: *Paramecium* – Structure, osmo-regulation and reproduction (binary fission and conjugation). Locomotion and Nutrition in Protozoa. Malaria and Amoebiasis (causes, symptoms, prevention and control).

Unit II

Porifera: General characters and classification up to classes with names of examples. Type study: *Leucosolenia* – external morphology – body wall - reproduction. Canal system in sponges.

Coelenterata: General characters and classification up to classes with names of examples only. Type study: *Obelia* - structure of the colony and life history. Corals, Coral reefs and their significance.

Unit III

Platyhelminthes: General characters and classification up to classes with names of examples only. Type study: Liver fluke (structure and life cycle), Tape worm (structure). **Aschelminthes:** General characters and classification up to classes with names of examples only. Pathogenicity and control measures of *Ascaris lumbricoides*, *Wuchereria bancrofti*, *Enterobius vermicularis*, *Ancylostoma duodenale* and *Dracunculus medinensis*. Parasitic adaptations of Helminthes.

Unit IV

Annelida: General characters and classification up to classes with names of examples only. Type study: Earthworm (structure and nephridia). Metamerism in Annelida. **Arthropoda:** General characters and classification up to classes with names of examples. Type study: *Panaeus* - external characters, appendages, compound eye, reproductive system and life cycle. Mouth parts of insects. Pest of Paddy (*Leptocorisa varicornis*), Coconut (*Oryctes rhinoceros*).

Unit V

Mollusca: General characters and classification up to classes with names of examples only. Type study: Pila - external characters – shell - pallial complex - digestive system - respiratory system. Cephalopods as advanced molluscs. **Echinodermata:** General characters and classification with names of examples only. Type study: Star fish – external characters and water vascular system. Larval forms of Echinoderms and their phylogenetic significance.

Textbook:

Nair, N.C., Leelavathy, S., Soundara Pandian, N., Murugan, T. & Arumugam, N. (2012). *A Textbook of Invertebrates*. Nagercoil: Saras Publication.

Reference Books:

1. Jordan, E.L. & Verma, P.S. (2010). *Invertebrate Zoology*. New Delhi: S. Chand & Co. Ltd.
2. Kotpal, R.L. (2004). *Modern Textbook of Zoology- Invertebrates* (9th ed.). Meerut: Rastogi Publications.
3. Ayyar, E.K. & Ananthakrishnan, T.N. (1992). *Manual of Zoology, Vol. I (Invertebrata), Part I & II*. Madras: S. Viswanathan Printers and Publishers Pvt. Ltd.
4. Dhami, P.S. & Dhami, J.K. (1979). *Invertebrate Zoology*. Ram Nagar, New Delhi: S. Chand & Co. Ltd.
5. Hickman, C.P. Jr., Hickman, F.M. & Roberts, L.S. (1984). *Integrated Principles of Zoology* (7th ed.). St. Louis: Times Merror / Mosby College Publication,
6. Jain, A.P. (2002). *Biology of Invertebrates* (4th ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.

Semester I
Major Practical I (Invertebrate Zoology)
Sub. Code: ZC17P1

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	50

Objectives:

1. To provide the ability to recognize the major groups of invertebrates.
2. To reinforce the basic laboratory skills including microscopy, dissection and careful observation.

Practicals

1. Observation of live *Paramecium* – Hay culture
2. Observation of spicules – Sponge
3. Mounting
 - Cockroach – mouth parts
 - Cockroach - salivary gland apparatus
 - Cockroach - trachea
4. Dissection:
 - Cockroach - Digestive system
 - Cockroach - Nervous system

Spotters

Amoeba, *Paramecium*, Euglena, *Spongilla*, Sponge gemmule, *Obelia*, *Physalia*, Coral (Fungia), Planaria, Liver fluke, Tapeworm, Cercaria larva, *Ascaris* (Male and Female), Earthworm, Nereis, Leech, Trochophore larva, *Penaeus*, Millipede, Centipede, *Oryctes rhinoceros*, Nauplius larva, Zoa larva, Pila, *Lamellidens*, *Pinctada*, Sepia, Octopus, Chiton, Starfish, Sea urchin, Sea Cucumber, Bipinnaria larva.

Semester I

UG - NMEC – Public Health and Hygiene

(Interdisciplinary)

Sub. Code: ZNM171

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives:

1. To make the students understand the various aspects of health and hygiene and to practice what they learn to cherish a healthy life.
2. To get job opportunities as health care taker, health inspector, beautician, project assistant in environment related programs, develop skill for personal care, maternal health, etc.

Unit I

Nutrition and health: Concept of health – physical, mental, social and spiritual. Positive health. Quality of health index. Nutrition: carbohydrates, lipids, proteins, vitamins, minerals and water. Snacking and fast food. BMI – obesity – malnutrition (Kwashiorkar and Marasmus). Food hygiene, food toxicants and adulterants.

Unit II

Personal health care: Skin: General care – Skin problems – Anti-ageing strategies. Hair: General care – preventing hair loss – anti-dandruff strategies. Teeth: General care – common dental problems. Eye: General care – common eye problems – contact lens. Ear: General care – common ear problems – hearing-aid equipment.

Unit III

Maternal and Child health: Motherhood – Pregnancy confirmation. Antenatal care – Physical and emotional changes – common problems during pregnancy- Intranatal care – Labour and delivery – Post natal care. Care of the newborn – feeding – nutritional guidelines – care of under-five (toddler and pre-school). Family planning. Table showing vaccination schedule in India.

Unit IV

Environment and health: Ventilation – standards of housing - Importance of Excreta disposal. Sanitary health measures during fairs and festivals: Environmental sanitation – Food sanitation – control of infectious diseases. Swachh Bharat Mission.

Unit V

Alternative medicine and First aid: Naturopathy – Homeopathy – Siddha - Ayurveda – Unani. Acupuncture. **First aid:** First aid procedures for dehydration - heart attack – poisoning - electric shocks - drowning - snake bite – Road accidents: bleeding - fractures and dislocation – Fire accidents: burns.

Textbook:

Sorna Raj, R., Kumaresan, V. (2012). *Public Health and Hygiene*. Nagercoil.: Saras Publication.

Reference Books:

1. Park, K. (2005). *Park's Textbook of Preventive and Social Medicine* (18th ed.). Jabalpur: M/S. Banarsidas Bhanot Publishers.
2. Lakshmana Sarma, K. & Swaminathan. S. (2011). *Speaking of Nature Cure*. New Delhi: Sterling Publications Pvt. Ltd.
3. Hoon, R.S. (1983). *First aid to the Injured*. New Delhi: Published by St. John Ambulance Association, Printed at The Statesman's Press.
4. Rae Bains (1984). *Health and hygiene*. USA: Troll Associates Publisher.

Semester II
Major core II - Chordate Zoology
Sub. Code: ZC1721

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To study the structure, functional organization, adaptation and the economic importance of lower and higher chordates.
2. To recognize, describe and identify the major groups of chordates and to gain employment in academic and research institutions.

Unit I

Introduction to **Chordata**: General characters of chordates and classification up to classes with names of examples only. **Prochordata**: General characters and classification up to classes with examples only. Type study: Amphioxus – external features, digestive system and excretory system. External features and biological significance of the following: *Ascidian*, *Balanoglossus*, *Salpa*, *Agnatha*: *Petromyzon* - external morphology, Ammocoetes larva.

Unit II

Pisces: General characters and classification up to subclasses with names of the examples only. Type study: *Scoliodon* - external characters, placoid scales, digestive system, respiratory system, circulatory system, nervous system, receptor organs, urino-genital system. Accessory respiratory organs in fishes, Migration of fishes, Lungfishes (Dipnoi).

Unit III

Amphibia: General characters and classification up to orders with names of the examples only. Type study: Frog – External characters, Endoskeleton: Skull, typical vertebra, atlas, girdles and limbs. Biological significance of Axolotl larva, Ichthyophis. Parental care in Amphibia. **Reptilia**: General characters and classification up to orders with names of the examples only. Type study: *Calotes* – External characters, circulatory system and excretory system. Identification and study of few poisonous snakes in India - first aid for snake bite and anti-venom.

Unit IV

Aves: General characters and classification up to sub classes with names of the examples only. Type study: *Columba livia* - external characters, exoskeleton, flight muscles, digestive system, respiratory system and urino-genital system. Migration of birds, Flight adaptation in birds, Flightless birds (Ratitae): general characters and examples.

Unit V

Mammalia: General characters and classification up to subclasses with names of the examples only. Type study: Rabbit - external morphology, structure of skin, dentition, digestive system,

respiratory system, urinogenital system. Structure of heart and brain. Egg laying mammals. Pouched mammals. Adaptations of aquatic mammals.

Textbook:

Thangamani, A., Prasannakumar, S., Narayanan, L.M. and Arumugam, N. (2014). *Chordate Zoology*. Nagercoil: Saras Publications.

Reference Books:

1. Jordan, E.L. & Verma, P.S. (2010). *Chordate Zoology* (11th ed.). New Delhi: S. Chand and Company Ltd.
2. Kardong, K. (2002). *Vertebrates: Comparative Anatomy, Function and Evolution*. Chennai: Tata McGraw Hill Publishing Company Ltd.
3. Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. (1995). *A Manual of Zoology, Volume II (Part I & II)*. Chennai: S. Viswanathan Pvt. Ltd.
4. Kotpal, R. L. (2014). *Modern text book of Zoology – Vertebrates* (3rd ed.). Meerut: Rastogi Publications.
5. Dhami P.S & Dhami J.K. (1972). *Chordate Zoology*. New Delhi: S. Chand and Company Ltd.
6. Young, J. Z. (2004). *The Life of Vertebrates* (3rd ed.). London: Oxford University Press.
7. Newman, H.H. (1981). *The Phylum Chordata*. Agra: Satish Book Enterprises.
8. Parker, T.J. & Hanswell, W.A. (1964). *Text Book of Zoology, Volume II (Chordata)*. New Delhi: A.Z.T.B.S. Publishers and Distributors.

Semester II
Major Practical II (Chordate Zoology)
Sub. Code: ZC17P2

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	50

Objectives:

1. To recognize and describe the morphology and anatomy of the chordates.
2. To create interest in chordate biodiversity through animal album and bird watches diary.

Practicals

- 1) **Shark:** Mounting of Placoid scales
- 2) **Frog:** Arterial system*.
- 3) **Frog:** Brain*.
- 4) **Reptiles:** Key for Identification of poisonous and non-poisonous snakes.
- 5) **Pigeon:**
 - i. External features and identification of feathers.
 - ii. Digestive system*
 - iii. Respiratory system*
- 6) **Submission** of an “Animal Album” containing photographs or paper cuttings of the locally available chordates of different taxa with brief writes up.
- 7) Maintenance of campus **Bird-watcher’s Diary** (group work).
- 8) **Field visit** to places of Zoological importance.

* Models/ Chart/ CD can be used. Students have to draw the diagram and write detailed account in the observation note book.

Museum specimens / slides / charts:

Amphioxus, *Balanoglossus*, *Ascidian*, *Petromyzon*, *Ammocoetes* larva, *Narcine*, *Hippocampus*, *Anguilla*, *Rhacophorus*, *Axolotl* larva, *Ichthyophis*, Salamander, House lizard, Chamaeleon, *Draco*, *Chelone*, Cobra, Sparrow, Wood pecker, Kingfisher, Pelican, Penguin, Owl, Pangolin, Kangaroo, Bat, Squirrel, Loris, Whale, typical vertebra (frog), atlas (frog), pectoral girdle (frog), pelvic girdle (frog), forelimb skeleton (frog), and hind limb skeleton (frog).

Semester II
UG - NMEC - Common Ailments and Simple Remedies
Sub. Code: ZNM172
(Interdisciplinary)

No. of hours/week	No. of credits	Total number of hours	Marks
4	3	60	100

Objectives:

1. To create awareness of the changing life style and its impact in human health.
2. To acquire sufficient foundation for achieving a reasonable level of employability.

Unit I

Anaemia and types of anaemia. Blood pressure-types, symptoms, treatments and prevention. Stroke and Heart attack. Diabetes- causes, symptoms, diagnosis and treatment.

Unit II

Dental caries and Pyorrhoea - causes, symptoms, treatment and prevention. Jaundice- causes, types, symptoms, treatment and prevention. Typhoid- causes, types, symptoms and treatment, Digestive disorders: Diarrhoea - causes and treatment, Chronic constipation- causes, prevention.

Unit III

Common cold, cough-treatment, primary complex- causes and treatment, Asthma- causes, symptoms and treatment. Headache- causes and types.

Unit IV

Dengue fever- causes, types, symptoms and treatment, Malaria - causes, types, symptoms and treatment, Filariasis (Elephantiasis) - causes, types, symptoms and treatment.

Unit V

Aging- old age related ailments - Depression of loneliness and some remedies to keep them engaged, loss of memory, osteoporosis, Parkinson's disease, Alzheimer's disease, Fomentation and cleansing enema. Arthritis- causes, types, symptoms and treatments.

Textbook:

John M. Fowler (1970). *Radiant Living*. Pune: Oriental Watchman Publishing House.

Reference Books:

1. Chugh, S.N. (2006). *Emergency Medicine* (2nd ed.). India: PeePee Publishers and Distributors Pvt.
2. Clifford R. Anderson (1999). *Your Guide to Health*. Pune: Oriental Watchman Publishing House.
3. Chawla, N.P.S. (1994). *Penguin India Family Medical Encyclopaedia*. New Delhi: Penguin Book Publication.
4. Valantine Fuster, R. & Wayne Alexander (2001). *The Heart* (10th ed.). USA: McGraw-Hill Publications.
5. Anne McIntyre (1994). *Simple Home Remedies for Common Ailments*. USA: Gaia Books Publisher.

Semester III
Major core III - Cell Biology
Sub. Code: ZC1731

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To enable the students to know about the diversified nature of cells and also the location, structure and functions of all cellular components.
2. To develop skill in micro- and molecular techniques.

Unit I

Cell and microtechniques: Scope of cell Biology. Cell theory. Microscopy: Compound, phase contrast and electron microscope. Cytological techniques: Fixation and fixatives – types of stains. General organization of a prokaryotic (Bacteria) and Eukaryotic cell.

Unit II

Cell organelles: Ultrastructure and functions of Plasma membrane, Mitochondria, Ribosomes, Endoplasmic reticulum, Golgi complex, Lysosomes, Centrosomes.

Unit III

Nucleus: Ultrastructure and functions of Nucleus - Nuclear membrane, Nucleolus. Chromosomes - types, structure and functions. Special types of chromosomes - Polytene and Lampbrush. Structure, functions and types of Nucleic acids (DNA & RNA). DNA replication in prokaryotes.

Unit IV

Gene expression and regulation: General characteristics of Genetic code. Structure of gene - promoter sequence and coding sequence. Protein synthesis – transcription and translation in prokaryotes. Regulation of gene expression - Lac operon.

Unit V

Cell division and significance: Cell cycle - Mitosis and Meiosis, mitotic apparatus, anaphase chromosomal movements and synaptonemal complex. Cancer - properties of cancer cells, types, causes, diagnosis and treatment, oncogenes. Aging and Apoptosis.

Textbook:

Arumugam, N. (2015). *Cell Biology*, Nagercoil: Saras Publications.

Reference Books:

1. Prakash S. Lohar (2009). *Cell and Molecular Biology*, 5th Ed. Chennai: MJP Publishers.
2. Rastogi, S.C. (2008). *Cell Biology* (2nd ed.). New Delhi: New Age International (P) Limited Publishers.
3. Powar, C.B. (2013). *Cell Biology*. Bombay: Himalaya Publishing House.
4. De Robertis, E. M. F. (2011). *Cell Biology* (8th ed.). New York: Lippincott Williams & Wilkins Publication.
5. Singh, S.P. and Tomar, B.S. (2014). *Cell Biology*, (10th ed.). New Delhi: Rastogi Publications.

Semester III
Major Elective I – (a) Biochemistry and Biophysics
Sub. Code: ZC1732

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To enrich the knowledge of students on the structure, classification and metabolism of biomolecules and to learn the principle and functions of specified bio-instruments.
2. To develop practical skills on biochemical techniques and to use bioinstruments.

Unit I

Bonds and Buffer: Atoms – Chemical bonds – Isotopes - Hydrogen ion concentration - pH. Measurement of pH. Acids and bases - Acidosis and alkalosis. Buffers - Mechanism of buffer action - Hendersen-Hasselbalch equation - Biological buffer systems - Significance of buffers.

Unit II

Proteins: Amino acids - classification, structure and properties. Proteins - classification, structure (primary, secondary, tertiary and quaternary), Haemoglobin, Silk - biological functions of proteins. Enzymes - Classification of enzymes, nomenclature and properties, mechanism of enzyme action.

Unit III

Carbohydrates and Lipids: Carbohydrates - classification, Monosaccharides (glucose and fructose), Disaccharides (sucrose and lactose), Polysaccharides (glycogen and hyaluronic acid), biological functions of carbohydrates. Lipids - classification, simple lipids (triglycerides and waxes), Compound lipids (lecithin), Derived lipids (cholesterol), biological functions of lipids.

Unit IV

Thermodynamics and Light: Laws of thermodynamics, enthalpy, entropy and free energy, Redox reactions and redox potential, ATP bioenergetics. Membrane conductivity - diffusion, osmosis and active transport - mechanism and biological significance. Light - nature and properties - electromagnetic spectrum - Absorption and Emission spectrum, Fluorescence and Phosphorescence - Bioluminescence.

Bioinstrumentation: Centrifugation - principle and applications of differential and density gradient centrifugation. Types of centrifuges. Colorimeter and spectrophotometer - principle, instrument and applications. Chromatography – principle and applications of paper, thin layer and column chromatography. Electrophoresis – principle and applications of Agarose and PAGE.

Textbook:

Annie and Arumugam, N. (2015). *Biochemistry and Biophysics*. Nagercoil: Saras Publications.

Reference Books:

1. Jain J.L., Sunjay Jain and Nitin Jain (2007). *Fundamentals of Biochemistry* (6th ed.). New Delhi: S. Chand and Company Ltd.
2. Satyanarayana, V. (2005). *Essentials of Biochemistry*. Calcutta: Books and Allied (P) Ltd.
3. Sr. Mercy, P.D., Sr. Basil Rose, M.R. and Dulsey Fathima (2004). *Biochemistry and Biophysics*. Nagercoil: Sathana Publications.
4. John Jothi Prakash, E., David Paul Raj, M., Ratnavathy, D., Kamala, T. and Susheela Bai, C. (2000). *Basic Biochemistry and Biophysics*. Valliyoor: JPR Publications.
5. Thiravia Raj, S. (2005). *Biophysics*. Nagercoil: Saras Publications.
6. Narayanan, P. (2000). *Essentials of Biophysics*. New Delhi: New Age International publishers.
7. Daniel, M. (2000). *Biophysics for Biologists*. New Delhi: Agrobios.
8. Vasantha Pattabhi and N. Gautham (2002). *Biophysics*. New Delhi: Narosa Publishing House.
9. Arumugam, N. and Kumaresan, V. (2016). *Biophysics and Bioinstrumentation*. Nagercoil: Saras Publications.

Semester III
Major Elective I - (b) Clinical Laboratory Technology
Sub. Code: ZC1733

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To gain knowledge on the laboratory techniques adopted in medical diagnostic laboratories.
2. To procure jobs in hospitals, research laboratories and pharmaceutical industries.

Unit I

Essential pre-requisites of a Clinical Laboratory: Scope; Safety and first aid in laboratory accidents. Cleaning of glassware; Sterilization – physical and chemical methods. Preparation of Normal, Molar and Percentage solution. Biomedical waste management.

Unit II

Common Laboratory Instruments and their applications: Microscope, Balance, pH meter, Colorimeter, Autoanalyser, Centrifuge, Incubator, Water bath, Haemocytometer, Sahli's haemoglobinometer.

Clinical Haematology: Collection of blood (Venous and capillary), Blood grouping, Separation of plasma and serum, Blood cell count – Total count and differential count, Haemoglobin estimation by Sahli's method, Erythrocyte sedimentation rate (ESR). Analysis of blood glucose, HbA1c test, serum urea, serum creatinine, alkaline phosphatase, cholesterol, High density lipid (HDL) and low density lipid (LDL), Triglycerides.

Unit IV

Examination of body fluids: Sputum analysis – Physical properties and microscopic examination. Cerebrospinal fluid - Collection, Physical, chemical and microscopic examination. Serous fluid (Pleural, pericardial and peritoneal), Synovial fluid.

Unit V

Urine and Stool Analysis: Urine – collection, composition, volume, colour and transparency. Analysis of urine for glucose, albumin, bilirubin, urobilinogen and ketone. Microscopic examination for bacteria, organized and unorganized deposits and blood. Pregnancy test. Stool - collection, types. Microscopic examination of stool. Identification of intestinal parasites (Saline wet mount). Testing faecal occult blood.

Textbook:

Rajan, S. (2012). *Manual for Medical Laboratory and Technology* (1st ed.). Chennai: Anjanaa Book House.

Reference Books:

1. Kanai, L. Mukherjee (2005). *Medical Laboratory Technology, A procedure manual for routine diagnostic tests*, Vol I, II & III (19th ed.). New Delhi: Tata McGraw – Hill Publishing Company Ltd.
2. John Bernard Henry (2001). *Clinical diagnosis and management by laboratory methods* (20th ed.). Philadelphia: Saunders & Co.
3. Ramnik Sood, M.D. (2003). *Medical Laboratory Technology, Methods and Interpretation* (4th ed.). New Delhi: Jaypee Brothers Medical Publishers (P) Ltd.
4. Mary Vijaya, T., Mini, M.L., Sunitha Kumari, K., Asha, K.R.T. (2003). *Practical Clinical Biochemistry Manual*. Kaliakkavilai: Rishi Publications.

Semester III
Major Elective I - (c) Bioinstrumentation
Sub. Code: ZC1734

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To know about the instruments used in biological laboratories and learn their operation technique and applications.
2. To develop skill in handling bioinstruments.

Unit I

Units of measurements – Metric system, conversion of Units. Microscopy – principles and types (Dark field, Polarizing and Confocal). Autoclave – principle, applications and types. Centrifuge - principles and types (clinical, ultra centrifuges). pH - Sorenson's pH scale, pH Meter - principle and applications. Manometry - principle and applications of Warburg manometer.

Unit III

Chromatography: Principles, types and applications of paper, thin layer, column Chromatography. Electrophoresis: Principles and applications of agarose and SDS - PAGE.

Unit IV

Spectroscopy: principles and uses of colorimetry and NMR (Nuclear Magnetic Resonance) spectroscopy; Radio isotopic technique: Radio immuno assay, Biochemical applications of radio isotopes.

Unit V

Biosensors: principle, types (Enzyme, Bacterial electrodes, Environmental Biosensors and Bioreporters and applications). DNA and RNA sequencing methods. PCR: principle and application.

Textbook:

Arumugam, N. and Kumaresan, V. (2012). *Biophysics and Bioinstrumentation*. Nagercoil: Saras publications.

Reference Books:

1. Boyer, R. (2000). *Modern Experimental Biochemistry* (3rd ed.). USA: Addison Wesley Longman, Inc.
2. Mohanty, P.K. (2000). *Illustrated Dictionary of Biology*. Ludhiana: Kalyani Publishers.
3. Ludhiana, Wilson, K. and Walker, J. (2010). *Principles and techniques of Biochemistry and Molecular Biology* (7th ed.). UK: Cambridge University Press.
2. Van Holde, K.E., Johnson, W.C. and Ho, P.S. (2006). *Principles of Physical Biochemistry*, (2nd ed.). New Jersey: Pearson Prentice Hall.
3. Sharma, V. K. (1991). *Techniques in Microscopy and Cell Biology*. New Delhi: Tata-McGraw Hill Publishing Ltd.

Semester III
Major Practical III (Cell Biology, Biochemistry and Biophysics)
Sub. Code: ZC17P3

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	100

Objectives:

1. To develop skill in identifying cell types and cell division.
2. To apply working principles in basic bio instruments and to interpret the biological changes.

Practicals

1. Observation of mitosis in onion root tip.
2. Observation of giant chromosomes in *Chironomus* larva.
3. Preparation of Human blood smear.
4. Smear preparation of Squamous epithelium.
5. Qualitative test for carbohydrates, lipids and proteins.
6. Quantitative estimation of protein by Biuret method.
7. Determination of pH using pH meter.
8. Separation of amino acids using paper chromatography.
9. Verification of Beer's Law.
10. Demonstration of osmosis using grapes.

Charts/ Models/ Bookplates:

Compound microscope, Mitochondria, Golgi complex, Endoplasmic reticulum, Ribosomes, Lysosomes (polymorphism), Interphase nucleus, DNA (Watson & Crick model), tRNA, Glucose, Amino acid, Cholesterol, ATP, EM spectrum, Centrifuge, Colorimeter, pH meter.

Semester III
Allied Zoology - General Zoology
Sub. Code: ZA1731

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To acquire a basic knowledge about animal diversity and general principles of Cell Biology, Genetics, Developmental Biology, Evolution and Physiology.
2. To seek employment in educational institutions and museums.

Unit I

Invertebrate Zoology: General characters of Invertebrates - Classification up to phylum with two examples for each. *Paramecium* - external features, conjugation. *Obelia* – external features, polymorphism. *Ascaris* - external features, parasitic adaptations. *Penaeus* – external features. Star fish – external features, water vascular system.

Unit II

Chordate Zoology: General characters of chordates - Outline classification up to classes with one example and characteristics of Chordates. Rabbit – external characters. Migration of fishes. Identification of poisonous and non-poisonous snakes, poison apparatus, first-aid for snake bite. Flight adaptations in birds. Dentition in mammals.

Unit III

Cell Biology and Genetics: Structure of prokaryotic and eukaryotic cell. Human chromosomes – structure – types and function. Simple Mendelian traits in man, Genetics of blood groups in man, sex linked inheritance in man – colour blindness and haemophilia. Non-disjunction and syndromes in man: Klinefelter's, Turner's and Down's syndrome.

Unit IV

Developmental Zoology and Evolution: Early development in frog - structure of sperm and ovum. Fertilization, cleavage, blastulation and gastrulation. Placenta – Types and functions. Urey Miller Experiment and Modern synthetic theory of evolution.

Physiology: Digestion – digestion of carbohydrates, proteins and fats. Respiration – structure and functions of lungs in man. Excretion - structure and functions of kidney in man. Circulation: structure and function of human heart. Nervous system - central, peripheral, sympathetic, parasympathetic and structure of a neuron.

Textbook:

Arumugam, N. (2011). *Allied Zoology*, Vol. I to III. Nagercoil: Saras Publications.

Reference Books:

1. Ekambaranatha Ayyer, M.A. (1986). *Manual of Zoology* Vol. I & II. Chennai: S. Viswanathan Printers and Publishers Pvt. Ltd.
2. Jordan, E.L. and Verma, P.S. (1988). *Chordate Zoology* New Delhi: S. Chand and Co. Ltd.
3. Kotpal, R.L. (2004). *Modern Text Book of Zoology – Invertebrates* (9th ed.). Meerut: Rastogi Publications.
4. Kotpal, R.L. (2004). *Vertebrates*. Meerut: Rastogi Publications.
5. Nagabhusanum, R., Kodarkar, M.S. and Sarogini, R. (1982). *Textbook of Animal Physiology* (2nd ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Verma, P.S. and Agarwal, V.K. (2003). *Chordate embryology* (10th ed.). New Delhi: S. Chand and Co. Ltd.
7. Rastogi, V.B. and Jayaraj, M.S. (2000). *Textbook of Genetics*. Meerut: Kedarnath Ramnath Publishers.
8. Verma, P.S. and Agarwal, V.K. (2010). *Cell Biology, Genetics, Molecular Biology, Physiology, Evolution and Ecology*. New Delhi: S. Chand & Co.

Semester IV
Major Core IV – Genetics
Sub. Code: ZC1741

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To enable the students to understand the basic principles of hereditary mechanisms and its applications.
2. To create job opportunities in genetic counseling centers, forensic and clinical laboratories.

Unit I

Mendelian laws of inheritance - Monohybrid and dihybrid - back cross and test cross. Complete, incomplete and codominance. Interactions of genes: Complementary genes, Supplementary genes, Epistasis, Lethal genes. Polygenic inheritance (Skin colour in man), Multiple alleles: ABO blood group in man, Rh factor in man; coat colour in rabbit.

Linkage - kinds, theories of linkage, linkage groups. Crossing over - mechanism, theories of crossing over, cytological evidence (Stern's experiment and Tetrad analysis), significance of crossing over. Chromosome map: two point and three point cross, construction of chromosome map. Sex determination in man and *Drosophila*. Non disjunction - Primary and secondary non disjunction in *Drosophila*. Syndromes in man: Turner's, Klinefelter's and Down syndrome.

Unit III

Cytoplasmic inheritance - Kappa particles in *Paramecium*, milk factor in mice, shell coiling in *Limnaea*. DNA as genetic material - Bacterial transformation, conjugation and transduction. Mutation: Chromosomal mutation - changes in structure and number, aneuploidy and euploidy, Gene mutation - mutagens. DNA repair mechanisms.

Unit IV

Human chromosomes: autosomes and allosomes – Karyotype and idiogram. Simple Mendelian traits in man. Twins - types, development and application. Inborn errors of metabolism. (Phenylketonuria, Alkaptonuria, Albinism). Sex - Linked genes and their inheritance: X - linked genes (Colour blindness and Haemophilia), holandric genes.

Unit V

Population genetics – Hardy Weinberg equilibrium – calculation of gene frequency – factors affecting gene frequency – selection, mutation, genetic drift and migration. Inbreeding, out breeding and heterosis. Eugenics, Euthenics and Euphenics. Pedigree analysis. Genetic prognosis - Genetic counselling.

Textbook:

Meyyan, R. P. (2011). *Genetics*. Nagercoil: Saras Publications.

Reference Books:

1. Verma, P.S. and Agarwal, V.K. (2009). *Genetics*, Revised ed. New Delhi: S. Chand & Co.
2. Peter Snustad, D. and Michael J. Simmons (2010). *Principles of Genetics* (2nd ed.). USA: John Wiley and Sons.
3. Chatterjee, S. (2009). *Genetics*. New Delhi: APH Publishing Corporation.
4. Singh, B.D. (2008). *Fundamentals of Genetics* (4th ed.). Ludhiana: Kalyani Publishers.
5. Gardner, Simmons, Snustad (2006). *Principles of Genetics* (8th ed.). USA: John Wiley & Sons.
6. Ahluwalia, K.B. (2009). *Genetics* (2nd ed.). New Delhi: New Age International.

Semester IV
Major Elective II – (a) Biostatistics and Computer Applications
Sub. Code: ZC1742

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To enrich the knowledge of students on the nature of life and to learn some basic methods in statistics and computer.
2. To utilize both computer software and calculator based methods of bio statistical analysis. Basic concepts of biostatistics: Population, Data, Sample and variable. Collection of data - sampling methods. Processing of data: classification and tabulation. Presentation of data: Diagrams and graphs.

Unit II

Measures of central tendency – Arithmetic Mean, median, mode. Measures of dispersion – Range, Quartile deviation, Percentiles, Mean deviation, Co-efficient deviation - standard deviation. Variance, co-efficient of variation, Standard error.

Unit III

Probability: Basic concepts – Types: apriori and aposteriori – theorems: Addition and multiplication – permutation and combination. Test of significance: Chi square test and Student's *t* - test.

Unit IV

Introduction to computers: Types of computers - Components of computer: input devices, output devices, CPU, storage devices, Operating system. MS-Office: MS word - Creating word document – editing - aligning – bulleting – printing.

Unit V

MS - Excel: Entering and editing cell entries – adjusting row and column height –charts. MS - PowerPoint: Steps to create a presentation – slide presentation. Information network: Internet, email, mail transfer, web site, internet browsing.

Textbook:

Arumugam. N. (2015). *Biostatistics, Computer application and Bioinformatics*. Nagercoil: Saras Publications.

Reference Books:

1. Ramakrishnan, P. (2015). *Biostatistics*. Nagercoil: Saras Publications.
2. John De Britto, A. (2011). *Biostatistics*. Palayamkottai: St. Xavier's College (Autonomous).
3. Pranab Kumar Banerjee (2005). *An Introduction to Biostatistics*. New Delhi: S. Chand and Company Ltd.
4. Gurumani, N. (2005). *An Introduction to Biostatistics*. Chennai: MJP Publishers.
5. Jeni Chandar Padua and Anto Hepsi Bai (2014). *Computer for beginners*. Nagercoil: Print Point Publishers.

Semester IV
Major Elective II – (b) Bioinformatics
Sub. Code: ZC1743

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To understand the application of computer technology and learn to process the biological data.
2. To seek employability in educational institutions and research laboratories.

Introduction to Bioinformatics: Definition, introduction, history and scope. Databanks – Gen Bank, PDB. Literature Databanks - Pubmed, Med line. Human Genome Project.

Unit II

Biological databases: Proteins and nucleic acids. Sequence - EMBL, DDBJ. Structural database - CATH, SCOP. Specialized – Genome data base, EST.

Unit III

Sequence Alignment: Matrices (BLOSUM and PAM), Algorithm (Needleman Wunsch & Smith Waterman). Tools for sequence alignment – BLAST, FASTA.

Unit IV

Phylogenetic analysis: Molecular phylogenetic analysis; methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees – maximum parsimony, distance and maximum likelihood; phylogenetic software resources.

Unit V

Drug Designing: Drug discovery process – drug target identification, target validation, Lead compound identification, Lead optimization, Docking (importance, mechanics of docking, docking sites), Quantitative structure-activity relationship. Preclinical and clinical development.

Textbook:

Sundaralingam, R. and Kumaresan, V. (2008). *Bioinformatics*. Nagercoil: Saras Publications.

Reference Books:

1. Gladis Helen Hepsyba, S. and Hemalatha, C.R. (2009). *Basic Bioinformatics*. Chennai: MJP Publishers.
2. John Britto, A. (2011). *Bioinformatics*. Palayamkottai: St. Xavier' College.
3. Jin Xiong (2006). *Essential Bioinformatics*. USA: Cambridge University Press.
4. Hooman H. Rashidi and Lukas K. Buehler (2000). *Bioinformatics Basics: Application in Biological Science and Medicine*. USA: CRC Press.

Semester IV
Major Elective II – (c) Apiculture
Sub. Code: ZC1744

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To make the students understand the various dimensions of the life of the honey bees and bee products.
2. To learn the profitable methods of rearing these social insects so as to make use of this learning for self-employment.

Scope of Apiculture: Honey bee - classification of bees – Rock bee, Indian bee, Little bee and Dammer bee – their classification. Bee colony- queen, drone and workers – functions of the members. Anatomy and organ systems of honey bee. Development of honey bee – egg, larva and pupa – time taken for the development of queen drone, and workers. Life history of *Apis indica*. Food of the bee - honey and pollen – artificial feeding – behaviour of bees – dances.

Unit II

Principles of Apiculture: Arranging an apiary – Position – space – direction. Acquiring bees – care of newly captured colonies – handling the bees. Bee keeping - the bee hive and comb architecture. Artificial hives- Newton’s hive. Other appliances used in apiaries.

Unit III

Honey Bee products: Honey – extraction of honey – preservation and storage of honey – properties and chemical composition, nutritive value, medicinal, value – honey as daily food. Bee wax –methods of extraction – characteristics and uses. Bee venom – methods of extraction– composition and uses.

Unit IV

Enemies and diseases: Enemies of bees – Greater wax moth, lesser wax moth, ants, wasps, lice, beetles and birds – their control. Bacterial, viral and fungal brood diseases

Unit V

Swarming: Causes, prevention and control. Robbing and fighting – causes, prevention and control. Uniting stocks – different methods. **Queen rearing** – different methods - Supersedure. **Foraging** - Bee pasturage. Relationship of plants and Honey Bees.

Textbook:

Johnson, J. and Jeya Chandra, I. (2008). *Apiculture*. Marthandam: Olympic Grafix.

Reference Books:

1. R.C. Mishra (1995). *Honey Bees and their management in India*. New Delhi: ICAR.
2. Johnson, J. & I. Jeya Chandra (2008). *Apiculture*. Marthandam: Olympic Offset Printers.
3. George A Carter (2004). *Bee Keeping*. New Delhi: Biotech books.
4. Mishra, R.C. (1998). *Perspectives in Indian Apiculture*. Bikaner: Agro Botanica.

Semester IV
Major Practical IV (Genetics, Biostatistics and Computer Applications)
Sub. Code: ZC17P4

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	100

Objectives:

1. To learn and practice the basic principles of inheritance in a firsthand manner.
2. To train the students learn and perform experiments, collect data, analyze the data, learn to interpret the data and draw conclusion from it.
 1. Observation of simple Mendelian traits in man.
 2. Verification of monohybrid and dihybrid ratio using beads.
 3. Culture of *Drosophila* (wild) in the laboratory to study various stages of life cycle, eye colour and sexual dimorphic characters (Demonstration only).
 4. Observation and study of polygenic inheritance of quantitative traits to be interpreted in graphs - length of pods / leaves.
 5. Blood group identification.
 6. Analysis of data (ungrouped) - mean, median, mode, standard deviation (using neem leaves).
 7. Study of Probability using coin tossing with one coin and testing the significance using chi square test.
 8. MS word.

Charts / Models / Bookplates:

Syndromes (Klinefelter's, syndrome, Turner's syndrome, Down syndrome), Sex-linked inheritance (Colour blindness, Haemophilia, Hypertrichosis), Bar diagram, Histogram, Pie diagram.

Semester IV
Allied Zoology - Applied Zoology
Sub. Code: ZA1741

No. of hours/week	No. of credits	Total number of hours	Marks
4	4	60	100

Objectives:

1. To understand the concepts of Apiculture, Sericulture, Poultry, Dairy farming and Aquaculture.
2. To acquire basic knowledge in applied Zoology and motivate the students for self-employment and to discern distinct entrepreneurial traits.

Unit I

Apiculture: classification and kinds of bees, bees and their society - caste distinction and their functions. Methods of bee keeping (primitive and modern). Honey bee products: honey, bee wax, bee venom.

Unit II

Sericulture: Moriculture – methods of propagation – Common species of Silkworm – Life cycle of mulberry silkworm (egg, larva, pupa and adult). Rearing of silkworm – mounting – spinning-harvesting of cocoons – silk reeling and marketing.

Unit III

Poultry Farming: Poultry housing - types of poultry houses – management of chick, growers, layers and broilers. Sexing in chicks, Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis.

Unit IV

Dairy Farming: Breeds of Dairy animals – Establishment of a typical Dairy farm – Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, Foot and Mouth Disease). Dairy products (Standard milk, skimmed milk, toned milk and fermented milk - curd, ghee, cheese) Pasteurization.

Aquaculture: Aquaculture in India – Important cultivable organisms and their qualities – culture of Indian major carps, Marine prawn culture, Pearl culture. Integrated fish culture (Paddy cum fish culture).

Textbook:

Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. (2011). *Applied Zoology*. Nagercoil: Saras Publications.

Reference Books:

1. Johnson, J. and Jeya Chandra, I. (2005). *Apiculture*. Marthandam: Olympic Grafix.
2. Ganga, G. and Sulochana Chetty (1997). *An Introduction to Sericulture*. New Delhi: Oxford and IBH Publishing Co.Pvt. Ltd.
3. Gnanamani, M.R. (2005). *Profitable Poultry Farming*. Madurai: J. Hitone Publications.
4. Santhanakumar, G. and Selvaraj, A.M. (2002). *Concepts of Aquaculture*. Nagercoil: Meenam Publications.
5. John Moran (2005). *Tropical Dairy Farming*. Australia: Landlinks Press.
6. Uma Shankar Singh (2008). *Dairy Farming*. New Delhi: Anmol Publishers.

Semester IV
Allied Zoology Practical (General Zoology & Applied Zoology)
Sub. Code: ZA17P1
(Conducted during Semester III & IV)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Objectives:

1. To develop practical skills in basic concepts of biology.
2. To make students to acquire more practical knowledge through industrial visits to agro-based farms.

General Zoology

1. Dissection: Cockroach – Nervous system.
2. Mounting: Prawn appendages.
3. Mounting: Shark – Placoid scale.
4. Observation of simple Mendelian traits in man.
5. Observation of frog's egg.
6. Analysis of glucose and albumin in Urine.

Museum specimens

Paramecium, *Obelia*, *Ascaris* (male and female), *Penaeus*, Starfish (oral and aboral), *Amphioxus*, Eel, *Naja naja*, Pelican, Rabbit.

Slides/Charts/Models/Bookplates:

DNA (Watson & Crick Model), Colour blindness, Shark and *Echeneis*, Ancon Sheep, Industrial melanism.

Applied Zoology

1. Testing milk using lactometer.
2. Estimation of oxygen in water samples.
3. Estimation of salinity in water samples.
4. Visit to places having importance related to theory.

Spotters / Models / Charts / Bookplates

Honey bee (worker, queen and drone), Newton's bee-hive, silkworm (egg, larva, pupa and adult), Chandrika, Rearing stand, Poultry feeders, Fowl pox, Coccidiosis, *Catla catla*, Rohu, Mrigala.

Semester V
Major Core V - Physiology
Sub. Code: ZC1751

No. of hours/week	No. of credits	Total number of hours	Marks
6	6	90	100

Objectives:

1. To make students understand the functional significance of the different organs and organ systems of animals.
2. To provide job opportunities in academic institutions, National Health Service Centers, Pharmaceutical and biotechnology industries.

Unit I

Food constituents and their importance: Carbohydrates, proteins, lipids, vitamins and mineral salts. Balanced diet and Malnutrition. **Digestion and Absorption:** Digestive system of man, role of enzymes in carbohydrate, protein and fat digestion, absorption of digested food materials. **Metabolism:** Anabolism and catabolism, Glycogenesis, Glycogenolysis, Glycolysis, Krebs' cycle, Electron transport system, Deamination, Transamination, Urea cycle, β oxidation of fatty acid.

Unit II

Respiration: Respiratory organs in man, respiratory pigments, transport of O₂ and CO₂, oxygen dissociation curve, Bohr's effect, Chloride shift, Anaerobiosis, Respiratory Quotient. **Osmoregulation:** Osmosis; Osmoconformers and osmoregulators, Mechanism of osmoregulation, Osmoregulation in crustaceans, fishes and mammals. **Thermoregulation:** Poikilotherms and Homeotherms, Mechanism of thermoregulation.

Unit III

Circulation: Myogenic and neurogenic heart, structure of human heart, heart beat - its origin and conduction, pace maker, cardiac cycle and ECG, blood pressure. Heart diseases: atherosclerosis, acute coronary occlusion, myocardial infarction. **Excretion:** Patterns of excretion, Structure of kidney in man, nephron, mechanism of urine formation, composition of urine. Nephritis and Dialysis. **Bioluminescence:** Bioluminescence in animals, biochemistry and significance of bioluminescence.

Unit IV

Muscle physiology: Types of muscles, ultrastructure and properties of skeletal muscle, factors affecting excitability. Theories and mechanism of muscle contraction and Rigor mortis. **Neurophysiology:** Structure and types of neurons, neurotransmitters, conduction of nerve impulse through myelinated and non-myelinated nerve, synapse and neuromuscular junction.

Unit V

Endocrine Physiology: Pituitary, Thyroid, Parathyroid, Adrenal, Islets of Langerhans. **Reproductive Physiology:** Male reproductive system and structure of sperm - Female reproductive system, structure of graffian follicle and ovum. Sexual cycles: oestrus cycle and menstrual cycle - Menopause. Hormonal regulation of menstruation, pregnancy and lactation.

Textbook:

Arumugam, N. (2014). *Animal Physiology*. Nagercoil: Saras Publications.

Reference Books:

1. Goel, K. A. and K.V. Sastry (1998). *A Text Book of Animal Physiology* (6th ed.). Meerut: Rastogi Publications.
2. Singh, H.R. Shoban Lal Nagin (1995). *Animal Physiology and Related Biochemistry* New Delhi: S. Chand and Co.
3. Nagabhushan, R. Kodarkar, M.S. and Sarojini, R. (1982). *Text book of Animal Physiology* (2nd ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
4. Agarwal R.A., Srivastava, A.K. and Kaushal Kumar (1998). *Animal Physiology and Biochemistry* (3rd ed.). New Delhi: S. Chand and Company Ltd.
5. Arora, M.P. (2007). *Animal Physiology* (6th ed.). Mumbai: Himalayan Publishing House.
6. William S. Hoar (1991). *General and Comparative Physiology*. New Delhi: Prentice Hall of India Publications.

Semester V
Major Core VI – Developmental Zoology
Sub. Code: ZC1752

No. of hours/week	No. of credits	Total number of hours	Marks
6	6	90	100

Objectives:

1. To understand the sequential changes from cellular grade of organization to organ grade of organization in the development of multicellular organisms.
2. To pursue a wide range of career related to women's health and also in fields concerned with maternal, foetal and reproductive medicine.

Unit I

Gametogenesis: Spermatogenesis, Oogenesis. Types of sperm and egg, egg membranes. Structure of sperm and egg of frog, chick and human. **Fertilization:** significance, types, chemical and cytological factors involved in fertilization - physiological changes in fertilization. Asexual reproduction. **Parthenogenesis:** types and significance.

Unit II

Cleavage: Planes and patterns of cleavage, cleavage and blastulation in frog. Fate map of frog. Morphogenetic movements. Gastrulation in frog. **Organogenesis:** Development of brain, eye, heart, digestive system in frog.

Unit III

Organizer: Spemann's experiments - organizer in amphibian embryo, embryonic induction - neural induction. Competence. **Gradient theory:** gradient system - types, experimental evidences, mechanism. Morphogenetic fields. **Extra embryonic membranes:** Development of foetal membranes. Placenta in mammals - classification, functions and development.

Unit IV

Metamorphosis: Types, Insect and Amphibian metamorphosis - hormonal control. **Regeneration:** types, regeneration in Planaria and Amphibia, factors influencing regeneration, physiological changes involved in regeneration.

Nucleo-cytoplasmic interaction: Acetabularia. **In vitro fertilization:** Infertility - artificial insemination - cryopreservation of sperm and ovum - test tube babies – amniocentesis. **Birth control:** contraceptive devices - surgical method- hormonal method - physical barriers - IUCD.

Textbook:

Arumugam, N. (2014). *A text book of Embryology*. Nagercoil: Saras Publications.

Reference Books:

1. Verma, P.S. and Agarwal, V.K. (2003). *Chordate Embryology*. New Delhi: Narosa Publishing House.
2. Sastry, K.V. and Shukla, V. (2003). *Developmental Biology*. Meerut: Rastogi Publications.
3. Balinsky, B. I. and B.C. Fabian (1981). *An Introduction to Embryology* (5th ed.). New York: Saunders Publishing College.
4. Gayatri Prakash (2007). *Reproductive Biology*. New Delhi: Narosa Publishing House.

Semester V
Major Core VII - Ecology and Toxicology
Sub. Code: ZC1753

No. of hours/ week	No. of credits	Total number of hours	Marks
5	5	75	100

Objectives:

1. To provide the opportunity for students to develop a deep understanding of various aspects of the environment and apply that knowledge to current environmental issues and for wise environmental management.
2. To seek employment in Food and Drug Administration agency and Environmental Protection Agency.

Unit I

Ecology: Scope - Branches of ecology, Abiotic factors: Biological effects of temperature and light. Concept of limiting factors: Liebig's law of minimum, Shelford's law of tolerance. **Biotic factors:** mutualism – commensalism – antagonism (antibiosis, parasitism, predation and competition). **Habitat ecology:** Characteristics and communities of Aquatic – freshwater (pond) and marine – terrestrial (forest, grass land, Desert) and adaptations of organisms.

Unit II

Ecosystem: Structure (abiotic and biotic) - food chain and food web - Trophic levels - energy flow and ecological pyramids. **Biogeochemical cycle:** nitrogen and phosphorous cycle. **Population ecology:** density, natality, mortality, age distribution, population growth, biotic potential, population dispersal and dispersion, regulation.

Unit III

Community: Community structure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype. **Ecological succession:** types, general process, Concepts of climax, patterns of succession. Animal distribution – continuous, discontinuous. Zoogeographical regions of world.

Wild life conservation: Necessity, causes, endangered species, methods of conservation - in situ (sanctuaries and national parks) and ex situ (zoo and germplasm bank). Remote sensing and its applications in agriculture, fisheries, forest management and food management. **Urbanization:** Possible advantages of urbanization – problems, solutions.

Unit V

Toxicology: Toxicants - classification - toxicity (LC₅₀, and LD₅₀), toxic agents and their mode of action. Toxic effects of metals, solvents, pesticides, carcinogens, food additives, drugs and poisons and radiations. **Environmental toxicology:** environmental pollutants, toxicants and contaminants, behaviour of toxicants in the environment – effect of xenobiotics.

Textbook:

Arumugam, N. (2014). *Ecology and Toxicology*. Nagercoil: Saras Publications.

Reference Books:

1. Mercy, P.D. and Basil Rose, M.R. (2003). *Ecology and Toxicology*. Nagercoil: Sathana Publications,
2. Sharma, P.D. (1999). *Ecology and Environment*. Meerut: Rastogi Publications.
3. Dash, M.L., Tata M.C. (1996). *Fundamentals of Ecology*. New Delhi: McGraw Hill Publishing Company Ltd.
4. Trivedi, R.N. (1993). *Textbook of Environmental Sciences*. New Delhi: Anmol Publications Pvt. Ltd.
5. Shukla, S.K. and Srivastava, P.R. (1992). *Water Pollution and Toxicology*. New Delhi: Common-Wealth Publishers.
6. Subramanian, M.A. (2004). *Toxicology: Principles and methods*. Chennai: M. J. P. Publishers.
7. Verma, P.S. and Agarwal V. K. (1986). *Principles of Ecology*. New Delhi: S. Chand & Co. Pvt. Ltd.

Semester V
Major Elective III – (a) Aquaculture
Sub. Code: ZC1754

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Objectives:

1. To enable the students to realize the importance and culture of economically important aquatic organisms.
2. To provide means of sustenance and earning livelihood and monetary profit through commercial and industrial aquaculture.

Unit I

Introduction: Scope. Aquaculture in India – freshwater, coastal and marine. Culturable organisms. Construction of ponds. Types of fish ponds – nursery, rearing and culture ponds. Water quality management.

Types of culture: Extensive, intensive, semi – intensive, monoculture, monosex culture, poly culture, cage culture and pen culture. Integrated fish farming – paddy cum fish culture, animal husbandry cum fish culture and sewage-fed fish culture. Fish Nutrition: Artificial feed – feed formulation.

Unit III

Culture of aquatic organisms: Fin fish culture – culture of Indian major carp – collection of seed, breeding - bundh breeding and induced breeding, transport of seeds. Shell fish culture – freshwater prawn culture and edible oyster culture. Seaweed culture. Live feed and their culture – *Artemia*, diatoms, rotifers and algae.

Unit IV

Diseases: Bacterial - Bacterial Gill Rot, Enteritis, Infectious Dropsy. Viral - Epizotic Ulcerative Syndrome, Viral Haemorrhagic Septicemia. Fungal – Gill rot and Saprolegniasis. Ectoparasitic and Endoparasitic diseases – Argulosis, Lernaeasis, Dactylogyrosis, Ligulosis, Piscicolosis, Ichthyophthiriasis, Myxobolosis and Costiasis. Nutritional deficiency diseases.

Unit V

Harvesting: Crafts and gears - Post-harvest technology – Transportation - Rigor mortis - fish spoilage - Fish preservation techniques. **Fish marketing:** Co-operative marketing in fisheries.

Governmental agencies in aquaculture: CMFRI, CIFRI, MPEDA, FFDA, CIFA and CIBA.

Textbook:

Arumugam, N. (2010). *Aquaculture*. Nagercoil: Saras Publications.

Reference Books:

1. Chandral, Lily Premila and Latha. (2009). *Aquaculture*. Nagercoil: C.S.I. Diocesan Press
2. Santhana Kumar, G and A. M. Selvaraj (2002). *Concepts of Aquaculture*. Nagercoil: Meenam Publications.
3. Santhanam, R. (1995). *Fisheries Science*. New Delhi: Daya Publishing House.
4. Jhingran, V.G. (1997). *Fish and Fisheries of India*. New Delhi: Hindustan Publishing Co.
5. Khanna, S.S. (1988). *Introduction to Fishes*. Allahabad: Central Book Dept.

Semester V
Major Elective III – (b) Sericulture
Sub. Code: ZC1755

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Objectives:

1. To develop skills in sericulture in order to enable the students to adopt it as a vocation after their graduation as it is rural based and welfare-oriented agro based industry.
2. To develop entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.

Unit I

Introduction: Importance of Sericulture - Silk Road - Sericulture industry in India - Sericulture as cottage industry - Birth and role of CSB. **Moriculture:** Important mulberry varieties - Optimum conditions for mulberry growth. Planting system. Methods of propagation - seedling, vegetative and new methods - irrigation. – Biofertilizers. Green manuring Triacantanol and Seriboost. Pruning - harvesting of leaves - preservation of leaves. Nutritive value of mulberry.

Unit II

Diseases of Mulberry: Fungal - white and violet root rot and Fusarium root rot - fungal stem rot and stem canker and wilt diseases. Leaf spot and powdery mildew diseases; Bacterial - leaf blight and rot diseases. Viral - dwarf and leaf mosaic diseases. Nematode - root knot disease. Deficiency diseases - nitrogen, phosphorus, magnesium and potassium.

Unit III

Pests of Mulberry: Leaf eating insect pests - Mulberry pyralid - Bihar hairy caterpillar - wasp moth and Almond leaf bore. Borer pest - Stem girdler beetle and stem borer. **Biology of silkworm:** Taxonomic position of *Bombyx mori* – habit and habitat of silkworm – classification of silkworms – Life cycle of *B. mori* – morphology of egg, larva, pupa and adult. **Diseases of silkworm:** Pebrine, Grasserie, Flacherie and Muscardine.

Unit IV

Silkworm rearing: Rearing appliances and rearing operations. Maintenance of optimum conditions for rearing. Feeding, bed cleaning, spacing, care during moulting. Rearing methods – Chawki, shelf, floor and shoot rearing. Sampoorana. Mounting - Methods of mounting – Precautions to be taken during mounting – harvesting of cocoons. **Cocoon marketing:** transport of cocoons - physical characteristic of cocoons – Defective cocoons – cocoon markets. **Grainage technology:** grainages – procedures in a grainage – diapause and non-diapausing eggs – Transport of eggs.

Unit V

Silk reeling: Stifling – Sun drying – steam stifling – Hot air stifling – storage of cocoons – sorting of cocoons – deflossing - cocoon riddling – cocoon mixing – cocoon cooking – open pan and three pan system – brushing – reeling – country charka, cottage basin and multi-end reeling, re-reeling- lacing – skeining. Raw silk testing marketing. By products of sericulture. **Wild silk worm rearing:** Eri, Tasar and muga.

Textbook:

Johnson, M. and Kesary, M. (2008). *Sericulture*. Marthandam: CSI Press.

Reference Books:

1. Ganga, G and J. Sulochana Chetty (1997). *An Introduction to sericulture*. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd.
2. Food and Agriculture organization (1976). *Manual on sericulture I, II & III*. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd.
3. M.S. Jolly (1987). *Appropriate Sericulture Techniques*. Mysore: CSR & TI.
4. S.R. Ullal and M.N. Narasimhanna (1987). *Hand book of practical sericulture*. Bangalore: CSB.
5. M.N. Narasimhanna (1988). *Manual on silkworm egg production*. Bangalore: CSB.
6. S.B. Dandin and Giridhar, K. (2000). *Hand book of Sericulture Technologies*. Bangalore: CSB.

Semester V
Major Elective III – (c) Marine Biology
Sub. Code: ZC1756

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Objectives:

1. To enable the students to gain knowledge about the marine habitat and marine life.
2. To gain relevant knowledge and skills to acquire a range of diverse marine resource-based career.

Unit I

Classification of marine environment: Horizontal and vertical – names and extent of different oceans - Physiological oceanography – physical properties of water, specific gravity, solubility and their influence on marine organisms.

Unit II

Waves and tides: Origin, major water currents and their impact on animal and plant populations and productivity.

Unit III

Chemical Oceanography: Major and minor constituents of seawater. Salinity and chemical composition and their influence on productivity. **Energy cycle:** carbon, nitrogen, and phosphorus cycles in marine environment.

Unit IV

Biological Oceanography: Phyto and zooplanktons and their adaptations. Economically important sea weeds, fishes, prawn, molluscan and echinoderm populations.

Unit V

Marine Geology: Marine sediments and their economic importance – oil resources – pollutants and their effect - Coral reefs in the world. Marine national parks.

Textbook:

Dubey, S.K. (2005). *Marine Biology*. New Delhi: Dominant Publishers and Distributors.

Reference Books:

1. Peter Castro and Michael E. Huber (2009). *Marine Biology*. New Delhi: McGraw Hill Higher Education.
2. Manjushree Acharya (2011). *Marine Biology*. New Delhi: International Scientific Publishing House.
3. Veena (2010). *Understanding Marine Biology*. New Delhi: Discovery Publishing House.
4. Prasad, S.N. (2000). *Marine Biology*. New Delhi: Campus Book International.
5. Sir Frederick S. Russell and Sir Maurice Yonge (1971). *Advances in Marine Biology*. New York: Academic Press.

Semester V
Skill Based Course (SBC) – Vermitechnology
Sub. Code: ZSK175

No. of hours/week	No. of credits	Total number of hours	Marks
2	2	30	100

Objectives:

1. To impart knowledge on the production of vermicompost, a nutrient rich fertilizer.
2. To enable the students to generate and promote employment and organic farming.

Unit I

Vermitechnology: Definition and importance. Earthworm – Systematic position and salient features. Categories of earthworm – Anecic, Endogeic, Epigeic species. Biology of *Eisenia fetida*, *Lumbricus terrestris*, *Eudrilus eugenia*, *Megascolex mauritii*.

Unit II

Role of earthworms: Soil fertility and productivity. Earthworm and microorganisms, Pest and diseases of earthworm, Economic and medicinal importance.

Unit III

Vermiculture: Collection and preservation. Vermiculture techniques -Types (monoculture and polyculture). Vermicast - formation, shape, composition and importance. Vermiwash – preparation, composition and applications.

Unit IV

Vermicomposting: Requirements – earthworm, site, bed, feed, moisture and oxygen. Steps of vermicomposting - selection of site, containers, species, food, preparation of vermibed, inoculation of worms, feeding, watering the worm bed. Methods of vermicomposting,

Unit V

Harvesting and marketing: Harvesting of earthworms and vermicompost. Packaging, storing, and marketing of vermicompost. Economic viability of vermicomposting. Financial Support by Government.

Textbook:

Seetha Lekshmy, M. and Santhi, R. (2012). *Vermitechnology*. Nagercoil: Saras Publications.

Reference Books:

1. Mary Violet Christy, A. (2008). *Vermitechnology*. Chennai: MJP. Publishers.
2. Sultan Ahmed Ismail (2005). *The Earthworm* (2nd ed.). Goa: Other India Press.
3. Gupta, P.K. (2003). *Vermicomposting for sustainable Agriculture*. Jodhpur: Agrobios.
4. Ekambaranatha Ayyer (1989). *A Manual of Zoology, Part I, Invertebrata*. Chennai: S. Viswanathan Printers & Publishers Pvt. Ltd.
5. Dohama, A.K. (2004). *Vermicompost*, New Delhi: Vivekananda Kendra (NARDEP).
6. Dahama, A.K. (2009). *Organic farming for sustainable Agriculture* (2nd ed.). Jodhpur: Agrobios.

Semester V
Major Elective III – (c) Marine Biology

Sub. Code: ZC1761

No. of hours/week	No. of credits	Total number of hours	Marks
6	6	90	100

Objectives:

1. To learn the basic concepts of biotechnology and understand the various techniques pertaining to biotechnology.
2. To get employability in biotech industries.

Unit I

Plant and Animal cell culture: Culture media - cell culture technique - establishment of cell culture – primary and sub-culture - explant culture, callus culture, Somatic hybridization and micro-propagation Cell lines - large scale culture of cell lines - organ culture - embryo culture.

Unit II

Tissue engineering: Artificial skin and cartilage. Stem cells: characteristics, types and applications. **Transgenic animal technology:** Transgenesis – methods of transgenesis, applications of transgenic animals. **Hybridoma technology:** Production of Hybridoma, monoclonal antibodies: production and applications. **Bioreactors:** stirred tank and air–lift bioreactor.

Unit III

Metabolite production: Ethanol (primary metabolite) and Penicillin (secondary metabolite). Immobilization of enzymes and their applications. Biosensors – types and applications. Bacterial SCP and its applications. Sewage and waste water treatment. **Bioremediation:** Types, Degradation of Xenobiotics (hydrocarbon, pesticide), super bug – construction and application. Biomining and bioleaching. Biocontrol – *Bacillus thuringiensis*.

Unit IV

Genetic Engineering: Restriction enzymes, cloning vectors: SV40, Ti plasmid. Preparation of desired gene - Isolation of plasmid vector - insertion of desired gene into the vector - Introduction of rDNA into host cell – Screening and identification of cloned gene. DNA library. Molecular markers (RAPD & RFLP). Polymerase chain reaction. Southern blotting. DNA sequencing: Maxam and Gilbert’s method – Sanger’s method.

Unit V

DNA applications: Disease diagnosis – DNA probes, disease treatment – production of human insulin. Gene therapy – types and methods. Finger printing and its application in forensic medicine. Human Genome Project. **Bioethics:** Ethical implications of transgenic animals. Biosafety: Possible dangers of Genetically Engineered organisms (GEOs) and biohazards of rDNA technology. **Nanotechnology:** applications of nanotechnology in medicine, drug designing and cancer treatment.

Textbook:

Kumaresan, V. (2014). *Biotechnology*. Nagercoil: Saras Publications.

Reference Books:

1. Dubey, R.C. (2006). *A Text book of Biotechnology* (4th ed.). New Delhi: S. Chand and Co. Ltd.
2. Satyanarayana, V. (2005). *Biotechnology*. Kolkata: Books and Allied (P) Ltd.
3. Rema L.P. (2006). *Applied Biotechnology*. Chennai: MJP Publishers.
4. Prakash S. Lohar (2005). *Biotechnology*. Chennai: Kalyani Publishers.
5. Gupta P.K. (2004). *Elements of Biotechnology*. Meerut: Rastogi Publications.
6. Singh B.D. (2007). *Biotechnology - Expanding Horizon*, Chennai: Kalyani Publishers.
7. Trevan, M.D. Boffey, S., Goulding, K.H. and Stanbury, P. (2004). *Biotechnology - The Biological Principles*. New Delhi: Tata McGraw - Hill Publishing Company Limited.

Semester VI
Major Core IX - Immunology and Microbiology
Sub. Code: ZC1762

No. of hours/week	No. of credits	Total number of hours	Marks
6	6	90	100

Objectives:

1. To enable the students to become aware of the microbes around us and also to know about the processes involved in the elimination of invading microbes by the defense system of our body.
2. To provide proficiency in basic microbiological and immunological skills.

Unit I

Immunity and Lymphoid organs: History and scope. Types of immunity - Innate, acquired, passive and active. Vaccines and Immunization schedule. Primary and Secondary organs - Thymus, Bone marrow, Bursa of Fabricius, Spleen, Lymph node, Mucosa Associated Lymphoid Tissue.

Unit II

Cells of the immune system: Haemopoietic stem cells and haemopoiesis - lymphoid and myeloid lineage. Cells of immune system (T cells and B cells, macrophages). Antigen. Immunogens, haptens and adjuvants. Immunoglobulin: Immunoglobulin classes, structure and functions of IgG. Antigen – Antibody reactions.

Unit III

Immune response: Primary and secondary immune response, immunity to bacterial infections (humoral and cell-mediated immune response). Hypersensitivity: Allergens and types of hypersensitivity. Tumour immunology. Autoimmunity Rheumatoid arthritis.

Unit IV

Microbiology: History and scope. Whittaker's classification of microbes with two examples. Bacteria: structure of *E. coli*, bacterial growth curve, culture media, culture techniques- batch culture and continuous culture (chemostat and turbidostat). Virus: structure (TMV and T₄ phage) – reproduction of phages (lysogenic and lytic).

Unit V

Food Microbiology: Food poisoning, food spoilage and preservation. Industrial microbiology: Alcohol and Penicillin production. **Medical microbiology:** Bacterial diseases (Tuberculosis, Gonorrhoea, Streptococcal dermal infection), viral diseases (AIDS, Chicken pox, Hepatitis B, Rabies), fungal diseases (Mycotoxicosis and Aspergillosis).

Textbook:

Arumugam, N., Mani, A., Narayanan, L.M., Dulsy Fatima and Selvaraj, A.M. (2013). *Immunology and Microbiology*. Nagercoil: Saras publications.

Reference Books:

1. Kuby, T. (1994). *Immunology*. New York: W.H. Freeman and Company.
2. Tizard, I.R. (1995). *Immunology - an Introduction* (4th ed.). Philadelphia: Saunders College Publications.
3. Prescott, Lansing, M. John, P. Harley and Donald A. Klan (2005). *Microbiology*. New York: McGraw Hill Publishing Co. Ltd.
4. Pelczar, Michael J. E.C.S. Chan and Noel R. Krieg (2006). *Microbiology*. New York: Tata McGraw – Hill Publishing Co. Ltd.
5. Roger, Y. Stanier, John L. Ingraham, Mark L. Wheelis and Pager R. Painter (1988). *General Microbiology*. New Delhi: Macmillan India Ltd.

Semester VI
Major Core X - Evolutionary Biology
Sub. Code: ZC1763

No. of hours/week	No. of credits	Total number of hours	Marks
5	5	75	100

Objectives:

1. To discern the evolutionary significance of animals and origin of species.
2. To provide methods of investigating animal evolution, construction of phylogenetic trees and to get job in educational institutions and paleontological departments.

Unit I

Concepts and Evidences of Evolution: Origin of life - Theories and experiments; Evidences in support of evolution – morphology and comparative anatomy, embryology, physiology and biochemistry, palaeontology. Geological time scale.

Unit II

Theories of Evolution: Lamarckism, Neo-Lamarckism. Darwinism, Neo-Darwinism. Mutation theory of De Vries. Modern synthetic theory. Variation – types, sources – mutation, combination, hybridization, genetic drift, Founder's principle, polyploidy. Natural selection – Stabilizing, directional and disruptive selection.

Unit III

Isolating mechanisms: Types, origin and evolution of isolating mechanisms, role of isolation in speciation. **Species Concept and Speciation:** Species, sibling species, sub species, demes. Species concept - morphological, genetic and biological. Speciation - Phyletic and true speciation, mechanism of speciation. Patterns of speciation – allopatric, sympatric, quantum and parapatric.

Unit IV

Phylogenetic analysis: Tools for sequence alignment – BLAST, FASTA. Methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees – maximum parsimony, distance and maximum likelihood.

Unit V

Trends in Evolution, Mimicry and Colouration: Modes of evolution – micro, macro and mega evolution. Heterochrony- Paedomorphosis and Peramorphosis. Rate of evolution. Human Evolution – organic, cultural and future evolution. Mimicry and colouration. Extinction - types, causes and significance.

Textbook:

Arumugam, N. (2010). *Organic Evolution*. Nagercoil: Saras Publications

Reference books:

1. Arora, M.P. (2003). *Evolutionary Biology*. Chennai: Himalaya Publishing House.
2. Sanjib Chattopadhyay (2012). *LIFE: Evolution, Adaptation and Ethology*. Kolkata: Books and Allied (P) Ltd.
3. Verma, P.S. and V.K. Agarwal (1998). *Concept of Evolution*. New Delhi: S. Chand and Company Ltd.
4. Verma, P.S. and V.K. Agarwal (1982). *Principles of General Biology (Evolution)*. New Delhi: S. Chand and company Ltd.
5. Gladis Helen Hepsyba, S. and Hemalatha, C.R. (2009). *Basic Bioinformatics*. Chennai: MJP Publishers.
6. John Britto, A. (2011). *Bioinformatics*. Palayamkottai: St. Xavier' College.
7. Hooman H. Rashidi and Lukas K. Buehler (2000). *Bioinformatics Basics: Application in Biological Science and Medicine*. USA: CRC Press.
8. Sanjib Chattopadhyay (2008). *Evolution, Adaptation and Ethology*. Kolkatta: Books and Allied Pvt. Ltd.

Semester VI
Major Elective IV – (a) Applied Zoology
Sub. Code: ZC1764

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Objectives:

1. To deepen the knowledge of students in general and applied areas of Zoology.
2. To provide employment and job opportunities in the public, private and government sector.

Unit I

Apiculture: Scope – classification and kinds of bees – bees and their society – life cycle of *Apis indica* – food of honey bees - relationship between plants and bees. Methods of bee keeping (primitive and modern) – Honey bee products: honey, bee wax, bee venom. **Lac culture** – scope – lac insect *Laccifer lacca* and its life cycle – processing of lac - lac products and importance.

Unit II

Sericulture: Scope – Silk Road - CSB - Moriculture: varieties of mulberry, methods of propagation, harvesting of leaves – Common species of Silkworm– Life cycle of mulberry silkworm – Diseases of silkworm: pebrine, grasserie, sotto diseases, muscardine – pest of silkworm: uzifly. Rearing of silkworm – mounting – spinning - harvesting of cocoons – silk reeling and marketing.

Unit III

Poultry Keeping: Scope – commercial layers and broilers - poultry housing - types of poultry houses – management of chick, growers, layers and broilers – debeaking - sexing in chicks - Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis – vaccination.

Unit IV

Dairy Farming: Scope – Breeds of Dairy animals – Establishment of a typical Dairy farm – Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, FMD). Nutritive value of milk - dairy products (Standard milk, skimmed milk, toned milk and fermented milk-curd, ghee, cheese) Pasteurization. Leather industry – scope – processing of skin.

Unit V

Integrated Farming: Definition and Scope. Agri-based fish farming – paddy cum fish culture, Horticulture cum fish farming. Integrated bee keeping, Livestock cum fish farming – Duck cum fish culture, fish cum poultry farming, fish cum dairy farming, goat cum fish integration, fish cum pig farming - multi-trophic aquaculture – Livestock – Poultry – Fish - Horticulture.

Textbook:

Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. (2011). *Applied Zoology*. Nagercoil: Saras Publications.

Reference Books:

1. Vasantharaj David, B. (2004). *General and Applied Entomology* (2nd ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.
2. Johnson, J. and Jeya Chandra, I. (2005). *Apiculture*. Marthandam: Olympic Grafix.
3. Tharadevi, C.S., Jayashree, K.V. and Arumugam, N. (2014). *Bee Keeping*. Nagercoil : Saras Publications.
4. Johnson, M. and Kesary, M. (2015). *Sericulture* (5th ed.). Marthandam: CSI Press.
5. Ganga, G. and Sulochana Chetty (1997). *An Introduction to Sericulture*. Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Gnanamani, M.R. (2005). *Profitable Poultry Farming*. Madurai: J. Hitone Publications.
7. Shukla, G.S. and Upadhyay, V.B. (1998). *Economic Zoology*. Jaipur: Rastogi Publications.
8. John Moran (2005). *Tropical Dairy Farming*. Australia: Landlinks Press.
9. Uma Shankar Singh (2008). *Dairy Farming*. New Delhi: Anmol Publishers.

Semester VI
Major Elective IV – (b) Poultry Science
Sub. Code: ZC1765

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Objectives:

1. To make the students know about the rearing of poultry as a profitable self employment opportunity.
2. To apply entrepreneurial and teamwork skills in finding, evaluating and beginning the process of implementing new venture concepts.

Unit I

Poultry industry in India: Commercial layers and broilers. Sexing in one day old chicks. Poultry housing: General principles of building poultry house. Deep litter system - dropping pit – feeders – waterers - nest boxes. Laying cages - Californian cages - management of cage birds.

Unit II

Poultry manure: volume, composition and values. Nutritional content of eggs. **Management of poultry** : chicks, growers, layers and broilers. Lighting for chicks, growers, layers and broilers. Summer and winter management. Debeaking - Forced moulting.

Poultry nutrition: Protein and amino acid requirements for chicks, growers, layers and broilers - Symptoms of excessive dietary levels and deficiency. Carbohydrate and fat requirements for chicks, growers, layers and broilers - symptoms of excessive dietary levels and deficiency - . Requirements of vitamins and inorganic minerals - deficiency symptoms.

Unit IV

Requirements of poultry feed: Importance of feed additives in poultry feed. Preparation of supplementary feed for poultry – South Indian feed ingredients in relation to Metabolizable Energy (M.E) level, protein level, amino acid level, minerals (Ca & P) and fibre content. Mash for chick, grower, layer and broiler.

Unit V

Poultry diseases: Causes, symptoms, transmission, treatment, prevention and control of viral diseases (Ranikhet disease, fowl pox, infectious bronchitis, avian leucosis complex and Gumboro disease), bacterial (Fowl typhoid, Paratyphoid, Pullorum, Fowl cholera, Coryza, Mycoplasmosis), fungal diseases (Aspergillosis and Aflatoxicosis), Parasitic disease (Coccidiosis, Nematode infection, Tape worm infections) external parasites: Ticks, mites and lice. Prophylactic approach to diseases, Homeopathy in poultry diseases.

Textbook:

Gnanamani M.R. (2010). *Modern aspects of commercial Poultry keeping*. Madurai: Deepam Publications.

Reference Books:

1. Singh, K.S. and Panda, B. (1988). *Poultry Nutrition*. New Delhi: Kalyani Publishers.
2. Norris-Elye, L. C. R. (2005). *Poultry Science*. New Delhi: Biotech Books.
3. Colin G. Scanes, George Brant and Eugene Ensminger, M. (2004). *Poultry Science* (3rd ed.). New Jersey: Prentice Hall Publishers.
4. Nuhad J. Dagher (2008). *Poultry Production in Hot Climates*, London: CAB International.
5. David E. Swayne (2012). *The Diseases of Poultry* (13th ed.). New Jersey: Wiley – Blackwell Publishers.
6. Chauhan, H.V.S. and Sushovan Roy (2007). *Poultry Diseases - Diagnosis and Treatment*. Hyderabad: New Age International Publishers.

Semester VI
Major Elective IV - (c) Pest Management
Sub. Code: ZC1766

No. of hours/week	No. of credits	Total number of hours	Marks
5	4	75	100

Objectives:

1. To provide awareness on various pests and their control measures.
2. To apply Integrated Pest Management strategies to resonate home based food products with the general public.

Introduction: Definition of pest – Outline of pest groups affecting agricultural crops – population dynamics of pests – causes for pest out breaks - Pest control methods: cultural, chemical and biological pesticides, precautions, safety devices - pesticide poisoning symptoms and first aid.

Unit II

Pesticides: Organochlorine, Organosphorus and carbamates – Inorganic and Natural pesticides - Preparation of pesticides – Formulations – packages, manufacture, Toxicity levels – L.D. 50 values. Mode of action of pesticides.

Unit III

Pests of Agricultural importance: Bionomics and Life cycles of any two pests of the following: Cereals (rice); Oilseeds (Coconut, Groundnut); Vegetables (brinjal); pulses; Plantation crops (Coffee); Fruits (citrus fruits) and pesticide formulations.

Unit IV

Household pests and Pests of stored products: Household pests (Cockroaches, termites, silverfish, flies and mosquitoes) and their control measures. Rodents as pests – local rodents, life history, feeding habits, reproduction and behaviour – Methods of Rodent control. Stored grain pest (Rice Weevil, flour beetle, cigarette beetle).

Unit V

Mode of Pest Control: Pesticide spraying appliances. Residual toxicity of pesticides – Environment degradation and its prevention. Biological control of pest – parasites, predators and pathogens – chemosterilants – Pheromones. Integrated pest management and its relevance to 21st century.

Textbook:

David and Kumaraswami (1984). *Elements of Economic Entomology*. Madras: Popular Book depot.

Reference Books:

1. Nayar, Ananthkrishnan and David (1976). *General and Applied Entomology*. New Delhi: Tata McGraw Hill Publishers.
2. Metcalf and Flint (1973). *Destructive and useful Insects* (4th ed.). New Delhi: Tata McGraw Hill Publishers.
3. Roy, D.N. and Abrown, A.W. (1981). *Entomology: Medical and Veterinary* (3rd ed.). Bangalore: The Bangalore Printing and publishing company.
4. Cremllyn, R. (1979). *Pesticides: Preparation and mode of Action*. New Jersey: John Wiley & Sons Ltd.

Semester V
Major Practical V (Physiology and Developmental Zoology)
Sub. Code: ZC17P5
(Conducted during Semester V)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Objectives:

1. To understand the basic principles of animal physiology and report experimental data.
2. To identify the stages of embryonic development and the structures in the temporary and permanent preparations.

Physiology

1. Rate of oxygen consumption in a fish.
2. Effect of temperature on the opercular movement of a fish and calculation of Q_{10} .
3. Effect of temperature on the ciliary movement of bivalve.
4. Action of salivary amylase in relation to pH.
5. Action of salivary amylase in relation to enzyme concentration.
6. Estimation of haemoglobin - demonstration.
7. Counting of blood cells using haemocytometer (Demonstration).

Slides/ Models/ Charts:

Haemoglobin, ECG, Sphygmomanometer, Haemometer, Kymograph, Cardiac muscle, Striated and Non-striated muscle, Simple muscle curve.

Developmental Zoology

1. Observation of sperm and egg of Frog.
2. Temporary mounting and observation of Chick embryo.
3. Induced ovulation in frog (demonstration only).
4. Effect of thyroxin on Amphibian metamorphosis (demonstration only).
5. Observation of developmental stages in an insect.

Museum specimens/ Slides/ Models/ Charts:

Sperm and egg of Human.
Egg of insect, frog and bird.
Chick embryos of 24, 48, 72 and 96 hours.
Cleavage (2, 4, 8 and 16 cell stage), blastula and gastrula of frog.
Placenta – Diffuse, Discoidal, Zonary and Cotyledonary.

Semester VI
Major Practical VI (Ecology and Toxicology & Evolutionary
Biology)

Sub. Code: ZC17P6
(Conducted during Semester V & VI)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Objectives:

1. To investigate the relationship between the organisms and their environment.
2. To know the phylogenetic relations of the animal phyla and their traits in understanding the evolutionary relationship.

Ecology and Toxicology

1. Detection of transparency of water by Secchi disc.
2. Estimation of oxygen content of water samples.
3. Estimation of salinity of water samples.
4. Mounting of freshwater and marine planktons.
5. Analysis of producers and consumers in grass land.
6. Determination of 48 hours LC₅₀ of a pesticide.
7. Study of natural ecosystem and field report of the visit (compulsory).

Museum specimens/ Slides/ Models/ Charts:

Secchi disc, Mutualism (Hermit crab and Sea anemone), Commensalism (Echeneis and Shark), Parasitism (Sacculina on Crab), Cyclomorphosis (Daphnia).

Evolutionary Biology

1. Serial homology in prawn.
2. Prodigality of nature - Frog.
3. Mutant forms in *Drosophila*.
4. Observation of variation in finger prints.
5. Variations in the markings of Umbonium shells.
6. Demonstration of Natural selection on gene frequency using beads.
7. Demonstration of Genetic drift on gene frequency using beads.
8. Demonstration of DNA sequence alignment by BLAST and construction of cladogram.

Models / Charts / Specimen

Homology- fore limbs of vertebrates, Analogy - wings of animals, Vestigial organs, Nautiloid fossil, *Limulus*, *Peripatus*, *Archaeopteryx*, Darwin finches, Industrial melanism, Ancon sheep, Monarch and Viceroy butterfly, Stick insect, Krait and *Lycodon*.

Semester VI
Major Practical VII (Biotechnology, Immunology and Microbiology)
Sub. Code: ZC17P7
(Conducted during Semester VI)

No. of hours/week	No. of credits	Total number of hours	Marks
4	2	60	100

Objectives:

1. To familiarize the students with various immunological and microbiological techniques.
2. To implement experimental protocols and adapt them to carry out using biotechnological techniques.

Biotechnology

1. Isolation of genomic DNA.
2. Estimation of DNA by Diphenylamine (DPA) Method.
3. Estimation of BOD in Sewage.
4. Estimation of COD in sewage.
5. Immobilization of enzyme (Amylase/ Invertase/ Protease) using sodium alginate - Demonstration.
6. Polymerase Chain Reaction – Demonstration.
7. Production of Hybridoma and Monoclonal antibodies – Flow chart.

Models/ Charts/ Photos:

pBR 322, λ phage, SV40, Recombinant DNA, Electroporation unit, Southern blotting, RFLP, organ culture (Plasma clot method), Knockout mice, Dolly, Sanger's method of DNA sequencing, Biosensor, Callus, Explant, Micropropagation, Fermenter, rDNA, Human genome sequence, Penicillin, Biogas production.

Immunology & Microbiology

1. Dissection of Lymphoid organs of Rat - (Virtual demonstration).
2. Cleaning and sterilization of glass wares and Preparation of culture media for microbes.
3. Serial dilution technique.
4. Examination of bacterial motility by Hanging drop technique.
5. Staining of bacteria – simple staining and gram staining.
6. Radial immuno diffusion.

Charts/ Models/ Instruments related to theory:

Escherichia coli, TMV, T₄ phage, Bacterial growth curve, Chemostat, Autoclave, Hot air oven, Inoculation loop, Haemocytometer, Stage and Ocular micrometer.