



Goa University
P.O. Goa University, Taleigao Plateau, Goa 403 206
Syllabus of B.Sc. (Zoology) Programme

Implemented from:

FYBSc: 2010-11 (Approved in BOS March 2010, AC in April 2010)

SYBSc: 2011-12 (Approved in BOS February 2011, AC in March 2011)

TYBSc: 2009-10

A brief description of the course:

Purpose :

1. To understand the diversity of fauna (non chordate and chordate), structure and function of the different form of life and their relationship, the relationship between life and environment.
2. To understand the structure and function of cell, basics of molecular biology, basic of animal biotechnology.
3. To understand the scope of entrepreneurship through Applied Zoology.

Prerequisites : Elementary knowledge of Biology at Higher secondary level (10+2 level) with background knowledge of Chemistry.

Number of Semester: Six.

In the first four semesters: in each semester, a student has to study 2 papers of 100 marks (75 marks for theory and 25 marks for practical)

In the fifth and sixth semester: In each semester a student has to study 4 theory papers and 2 practical papers, each of 100 marks.

Project work (in group) of 100 marks

Field work: A compulsory component of practical knowledge for all semesters.

Institutions: Dhempe College, PES College, Carmel College, Quepem Govt. College, Chowgule College & Sanquelim Govt. College

F.Y.B.Sc.

I SEMESTER			
PAPER CODE	PAPER TITLE	CONTA CT HOURS	MARKS
ZP: 01	Diversity of Lower Non Chordates:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
ZP: 02	Cell Biology:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
II SEMESTER			
ZP: 03	Diversity of Higher Non-Chordate:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
ZP: 04	Genetics & Molecular Biology:	45 i.e. 3/week	75
	Practicals	45 i.e. 3/week	25

S.Y. B.Sc.

III SEMESTER			
ZP: 05	Diversity of Lower Chordates:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
ZP: 06	Animal Physiology:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
IV SEMESTER			
ZP: 07	Diversity of Higher Chordates:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25
ZP: 08	Ecology & Animal Behaviour:	45 i.e. 3/week	75
	Practicals:	45 i.e. 3/week	25

T.Y. B.Sc (Special)

V SEMESTER			
ZP:09	Comparative Anatomy of Vertebrates	60 i. e. 4/week	100
ZP:10	Human Physiology & Biochemistry	60 i. e. 4/week	100
ZP: 11	Applied Genetics & Evolution	60 i. e. 4/week	100
ZP: 12	Basic Animal Biotechnology	60 i. e. 4/week	100
ZLC: 01	Practicals: a. Comparative Anatomy of Vertebrates b. Human Physiology & Biochemistry	120 i.e. 8/week	100
ZLC: 02	Practicals: a. Applied Genetics & Evolution b. Basic Animal Biotechnology	120 i.e. 8/week	100
VI SEMESTER			
ZP: 13	Developmental Biology	60 i. e. 4/week	100
ZP: 14	Endocrinology	60 i. e. 4/week	100
ZP: 15	Environmental Biology & Toxicology	60 i. e. 4/week	100
ZP: 16	Animal Biotechnology Applications	60 i. e. 4/week	100
ZLC: 03	Practicals: a. Developmental Biology b. Endocrinology	120i. e. 8/week	100
ZLC: 04	Practicals: a. Environmental Biology & Toxicology b. Animal Biotechnology Applications	120i. e. 8/week	100
(GENERAL)			
V Term			
ZP: 17	Comparative Anatomy of Vertebrates & Histology	60 i. e. 4/week	100
ZP: 18	Environmental Physiology	60 i. e. 4/week	100
ZLC: 05	Practicals: a. Comparative Anatomy of Vertebrates & Histology b. Environmental Physiology	120 i. e. 8/week	100
VI Term			
ZP: 19	Applied Genetics	60 i. e. 4/week	100
ZP: 20	Economic Zoology	60 i. e. 4/week	100
ZLC: 06	Practicals: a. Applied Genetics b. Economic Zoology	120 i. e. 8/week	100

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 01	F.Y.B. Sc.	I	Diversity of Lower Non-Chordates	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

Objectives & Scope:

1. Review of the general characters and classification of the phyla listed below (up to classes). Classification of animals to be followed as in “**Invertebrate Zoology**” by **E L Jordan & PS Verma**.
2. The gross anatomy and life history of the types mentioned.
3. Local examples with common and scientific names are to be given more emphasis for all the groups.
4. Those not found in India too has to be cited as example because of taxonomic / phylogenetic or of other special significance.
5. At least one example from each class of invertebrates has to be included. Only those examples need to be mentioned which explain the general characters of the phylum / class.

I. General principles of animal taxonomy.

7 ch

Binomial nomenclature; hierarchy

Salient features of non-chordates and classification up to classes

Definition of species.

Phylogeny of non- Chordata

II. Phylum Protozoa

8 ch

General Topic ----- Comparative account of locomotion with respect to-Sarcodina, Mastigophora, Ciliophora; Nutrition and Skeleton in Protozoa.

III. Phylum Porifera

8 ch

Type----- *Sycon*

General Topic ----- Cell types, Skeleton, Canal system and Reproduction

IV. Phylum Cnidaria

8 ch

Type ----- *Obelia*

General Topic ----- Gastrovascular cavity, Polymorphism

Coral reefs (Definition, types and economic importance).

V. Phylum Platyhelminthes

6 ch

Type ----- *Planaria*.

General Topic----- Parasitism & Parasitic adaptation in Platyhelminthes

VI. Phylum Aschelminthes

3 ch

General Topic----- Bionomic importance of Nematodes.

VII. Phylum Annelida

5 ch

Type ----- *Nereis*

General Topic-----Metamerism in Annelids.

Text / Reference Books recommended:

1. Barnes, R. D. (2000). Invertebrate Zoology. Hall Saunders International Editions
 2. Kotpal, R. L (2000). Invertebrates. Rastogi Publication, Meerut.
 3. Ganguli, B.B.; Sinha, A.K., and Adhikari, S. (2000). Biology of Animals Vol-1. New Central Book Agency, Calcutta.
 4. Ayer Ekabaranath, M. (2000). A Manual of Zoology. Vol. I Part I & II. S. Viswanath, Madras.
 5. Dhama, P. S. and Dhama, J. K. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
 6. Jorden, E. L. & Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
 7. Parker, A.J. & Haswell, W.A.A. (2002). Textbook of Zoology. Vol. I. Macmillan.
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PRACTICALS

1. Study of animals with special reference to systematic position up to order level Habit, Habitat, Characteristic Features and Economic Importance of-----
Protozoa, Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida with at least One example from each class.
2. Observation of the following permanent slides:
T.S. of Sponges, *Obelia*, *Ascaris* (male & female), *Nereis*, *Planaria* & Liverfluke, Tapeworm scolex, Larval forms of Liverfluke.
3. Mountings:
Spicules in sponges, Parapodia of *Nereis*, Nematocyst of sea anemone, Setae and Nephridium from earthworm
4. Dissection:
Earthworm – Digestive system and Nervous system.
5. Identification of protozoans in pond water sample.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 02	F.Y.B. Sc.	I	Cell Biology	Th: 45 i.e. 3 /week Pr: 45 i.e. 3 /week	75 25

Objectives & Scope:

1. To make the students understand the structure and functions of cell organelles
2. To understand the importance of nucleus in the cell
3. To understand the role of various physical and chemical components of the cell
4. To have basic knowledge of cancer biology
5. To learn basic techniques in cytology

I. Overview of the General structure and organization of cells. 5 ch
Viruses, Prokaryotic and Eukaryotic Cells.

II. Cell Environment. 5 ch
Water, Salts and Ions; Biological molecules; Freezing and Thawing of cells;
Radiations in Cell environment (UV radiations, photodynamic sensitization).

(Treat as in Cell Physiology By Arthur C. Giese, 1983)

III. Cell Organelles 16 ch

A) Plasma Membrane:

Isolation and Characterization with reference to Composition, Fluid- Mosaic Model; Passive transport, Active transport and Bulk Transport.

B) Mitochondria:

Isolation, Chemical Composition, Ultra structure and functions with reference to energy transactions – Kreb's Cycle, Electron Transport system; Mitochondria as a semiautonomous organelle.

C) Isolation, Chemical composition, structure and functions of :

1. Endoplasmic reticulum
2. Ribosomes
3. Golgi complex
4. Lysosomes and polymorphism
5. Microbodies
6. Cytoskeleton – Microtubules, Microfilaments and Centrioles.

(Treat as in Cell Biology by C. B. Powar 2004)

IV. Cell Nucleus 6 ch

Isolation, Nucleus envelope, Nucleoplasm; General structure of metaphasic eukaryotic Chromosome; Euchromatin, Heterochromatin, Nucleolus, Structure of Nucleosome; Polytene and Lamp Brush Chromosome.

V. Cancer Biology

6 ch

General idea of cancer cells, Carcinomas, Sarcomas, Lymphomas, Leukemia; Characteristics of Cancer cells; Carcinogenesis - Mutation and Viral theories of Carcinogenesis; Environmental causes of cancer; Prevention and treatment

VI. Techniques in Cell Biology

7 ch

Principles and application of :

- Electron microscopy
- Centrifugation (ultra and refrigerated) techniques,
- TLC and Gel electrophoresis

Text / Reference Books recommended:

1. Giese, A. (1983). Cell Physiology Saunders International edition
 2. Powar, C.B. (2004). Cell biology, Himalaya Publication
 3. DeRobertis & Deli Robertis (2000). Cell and Molecular Biology. 6th Edition
 4. Bhamrah, H.S.; Kavita Juneja. Molecular Cell Biology. Anmol Publications Pvt. Ltd, New Delhi
 5. Kumar, H.D. (1996). Molecular Biology and Biotechnology, Vikas Publication, New Delhi.
 6. Verma and Agarwal (2004). Cell Biology, Genetics, Molecular Biology, Evolution & Ecology. S. Chand & Co. Ltd. New Delhi.
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PRACTICALS

1. Study of Prokaryotic cells using suitable staining techniques. Bacteria (Gram +ve and gram –ve) from curd and tarter
2. Study of Eukaryotic Cell using suitable staining technique (Buccal epithelial Cells)
3. Methods of Protozoan culture (any two types)
4. Study of cytoplasmic movements (Cyclosis) in *Paramecium*.
5. Cytoplasmic localization of Protein , Fat and Carbohydrates
6. Study of osmosis using human R.B.Cs.
7. Buccal smear preparation for localization of Mitochondria by using Janus Green stain
8. Study of Polytene chromosomes in *Drosophila* or *Chironomus* larva.
9. Study of Cancer cells through permanent slides.
10. Study of Cell organelle (any 3) through electron micrographs.
11. Separation of serum proteins by Electrophoresis (only for demonstration).
- 12 Separation of fats by TLC

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 03	F.Y.B. Sc.	II	Diversity of Higher Non-Chordates	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

Objectives & Scopes:

1. Review of the general characters and classification of the phyla listed below (up to classes). Classification of animals to be followed as in “**Invertebrate Zoology**” by **E L Jordan & PS Verma**.
2. The gross anatomy and life history of the types mentioned.
3. Local examples with common and scientific names are to be given more emphasis for all the groups.
4. Those not found in India too has to be cited as example because of taxonomic / phylogenetic or of other special significance.
5. At least one example from each class of invertebrates has to be included. Only those examples need to be mentioned which explain the general characters of the phylum / class.

I. Phylum Onychophora 5 ch

General topic-----Affinities and systematic position.

II. Phylum Arthropoda 8 ch

Type – Prawn (*Penaeus* sp)
General Topics – Crustaceans Larvae,

III. Phylum Arthropoda (General topics) 8 ch

Respiration and excretion in Arthropoda; Metamorphosis in Insects,
Mouth parts of insects.

IV. Phylum Mollusca. 13ch

Type----- *Pila*
General Topics – Foot and shell in Mollusca; Torsion in Gastropoda,.

V. Phylum Echinodermata 6 ch

Type ----- Starfish
General Topics ----- Larvae of echinoderms and symmetry in Echinodermata.

V I. Phylum Hemichordata 5 ch

General type-----Affinities and systematic position.

Text / Reference Books recommended:

1. Barnes, R. D. (2000). Invertebrate Zoology. Hall Saunders International Editions

2. Kotpal, R. L. (2000). Invertebrates. Rastogi Publication, Meerut.
 3. Ganguli, B. B., Sinha, A. K. and Adhikari, S. (2000). Biology of Animals Vol-1. New Central Book Agency, Calcutta.
 4. Ayer Ekabaranath, M. (2000). A Manual of Zoology. Vol. I Part I & II. S. Viswanath, Madras.
 5. Dhami, P.S. and Dhami, J. K. (2000). Invertebrate Zoology, S. Chand & Co. Pvt. Ltd. New Delhi.
 6. Jordan, E. L. and Verma, P.S. (2000). Invertebrate Zoology. S. Chand & Co. Pvt. Ltd. New Delhi.
 7. Parker, A.J. and Haswell, W.A.A. (2002). Textbook of Zoology. Vol. I. Macmillan.
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PRACTICALS:

1. Studies of animals with special reference to systematic position up to order level-
Habit, Habitat, Characteristic features, and Economic importance of – Onychophora, Arthropoda, Mollusca, Echinodermata, Hemichordata, with at least one example from each class.
2. Observation of the following permanent slides. Larval forms of Crustacea (any 5 only), larval forms of Echinoderms (any 3 only).
3. Mountings:
 - a) Honeybee- Mouth parts, legs and sting apparatus
 - b) Housefly- Mouth parts
 - c) Cockroach – Mouth parts,
 - d) Appendages of Prawn
4. Dissection
 - a. Prawn – Nervous system.
 - b. Pila – Digestive system
5. Listing and identifying local butterflies and preparation of checklist of butterflies of college campus.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 04	F.Y.B. Sc.	II	Genetics and Molecular Biology	Th: 45 i.e. 3/week Pr:45 i.e. 3/week	75 25

Objectives & Scope:

1. To make the students understand the structure and functions of gene
2. To understand the importance of Genetics
3. To have basic knowledge breeding and mutation
4. To understand the basics of Molecular biology
5. To learn basics in genetic engineering and animal biotechnology

I. Overview of Mendelian genetics and Modifications. 10 ch

Monohybrid cross, Dihybrid cross, Test cross and Interaction of gene (9:3:4, 9:7, 13:3, 15:1), Epistasis and Hypostasis.
Multiple alleles – Eg. Coat colour in Rabbit.
Multiple genes - Eg. Skin colour in Man.

II. Sex Determination and Sex related Inheritance. 9 ch

Sex Determination in Drosophila, Insects, Honeybee, Bonelia, Turtle, Birds, Man;
Sex related Inheritance – Sex Linked, Sex Limited and Sex influenced Inheritance.

III. Human Genetics. 7 ch

Pedigree analysis, Inheritance of Human traits – Brown Eyes, Polydactyl; Diabetes insipidus, Phenylketonuria, Sickle cell Anemia, Eugenics and Genetic Counseling.

IV. Gene Mutations 7 ch

Types of Gene Mutations (Base pair substitution and frame shift mutation), Natural and Induced Mutations; Molecular basis of Mutation – spontaneous mutation and induced mutation (chemical mutagens and radiation)

V. Inbreeding and Heterosis 4 ch

Definition of Inbreeding, Inbreeding depression, Practical application of Inbreeding.
Heterosis – Genetic basis; Application and Evolutionary significance.

VI. Elementary Idea of Genetic engineering and Animal Biotechnology 8 ch

Introduction to restriction enzymes; Ligases; Cloning vectors (Plasmids, Cosmids, Phagemids)
Application of Animal Biotechnology with reference to Aquaculture, Livestock (cattle), and Human health (Hormone and vaccines).

Text / Reference Books recommended:

1. Powar, C.B. (2003) “Genetics” Vol.I & Vol II.
2. Verma P.S. and V. K. Agarwal (2008) Cell biology, Genetics, molecular Biology, Evolutionary Ecology, S. Chand & Co. New Delhi
3. Singh, B. D. (2002) Biotechnology,

4. Bhamrah, H. S. and Kavita Juneja. "Molecular cell Biology", Anmol publications Pvt. Ltd.
 5. Gupta, P.K. (1996) "Genetics" Rastogi Publications.
 6. Ranga, M.M. "Animal Biotechnology (Agrobios), Published by Agrobios (India).
 7. Rastogi, Sharma, V.N. and Anuradha Tandon (1993). "Concepts in Molecular Biology". Wiley Eastern Ltd. N. Delhi.
 8. Smustad, Simmons, Jenkins (1999). "Principles of Genetics" John Wiley and sons. Inc.
 9. Daniel Fairbanks, W. Ralph Anderson. "Genetics, the Continuity of Life" (1999). Brooks/Cole Publishing Company, New York.
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PRACTICALS

1. Problems in Genetics through beads / seeds mixtures. Monohybrid and Dihybrid ratios.
2. Problems in Genetics on multiple alleles and Quantitative inheritance (multiple genes).
3. Preparation of Diploid complement of Rat or Mice by air drying technique.
4. Study of ABO blood group and Rh factor in Humans.
5. Drosophila culture techniques.
6. Study of phenotypic characters in Drosophila (Body colour, Wing pattern and Eye colour).
7. Determination of sex by Barr body method.
8. Karyotyping Analysis in Humans from Printed material.
 - a. Normal male or female
 - a. Klinefelter's Syndrome
 - b. Turner's Syndrome
 - c. Down's Syndrome
 - d. Philadelphia
8. Determination of allelic frequency of the following Mendelian Human traits-

Tongue Rolling, Ear lobes, Widow's peak, Clasping of hand, Thumb crossing pattern, Folding of arms, Hitch-hiker's thumb..

General note on field work:

In addition to the practical component, the student should undertake at least two Field Trips of not less than eight hours duration each (The fieldwork is to be treated as two contact hours per batch per week).

S.Y.B.Sc.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 05	S.Y.B. Sc.	III	Diversity of Lower Chordates	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

I: Biodiversity

4 ch

Definition, levels of biodiversity – genetic, species and ecosystem level diversity.

Conservation strategies; Biodiversity hotspots of India with examples and salient features.

II : Chordata

4ch

General characters, outline classification up to class, origin of chordates.

III : Protochordates

10 ch

Urochordata: General characters, Classification up to order, Phylogenetic relationships

Cephalochordata: External features of Branchiostoma; Affinities and Systematic position.

IV: Vertebrata

07 ch

General characters

Agnatha: Ostracodermi : Important features

Cyclostomata : General characters, Affinities and phylogenetic status

Gnathostomata : Important features.

V : Superclass pisces

10 ch

Classification up to order level.

Chondrichthyes : General characters and distribution with examples.

Osteichthyes : General characters and distribution with examples.

Dipnoi – General characters, affinities and systematic position.

VI. Pisces (General features)

10 ch

Air bladder in fishes, Accessory respiratory organs, Scales in fish, Migration in fishes, Parental care in fishes, Origin and types of fins, Adaptive radiation in teleostei, Economic importance

of fishes.

Text / Reference Books recommended:

1. Ayer, Ekambaranath H and Anantha Krishnan, T. N. Manual of Zoology Vol. II (Chordata) S. Viswanathan (Printers and publishers) Pvt. Ltd., Madras.
 2. Sinha, A.K., Adhikari, S., Ganguly, B.B., Biology of Animals. Vol. II New Central Book Agency, Calcutta.
 3. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
 4. Dhami & Dhami – Chordate Zoology.
 5. Kotpal, R.L., Modern Text book of Zoology Vertebrates Rastogi Publications, Shivaji Road, Meerut.
 6. Dr. Nigam, H.C., Biology of Chordates, Vishal Publications, Adda Hoshiarpur, Jolandhar city.
 7. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd.
 8. Parker, A.J. & Haswell, W.A., A Textbook of Zoology, Vol. II (New Ed.) Low price – publications, Delhi – 110052.
 9. Agarwal & Dalela – A textbook of vertebrate Zoology.
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PRACTICALS:

A. Museum specimens and slides :

Commonly available museum specimens with reference to protochordates, cyclostomata and pisces.

B. Observations : Accessory respiratory organs of two types.

C. Mountings :

The study of types of scales and weberian ossicles. Study of Ampulla of Lorenzini and internal ear of a bony fish.

D. Dissections

Brain of bony fish, Digestive system in bonyfish, heart and aortic arches in bonyfish.

E. Study of local edible fishes :

Study of type of fins in fishes.

Study of economically important fishes.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP : 06	S.Y.B. Sc.	III	Animal Physiology	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

- I Digestion** 7ch
Outline of digestive system and associated glands in mammals, including peristalsis.
Salivary digestion, Gastro –Intestinal digestion; Role gastro-intestinal hormone,
Role of Pancreas, Liver; Symbiotic digestion (pre and post gastric);
Absorption, assimilation, defecation; Concept of balanced diet in humans.
- II Respiration** 8 ch
Ventilation, Mechanism of breathing; Cellular respiration: Glycolysis, citric acid cycle,
Electron transport chain (Glycolysis to be dealt in details); Gaseous exchange: oxygen
Absorption, transport and delivery to the tissues; Carbon dioxide transport- chloride shift
and Bohr effect.
Respiratory pigments: haemoglobin, hemocyanin, chlorocruonin. Regulation of
Respiration: nervous and chemical.
- III Circulation** 7 ch
Types of hearts (Neurogenic and myogenic)
Conduction and regulation of heart beat in myogenic heart.
Cardiac cycle and ECG (human).
Haemodynamics- Regulation of blood pressure, blood viscosity, friction,
capillary pressure.
Tachycardia, bradycardia.
- IV Contraction and Movement** 9 ch
Types of muscles: structural and functional;
Structure and properties of smooth and cardiac muscles.
Skeletal Muscle: Ultrastructure, chemical composition and functional properties (muscle
twitch, summation, tetany, fatigue). Sliding filament theory of muscle contraction and its
physiological basis; Role of neurotransmitters (acetylcholine and adrenaline) in muscle

contraction.

V Excretion and Osmoregulation

7 ch

Types of Nitrogenous waste: ammonia, urea and uric acid; Urea Cycle.

Mammalian kidney: Functions of Kidney; Structure of mammalian nephron and process of urine formation.

Role of kidney in osmoregulation and acid base balance; Hormonal control of kidney.

VI Reproduction

7 ch

Structural and functional aspects of testis, Onset of puberty (development of secondary sexual character). Menstrual cycle in relation to ovarian cycle and menopause. Estrous cycle; Methods of fertility control : physical chemical and surgical.

Text / Reference Books recommended :

- 1 Mohan P. Arora 'Animal physiology' Himalaya publishing house.
- 2 Eckert R. "Animal physiology" CBS publishers.
- 3 R. Nagabhushanam, M. S. Kadarkar, R. Sarojini 'Text book of animal physiology', second edition, oxford and IBH publishing Co. Pvt. Ltd. New Delhi, Kolkata.
- 4 Vander, Sherman Luciano "Human physiology" MacGraw Hill publication.
- 5 Hoar "General and Comparative physiology" prentice hall.
- 6 Sujit Choudhuri "concise medical physiology" new central book agency.
- 7 Verma, Tyagi and Agarwal 'Animal physiology' S. Chand and Company.

PRACTICALS:

1. Preparation of haemin crystals and haemoglobin estimation of man (Sahlis method).
2. Detect the presence of Albumin, sugar, uric acid, ketone/ acetone bodies, chlorides, phosphates, calcium, bilirubin from urine sample.
3. Survey of digestive enzymes in the gut of cockroach.
4. Study of oxygen consumption in cockroach with reference to body weight.
5. Transport of glucose (qualitative) across the intestine of rat/ chick.

6. Determination of pulse rate at rest/ after exercise and measurement of blood pressure using sphygmomanometer and stethoscope in man.
7. A visit to the hospitals / primary health center to know about human fertility control methods and devices. Submission of report.
8. Composition and preparation of physiological solutions, buffers, vital stains, fixatives, stains.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 07	S.Y.B. Sc.	IV	Diversity of Higher Chordates	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

I. Depletion of biodiversity due to anthropogenic activities Benefits from Biodiversity, Introduction to Biodiversity Act, 2002, major threat to chordate biodiversity. 3 ch

II. Amphibia 8 ch
General characters and classification of amphibian diversity up to orders. Distinguishing features of anurans, apoda and urodela with suitable examples.

Origin of Amphibia, Parental care in Amphibia, Neotony and Paedogenesis.

III. Reptilia 10 ch

General characters and classification of reptiles up to orders (living orders only) with suitable examples.

Reptilian diversity with reference to diverse habitats.

Indian snakes (venomous and non venomous), Temporal fossae and arcades in reptiles, Poison apparatus and its working mechanisms, Extinct reptiles, Sense organs in reptiles.

IV. Aves 10 ch

General characters and classification up to order level giving suitable examples.

Birds as glorified reptiles, Flight adaptations in birds, Flightless birds or Ratitae, Diversity and adaptations of woodland, grassland, wetland and shore birds, Migration of birds.

V. Mammalia 6 ch

General characters and classification up to orders Distinctive features of prototheria, metatheria and eutheria with important examples, Affinities of prototheria,.

VI. Mammalia (General features) 8 ch

Flying mammals, Dentition in mammals, Aquatic mammals.

Detailed study general viscera and digestive systems of rat.

Text / Reference Books recommended:

1. Ayer, Ekambaranath H and Anantha Krishnan, T. N. Manual of Zoology Vol. II (Chordata) S. Viswanathan (Printers and publishers) Pvt. Ltd., Madras.
2. Sinha, A.K., Adhikari, S., Ganguly, B.B., Biology of Animals. Vol. II New Central Book Agency, Calcutta.
3. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
4. Dhama & Dhama – Chordate Zoology.
5. Kotpal, R.L., Modern Text book of Zoology Vertebrates Rastogi Publications, Shivaji Road, Meerut.
6. Nigam, H.C., Biology of Chordates, Vishal Publications, Adda Hoshiarpur, Jalandhar city.
7. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd.
8. Parker, A.J. & Haswell, W.A., A Textbook of Zoology, Vol. II (New Ed.) Low price – publications, Delhi – 110052.
9. Agarwal & Dalela – A textbook of vertebrate Zoology.
10. Salim Ali & Dillon Ripley, S., - A pictorial guide to the Birds of the Indian Subcontinent, Bombay Natural History Society, Oxford University Press, 1995.

PRACTICALS:

A. Museum specimens and slides :

Commonly available specimens to be shown with at least one example for each living orders in class amphibia, reptilia, aves and mammalia, the study may be made complete through field study as well.

B. Observation :

- 1) Of four different types of beaks and feet in the birds surrounding your area / campus,
- 2) Identification of venomous and non venomous snakes.

C. Mountings

1. Mounting of pecten in any suitable specimen,
2. Types of feathers in birds.

D. Dissections

Brain of rat, general viscera in rat,

E. Field Oriented study

Bird watching and preparation of checklist of birds of college campus.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 08	S.Y.B. Sc.	IV	Ecology & Animal Behaviour	Th: 45 i.e. 3/week Pr: 45 i.e. 3/week	75 25

I: Environmental factors and animal interactions

8 ch

- a. Introduction, Shelford's law of tolerance; liebig's law of minimum;
- b. Physical factors: soil-classification of soil, soil profile and soil biota; Temperature-
Effect of temperature on animals, Thermal stratification in lakes and sea; Light-
Effect of light on animals, light stratification in lakes and sea; Water-water as a
medium for life,
- c. Chemical factors: Atmospheric gases, dissolved gases, pH, nutrients, and food.
- d. Inter specific interactions-mutualism, commensalisms, amensalism (antibiosis),
parasitism, and predation.

II: Community

7 ch

Introduction, characters of a community, classification of a community, community periodism, community stratification, community succession, development of animal community in hydrosere and xerosere; climax community, ecotone and edge effect.

III: Ecological adaptations of animals

8 ch

Kinds of adaptations (inherited and acquired adaptations)

1. Structural adaptations (Aquatic, pelagic, deep sea, desert, volant, cursorial, fossorial and subterranean adaptations, parasitic adaptations)
2. Physiological adaptations
3. Protective adaptations
4. Mimicry (Protective and aggressive mimicry)

IV: Types of animal behaviour

8 ch

1. Innate behaviour-Taxes, reflexes, instincts, motivation.
2. Learned behaviour- Habituation, Imprinting, conditioned reflexes, insight learning.
3. Social behaviour - Types of animal society, colony in honey bees, communication in honey bees, monkey troops.
4. Biological clock - Circadian rhythm.

V Behavioural Ecology

8 ch

- i. Approaches to the study of behaviour: psychological, physiological, and ethological, fixed action patterns (more complex behavioural patterns) and signalling devices, innate releasing mechanisms.
- ii. Application of ethological techniques (ethogram) to human behaviour.

VI. Reproductive behaviour

6 ch

Methods in the study of hormones and behaviour (Correlation method, castration, and replacement), territoriality and aggression.

Text / Reference Books recommended :

1. Verma P.S and Agarwal B.K. (2002). Environmental Biology (Principles of Ecology). S.S. Chand and Co Publishers.
2. Sharma P.D. Ecology and Environmental Biology,
3. Arora M.P. Animal behaviour, Himalaya Publishing House, New Delhi
4. Arora M.P. (2004). Ecology, Himalaya Publishing House, New Delhi.
Price and Stoker. Animal behaviour in Laboratory and field. Freeman Publishers.
5. Drickamen and Vessey. Animal behaviour-Concepts, processes and methods, Wadsworth

publishers.

6. P.J.B. Slater (1999). Essentials of Animal behaviour, Cambridge University Press.
7. Pandey J. & M.S. Sharma (1999). Environmental Science, Practical and field manual. Yash Publications.
8. Trivedy R.K., Goel P.K, Trisal C.L (1987). Practical methods in Ecology and environmental Science, Environmental Publications, Karad.

PRACTICALS:

1. a. Determination of particle size of sediment sample.
b. Determination of water holding capacity of different types of soil.
2. a. Estimation of Dissolved oxygen of given water samples (Wrinkler's Iodometric method).
b. Estimation of Dissolved carbon dioxide of given water samples.
3. Estimation of organic matter of soil (Walkley & Black method).
4. Identification of Zooplankton in given water sample.
5. Study of ecological adaptations:-
 - Aquatic (Ranatra, *Physalia*, Duck, fish).
 - Volant (Dragon fly, Parakeet, Bat).
 - Desert (*Phrynosoma*, Camel, Hedgehog).
6. Study of ecological adaptations (Cont..)
 - Cursorial (Ostrich, Tiger, Horse).
 - Fossorial (Mabuya, Rabbit, Cobra).
 - Parasitic (Leech, Tapeworm, *Pediculus*)
7. a. Study of chemotaxis in *Paramoecium*.
b. Study of phototaxis in Earthworm.

8. Study of type of insect nests (Bees, Wasps, ants, termites)
9. Study of type of bird nests.
10. Study of Eye withdrawal reflex in Crab to study habituation.
11. Film show on animal behaviour and adaptations.

General note on field work:

In addition to the regular lectures and practicals, students should undertake 2 local field trips (each of not less than eight hours duration) and a long trip of not less than 72 hrs. duration.

The field work is to be treated as 2 lecture hours per batch per week.

T.Y. B.Sc.
ZOOLOGY

T.Y. B.Sc. (SPECIAL)			
V Term			
ZP:09	Comparative Anatomy of Vertebrates	60 i. e. 4/week	100
ZP:10	Human Physiology & Biochemistry	60 i. e. 4/week	100
ZP: 11	Applied Genetics & Evolution	60 i. e. 4/week	100
ZP: 12	Basic Animal Biotechnology	60 i. e. 4/week	100
ZLC: 01	Practicals: a. Comparative Anatomy of Vertebrates b. Human Physiology & Biochemistry	120 i.e. 8/week	100
ZLC: 02	Practicals: a. Applied Genetics & Evolution b. Basic Animal Biotechnology	120 i.e. 8/week	100
VI Term			
ZP: 13	Developmental Biology	60 i. e. 4/week	100
ZP: 14	Endocrinology	60 i. e. 4/week	100
ZP: 15	Environmental Biology & Toxicology	60 i. e. 4/week	100
ZP: 16	Animal Biotechnology Applications	60 i. e. 4/week	100
ZLC: 03	Practicals: a. Developmental Biology b. Endocrinology	120 i. e. 8/week	100
ZLC: 04	Practicals: a. Environmental Biology & Toxicology b. Animal Biotechnology Applications	120 i. e. 8/week	100
(GENERAL)			
V Term			
ZP: 17	Comparative Anatomy of Vertebrates & Histology	60 i. e. 4/week	100
ZP: 18	Environmental Physiology	60 i. e. 4/week	100
ZLC: 05	Practicals: a. Comparative Anatomy of Vertebrates & Histology b. Environmental Physiology	120 i. e. 8/week	50
VI Term			
ZP: 19	Applied Genetics	60 i. e. 4/week	100
ZP: 20	Economic Zoology	60 i. e. 4/week	100
ZLC: 06	Practicals: a. Applied Genetics b. Economic Zoology	120 i. e. 8/week	50

T.Y.B.Sc.
(SPECIAL)

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 09	T.Y.B. Sc.	V	Comparative anatomy of Vertebrates	60 i.e. 4/week	100

Unit I : Skeletal System

10 ch

1:1 : Concept of Chondrocranium, Dermatocranium and Splanchnocranium

1:2 : The tetrapod hyoid – Hyoid apparatus (Amphibians, reptiles, birds & mammals)

1:3 : Jaw suspension

Unit 2 : Integumentary system

10 ch

2.1 Integument Proper :Comparative anatomy of the integument

2.2 Epidermal derivatives and their modifications: Glands – classification based on structure and modes of secretion. Comparative anatomy of integumentary glands. Scales, feather, hair, beaks & bills, claws, nails and floofs, horns and antlers.

2.2 : Dermal Derivatives – Scales and scutes.

2.3 : Integumentary pigments – Poikilotherms and Homeotherms.

2.4 : Functions of skin

Unit 3 : Respiratory system

08 ch

3.1 Gills – types, gross idea of gills in fishes and amphibians.

3.2 Origin of lungs and swim bladder (functions not to be included)

3.3 Lungs and air ducts – Larynx, trachea and Bronchi (Gross idea in different vertebrates. Mechanism of respiration not to be included).

Unit 4 : Circulatory System

11 ch

10.1 Heart, comparative anatomy (Cartilaginous fish, bony fish, lung fish – protopterus, frog, reptiles (calotes and crocodiles), pigeon and rabbit.

10.2 Evolution of aortic arches – shark, bonyfish, protopterus, frog, calotes, pigeon, rabbit.

10.3 Portal circulation – Hepatic & Renal portal circulation. (mention only).

Unit 5 : Excretory System

10 ch

5.1 Types of Kidneys – Archinephros, The Anamniote kidney – pronephros, opisthonephros – comparative anatomy of opisthonephros (cyclostomes, fishes and amphibians).

The Amniote kidney-mesonephros, metanephros, Comparative Anatomy of metanephros (Reptiles, birds and mammals.)

5.2 Urinary Bladder

5.3 Structure of glomerulus, uriniferous tubules and maintenance of water balance kidney – structure and function.

Unit 6 : Nervous system

11 ch

6.1 Primary Divisions

6.2 Central Nervous System

The brain – primary divisions, flexures, gray and white matter of brain.

Myelencephalon, metencephalon, mesencephalon, Diencephalon, Telencephalon – a comparative study in different vertebrates.

6.3 Peripheral Nervous System

Cranial nerves and Spinal nerves in general.

6.4 Autonomic nervous system in general.

Text / Reference Books recommended :

1. Romer, A. S. & Parsons, T. S. The Vertebrate Body, (New Edn.) Holt Saunder International Eds.
2. Weichert, C. K. Anatomy of the chordates. Mc Graw Hill & Co.
3. Kent, G. C. Comparative Anatomy of Vertebrates, C.V. Mosley & Co.
4. Webster, D. & Webster, M. Comparative Vertebrate Morphology published by Academic press.
5. Jordan, E. L., & Verma, P.S., Chordate Zoology (New Edn.) S. Chand & Co.
6. Dhami & Dhami – Chordate Zoology.
7. Sinha, A. K., Adhikari, S., Ganguly, B.B., Biology of Animals Vol. II New Central Book Agency, 8/1 Chintamani Das Lane, Calcutta.
8. Dr. Nigam, H.C., Biology of chordates, Vishal publications, adda hoshiarpur, Jalandhar city.
9. Prasad, S. N., Chordates, Vikas Publishing House, Pvt. Ltd.
10. Parker, A. J. & Haswell, W.A., A textbook of Zoology, Vol. II (New Edn.) Low price publications, 425, Nimri, Ashok Vihar, Phase IV, Delhi – 110052.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP : 10	T.Y.B. Sc.	V	Human Physiology & Biochemistry	60 i.e. 4/week	100

Unit I Haematology : **10 ch**

Introduction, properties, Composition of blood-Inorganic and Organic.

PLASMA PROTEINS: Inorganic and organic constituents, functions

ERYTHROCYTES: Morphology, variation in numbers, functions, erythropoiesis including factors, haemoglobin , anaemia, ESR, packed cell volume.

LEUCOCYTES: morphology, types, normal count, functions, leucopoiesis, differential count

THROMBOCYTES: Structure, composition, normal count, functions, blood clotting process bleeding disorders.

(Clinical significance to be stressed wherever applicable).

Unit II Neurophysiology: **10 ch**

A brief introduction to human nervous system

Basic structure of neuron, synapse and its function, origin of nerve impulse, nerve action potential, synaptic transmission, Neurotransmitter (Acetylene choline in detail)- transport and release. Electro Encephalogram (EEG).

Reflex Activity: Definition, significance, reflex arc properties,

Neurophysiological bases of memory, sleep, emotion and pain.

Unit III Reproductive physiology: **8 ch**

Brief overview of reproduction in humans.

Fertilization, implantation, Pregnancy- placenta and its role. Maternal changes. Parturation- stages, Role of hormones in growth of mammary gland and lactation

Unit IV Biomolecules **5 ch**

A) Carbohydrates: Monosaccharides- Nomenclature, definition, occurrence, classification, optical isomerism, mutarotation, linear and ring structure of monosaccharides e.g. glucose, fructose, ribose, and deoxiribose.

Oligosaccharides- composition and biological roles of sucrose lactose, maltose.

Polysaccharides: occurrence, classification, composition and biological roles of

Homopolysaccharides- starch glycogen, cellulose, chitin,

Heteropolysaccharides- hyaluronic acid, chondroitin sulphate, heparin.

B) Proteins:

6 ch

Amino acids: Structure, classification (based on R. side groups), peptides.

Chemical bonds involved in protein structure.

Protein configuration- primary, secondary, tertiary and quaternary.

C) Lipids

6 ch

Lipids: definition, occurrence, broad classification, biological importance of fatty acids, simple lipids (fats, oils, waxes), Compound lipids (phospholipids, glycolipids), Derived lipids – steroids, cholesterol and its biological importance.

Unit V Enzymes:

6 ch

A REVIEW OF ENZYME AS CATALYST, CHEMICAL NATURE

Michaelis-Menton equation, derivation, significance, of K_m and V_{max} , double reciprocal plots. Enzyme activators, inhibitors (reversible and irreversible), coenzymes and isoenzymes.

Unit VI Biosynthesis of Nucleic Acids & Proteins

9 ch

Biosynthesis of nucleic acids (DNA, RNA) (Eukaryotes). Protein synthesis-Transcription and translation (eukaryotes).

Text / Reference Books recommended :

1. K. Jambulingam and P sambulingam “essential of medical physiology”. Jaypee brothers.
2. Subramanyan Madhavan Kutty and Singh “Human physiology”
3. Mohan Arora “Animal physiology” Himalaya publishing House.
4. Albert Lehninger “Principles of Biochemistry, CBS publishers and distributors.
5. Conn, Stumpf, Bruening “Outlines of Biochemistry”, John wiley
6. J.L.jain “Fundamentals of Biochemistry” S.Chand and Company
7. V. Satyanarayana ‘biochemistry books and allied (p) ltd.
8. C.C Chatterjee. Human Physiology. Allied medical publishers, Calcutta.

<i>CODE</i>	<i>CLASS</i>	<i>SEMESTER</i>	<i>TITLE</i>	<i>CONTACT HOURS</i>	<i>MARKS</i>
ZP :11	T.Y. B. Sc.	V	Applied Genetics & Evolution	60 i. e. 4/week	100

GENETICS 36 ch

1. Gene regulation in Prokaryotes and Eukaryotes 6 ch

In prokaryotes – the ‘lac’ operon; structure, function, regulation (positive and negative) and mutations. The ‘trp’ operon – structure, function and regulation (repression & attenuation). Regulation of lysis and lysogeny.

2. Genetic recombinations – transformation, conjugation and transduction. 8 ch

Transformation – Griffiths, Avery, Macleod, and McCartys, experiments. Natural and artificial transformation in bacteria. Transformation in eukaryotic cells, transposition (transposons)

3. Gene mapping and genome analysis – concept of linkage and crossing over linkage and physical mapping. 8 ch

Linkage mapping – construction by using 2-3 points tests

Physical mapping - Chromosome mapping, insitu hybridization (FISH). Restriction mapping – restriction fragment, length polymorphisum (RFLP) Pulse field gel electrophoresis (PFGE) DNA sequencing, ultimate physical mapping (Maxam Gilbert’s chemical and Sanger and Coulson’s enzymatic method).

4. Developmental genetics - Drosophila 4 ch

Drosophila – Genes that establish the body plan – maternal effect, segmentation, homeotic genes

5. Genetics of Cancer – Familial and sporadic cancer, classes of cancer genes. 5 ch

Knudson’s two-hit model for retinoblastoma, cancer development is multistep process.

Prtooncogenes, oncogenes, antioncogenes (Tumor suppression genes).

6. Biostatistics - 5 ch

Mean, mode, median, standard deviation, standard error, correlation, regression, chi-square, tests-

students ‘t’ test, (test of significance for correlation, regression; ‘F’ test, Non-parametric tests, to be dealt in practicals).

EVOLUTION

24 ch

1. Introduction to modern synthetic theory of evolution (Neo-Darwinism) and mechanism of Evolution. Variation : Definition, kinds, sources and role of variations in evolution; Natural selection: Definition, types, nature and working of natural selection, natural selection in action and role of natural selection in evolution. Isolation: Definition, isolating mechanism (all types) and role of isolations in evolution. 8ch
2. Concept of micro evolution, macro evolution, mega evolution 3ch
3. genetic basis of evolution – Population genetics: Gene pool, gene frequencies and Hardy- Weinberg equilibrium 3 ch
4. Speciation : Definition of species and sub species category, Allopatric and sympatric speciation, Inter specific and intra specific speciation 3 ch
5. Adaptations (all types), Divergent evolution, convergent evolution 4 ch
6. Study of Fossils: Definition, formation, types and determination of age of fossils (radio-active clock method), significance of study of fossils. 3 ch

Text / Refrence Books recommended :

1. Arora, P.N. and Malhan, P.K. 2003. Biostatistics - Himalaya Publications
2. Fair bank, D.J. and Andersen, W.R. 1999 Genetics the continuity of life Book / Cole publ. New York
3. Pawar, C.B. 2003 Genetic Vol II Himalaya Publ.

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|-----|--|--|--|
| 4. | Snustad, Simmons, Jenkins, 1999 | Principles of Genetics | John Wiley & Sons
New York |
| 5. | Strick Berger 1985 | Genetics | Mc Millan |
| 6. | Sharma, A.K. and Sharma A. 1980
(3 E) | Chromosome techniques :
Theory and practice | Butter works & Co. ltd.
London |
| 7. | Benjamin Lewis | Gene I to VII | |
| 8. | Andrew, A.T. 1986 | Electrophoresis 2 nd Edition | Oxford University |
| 9. | Singer, M and Berg P. 1991 | Genes and Genomics | University of Science
books Mill way |
| 10. | Strachan, T. and Read A.P. 1996 | Human Molecular Genetics | Hiller - liss |
| 11. | Miglani G.S. 2006 | Developmental Genetics | I. K. International Publ.
House, N. Delhi |
| 12. | Singh Shailendra | Genes and Evolution | Campus book |
| 13. | V.B. Rastogi | Organic Evolution | Kedar Nath Ram Nath |
| 14. | Volpe. E.P. | Understanding Evolution | Universal Book stall |

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 12	T.Y.B. Sc.	V	Fundamentals of Animal Biotechnology	60 i.e. 4/week	100

1. Biotechnology : An Overview – Scope and Importance 2 ch
2. Introduction to microbes – Bacterial identification, Nutritional types; Reproduction, Nutritional requirement – media, maintenance of media 11 ch
3. Enzymes in Genetic engineering (Nucleic acid Enzymology) Restriction enzymes - types and target sites; Ligases, Alkaline phosphatase, polynucleotide kinase, Transferase, Polymerases, Nuclease, Reverse transcriptase 10 ch
4. Recombinant DNA technology - Isolation of DNA, labeling, Probing and cloning Genomic library - Colony hybridization, plaque hybridization, chromosome walking, chromosome jumping. 8 ch
5. Genetic Engineering Techniques – Blotting Techniques – DNA by southern blotting, RNA by Northern and Protein by Western blotting; RFLP mapping, DNA sequencing. 8 ch
6. Gene cloning vectors - plasmids - Bacterial plasmids pBR 322 and its derivatives, pUC vectors; Bacteriophage vectors, Cosmids, Phagemids, virus vectors for animal cells, shuttle and expression vectors. 9 ch
7. Genetic Engineering: Gene Cloning, Gene transfer and expressions of induced genes, - Gene – cloning in bacteria and eukaryotes, Polymerase Chain Reaction (PCR), Gene transfer technology, human gene therapy. 12 ch

Text / Reference Books recommended :

- 1) Old, R.W. and Primrose, S.B. Principles of Gene Manipulation: An introduction to Genetic Engineering.
- 2) Meyers, R.A. (Edt) Molecular Biology and Biotechnology VCH Pub.

- 3) Brown T.A. 1990 Gene cloning an introduction VNR international Pub.
- 4) Purohit, S.S.2000. Biotechnology Fundamentals and Applications Agrobios India.
- 5) Wulf C and Anneliese cruega. Text book of Industrial microbiology
- 6) Prave, P. etal. Fundamentals of Biotechnology.
- 7) Tata McGraw Hill, 1993 Microbiology. Pelczar, Chan, Kreig
- 8) Dubey & Maheshwari 2004, Text Book of Microbiology S.Chand
- 9) Vinita Kale, K. Bhusari, Practical Microbiology : Principles and Techniques Himalaya Pub. 2005
- 10) Dubey & Maheshwari. Practical Microbiology by S. Chand 2005
- 11) Sambrook, J.Fritch, E.F. and Maniatis, T. 1989 (2nd Edition) Molecular Cloning: A Laboratory manual Cold spring halfow.
- 12) Naik, G.R. 2004. Basic Molecular Biology techniques. Himalaya Publ.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZLC: 01	T.Y.B. Sc.	V	Practicals: a. Comparative anatomy of Vertebrates b. Human Physiology & Biochemistry	120 i.e. 8/week	100

a. Comparative anatomy of Vertebrates

A. Observation of following skeleton specimens :

Dogfish – visceral skeleton.

Cartilaginous trunk and caudal vertebrae.

Bonyfish trunk and caudal vertebrae

Varanus – Atlas, Axis and Caudal vertebrae.

Snake – trunk vertebrae

Pigeon – cervical vertebrae, synsacrum

Rabbit – Vertebral column.

B. Study of girdles :

1. Pectoral girdles of shark, bonyfish, frog, varanus, pigeon, rabbit.

2. Pelvic girdles of Shark, bonyfish, frog, varanus, pigeon, rabbit.

C. Observation of – a) Hyoid apparatus of pigeon and rat.

b) Columella of pigeon.

D. Observation of four different types of internal gills in vertebrates

Salamander

Tadpole larva

Bony fish

Cartilaginous fish

E. Identification of heart of cartilaginous fish, bony fish, pigeon and rabbit.

F. Mounting

Chromatophores in fishes

Brain of chick

Brain of rat

G. Dissections

Heart and aortic arches of chick and rat.

Urinogenital system of chick and rat.

b. Human Physiology & Biochemistry:

1. Enumeration of Erythrocytes
2. Enumeration of leucocytes
3. Differential count of leucocytes
4. Estimation of erythrocyte sedimentation rate.
5. Estimation of blood cholesterol.
6. Separation of lipids by thin layer chromatography
7. Estimation of fatty acids by titration method
8. Colorimetric estimation of liver glycogen.
9. Colorimetric estimation of plasma glucose.
10. Effect of substrate concentration on amylase activity and determination of Km.

Text / Reference Books recommended :

1. J. Jayaraman 'lab manual in biochemistry' new age international.
2. David Plumer 'An introduction to practical biochemistry' Tata McGraw Hills.
3. T. Poddar , Mukhopadhaya, Das 'Advanced laboratory manual of zoology . Maemillan publication.
4. R. N. Roy 'physiology , biochemistry and biophysics' books and allied (p) ltd.
5. Agarwal and jindal 'advanced practical zoology' - pragati parkas

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZLC:0 2	T.Y.B. Sc.	V	Practicals: a. Applied Genetics & Evolution b. Fundamentals of Animal Biotechnology	120 i.e. 8/week	100

Applied Genetics & Evolution:

1. Extraction and Estimation of DNA
2. Extraction and Estimation of RNA
3. Extraction and Estimation of Protein
4. electrophoretic separation of DNA / RNA
5. Electrophoretic separation of Protein
6. Problems on Gene frequency (Allele frequencies) (ABO blood groups)
7. Problems on standard deviation, correlation, regression, chi-square, F-test, test of significance for regression co-relation. Non parametric tests.
8. Problems on DNA fingerprinting (fraternity test, forensic science) by using printed material / RFLP
9. Identification based on evolution topics – Fossils, Analogous, Homologous organs
10. To demonstrate the role of natural selection in evolving adaptations.
11. To demonstrate the role of natural selection in fixing favoured adaptations and eliminating mal-adaptation
12. An exercise to illustrate the concepts of Genetic drift.

Fundamentals of Animal Biotechnology

1. Introduction to microbiology laboratory - concepts of sterilization
2. Preparation of media, autoclaving, isolation of bacteria by streak method
3. Enumeration techniques: Viable count by spread plate method and Neubauer chamber
4. Observation of microorganisms - Negative staining, gram staining
5. Motility study by stab culture method.
6. IMViC test for pathogenic bacterial identification.
7. Extraction and estimation of m-RNA
8. Determination of the concentration and purity of DNA by UV-spectroscopy.
9. Isolation of plasmid DNA by alkaline lysis method.
10. Introduction of DNA into cells. (Demonstration)
 - a. Preparation of Frozen competent cells and their transformation.
 - b. Selection of transformed cells.
11. Molecular weight determination of plasmid using restriction enzymes. (Demonstration)
12. Restriction endonuclease digestion of plasmid DNA and agarose gel electrophoresis. (Demonstration)
13. Ligation of digested DNA. (Demonstration)

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 13	T.Y.B. Sc.	VI	Developmental Biology	60 i.e. 4/week	100

Unit 1 : Introduction

12 ch

Theories of development and differentiation. Branches of embryology. Scope of embryology.

Gametogenesis -Spermatogenesis, Oogenesis, Vitellogenesis, Egg membranes. Fertilization and parthenogenesis Sperm – Egg interactions, Biochemical events, Post fertilization events.

Types of Eggs, Patterns of cleavages, Germ layers, Gastrulation, Fate maps and Cell lineage.

Unit 2 : Transplantation, embryonic inductions, concept of organiser and competence 10 c

Definition of transplantation, Nuclear transplantations, Embryonic induction, Types of embryonic inductions, Experimental evidence to embryonic induction, Brachets Experiment and Experiment of Spemanns and Mangold – Concept of organiser primary organizer, Characteristics of an organiser, Regional specificity of organizer, Neural induction, Mechanism of neural induction – surface interaction and chemical interaction, Gradient theory of neural induction, Secondary, Tertiary and Quarternary organizers, Eye as an example of sequential induction, Competence.

Unit 3 : Early Development of Chick

22 ch

Structure of hen's egg, cleavage, blastula, Gastrulation, Origin and formation of primitive streak. Development of chick embryo upto 3 days of incubation.

Unit 4 : Extra embryonic membranes of chick

04 ch

Development, structure and functions of yolk sac, Amnion, chorion and allantois.

Unit 5 : Placenta and placentation

03 ch

Definition, Classification of the different types of placenta

Functions of placenta

Unit 6 : Regeneration and ageing

09 ch

Types, Regenerative ability in different animal groups, Mechanism of regeneration, Stimulus and suppression of regeneration, Polarity in regeneration.

Ageing – Concepts and models.

Stem Cells

Definition, Kinds of stem cells and their unique properties.

Protocol for the preparation of Embryonic stem cells in the laboratory.

Adult stem cells – their availability and function.

Similarities and differences between Embryonic and Adult stem cells.

Application of Human stem cells.

Text / Reference Books recommended :

- 1) Balinsky, B. I., An introduction of embryology, saundus college pub., Philadelphia.
- 2) Berril N. J., Developmental Biology, Mc Graw Hill, New Delhi.
- 3) Bruce M. Carlson, Patten's Foundations of Embryology 6th Edn. Mc Graw Hill, Inc.
- 4) Gilbert, S. F., Developmental Biology, Sinauer Associates, Sunderland.
- 5) Jain, P.C., Elements of Developmental Biology, Vishal Publications, Jalandhar–8
- 6) Mc. Ewen, R. S., Vertebrate Embryology, Oxford and IBH publishing company, New Delhi.
- 7) Nair, P.K.G., Achar, K.P., Principles of Animal Embryology - Himalaya Publishing House.
- 8) Suresh C. Goel, Principles of Animal Developmental Biology, Himalaya Publishing House.
- 9) Verma, P. S., Agarwal, V.K., Chordate Embryology (Developmental Biology) S. Chand and Company Ltd., Ram Nagar, N. Delhi.
- 10) Waddington, C.H., Principles of Development and Differentiation, the Macmillan Company, New York.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 14	T.Y.B. Sc.	VI	Endocrinology	60 i.e. 4/week	100

Unit I Introduction : 10 ch

Endocrinology, endocrine glands, concept of endocrine regulation of physiological process. Hormones: classification – proteins, steroid and derived hormones. Regulation of hormonal secretion- feed back control, secretory mechanism, Role of hypothalamus. Mechanism of hormone action-protein and steroid.

Unit II Hypophysis 5 ch

Gross anatomy in mammals. Histology of Adenohypophysis and neurohypophysis. Hypothalamo hypophyseal portal system, hormones of pituitary, their functions and effect on target organs. Disorders of pituitary.

Unit III Thyroid and Parathyroid 4 ch

Histology, thyroid hormones. Role of T3, T4. Thyroid disorders. Thyroid function test Parathyroid: histology, hormones, Regulation of blood calcium levels.

Unit IV Endocrine pancreas. 3 ch

Microscopic anatomy, hormones (insulin and glucagon), Regulation of blood glucose levels, diabetes mellitus.

Unit V Adrenal 4 ch

Adrenal cortex and medulla: functional anatomy, their hormones, regulation of secretion and biological functions of their hormones.

Unit VI Gonads 4 ch

Endocrine Testis: histology, endocrine component. Regulation of testicular function. Ovary: histology, endocrine structure ovary and hormones associated with ovarian cycle.

Text / Reference Books recommended :

1. Hadley: endocrinology.
2. C.D Turner and J.T Bagnara. General Endocrinology W.B. saunders

- publications
3. Eckert and Randall 'animal physiology' CBS publishers
 4. B.N. Yadav 'mammalian endocrinology' vishal publications.
 5. Ross Histology
 6. Fawcett Histology
 7. Bailey's text book of microscopic anatomy.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP :15	T.Y.B. Sc.	VI	Environmental Biology & Toxicology	60 i.e. 4/week	100

Unit 1: Natural resources:

8 ch

Introduction, resource cycle, mineral resources (distribution of minerals, classification of minerals, mineral wealth of India, mineral resources of Antarctica, mineral production), marine living resources, energy resources (renewable and non renewable resources of energy), nuclear energy (Uranium and Thorium), forest resources, water-a vital resource.

Unit 2: Population dynamics:

10 ch

Population density, natality of population, fecundity, mortality of population, life tables, age distribution of population, age pyramids, sex ratio, biotic potential and environmental resistance, growth form of population, growth rate of population, population dispersion: emigration, immigration, migration, regulation of population size.

Unit 3: Wildlife in India

12 ch

Introduction, reasons for depletion of wildlife, aim and necessity for wildlife conservation, endangered, vulnerable and rare species, methods of studying wildlife, wildlife protected areas, Role of Government and NGO's in wildlife conservation, Wildlife protection acts and legislation. Application of Remote sensing and GIS in wildlife studies.

Unit 4: Introduction to toxicology

6 ch

Definition, history, and importance of toxicology, toxicants, and toxicity, disciplines of toxicology.

Unit 5: Environmental toxicology

12 ch

Classification of environmental toxicants: toxicants contaminating food, toxicants present in atmosphere and hydrosphere, sources, environmental levels and toxicity of heavy metals e.g. mercury, lead, arsenic, cadmium, definition, and classification of pesticides. Safety evaluation of chemicals (process of risk assessment and safety evaluation programme)

Unit 6: Radioactive substances

12 ch

Introduction and definition of radionuclide and radioactive substances, ionizing radiation- definition and classification of ionizing radiation, electromagnetic radiation and corpuscular radiation, Alpha and beta particles, neutrons, gamma and cosmic rays, sources of radiation: natural sources, man-made sources, x-rays, radioactive fallouts, nuclear power, ore processing operations, fate of discharged radionuclide in the environment.

Text / Reference Books recommended :

1. Pandey R, Shukla J.P, Trivedi S.P (2006). Fundamentals of Toxicology, New Central Book Agency.
2. Omkar. Concepts of Toxicology, Shoban lal nagin chand and Co, Jalandhar, India.
3. Rajesh Gopal (2000). Fundamentals of wildlife management, Justice Home.
4. Verma P.S and Agarwal B.K. (2002). Environmental Biology (Principles of Ecology). S.S. Chand and Co Publishers.
5. Arora M.P. (2004). Ecology, Himalaya Publishing House, New Delhi.
6. Dash M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill Publishers, New Delhi.
7. Michael P. (1984). Ecological methods for field and laboratory investigations. Tata McGraw Hill Publishers, New Delhi.
8. T. Poddar, S. Mukhopadhyay, S.K. Das (2003). An advanced laboratory manual of Zoology, MacMilan India Ltd, Mumbai.
9. Gurkamal Basra: Wildlife of India, Vishvabharati publication.

<i>CODE</i>	<i>CLASS</i>	<i>SEMESTER</i>	<i>TITLE</i>	<i>CONTACT HOURS</i>	<i>MARKS</i>
ZP :16	T. Y. B. Sc.	VI	Animal Biotechnology Applications	60 i.e. 4/week	100

1. Animal Cell Culture 12 ch

History; Requirements of Cell-culture; Protocols for Primary Cell Culture; Subculture; Established Cell lines (common examples such as MRC, HeLa, CHO, BHK, Vero); Organ culture.

2. Large scale production of mammalian cells. 08 ch

3. Important products from cell culture: Tissue Plasminogen Activator (tPA), 06 ch
Factor VIII, Erythropoietin(EPO), Growth Hormone (GH), Interferons (IFN)

4. Hybridoma Technology 04 ch

Cell fusion, Production of Monoclonal antibodies (mAb), Applications of mAb

5. Vaccines – different types 04 ch

6. Manipulation of reproduction in dairy animals and humans: 10 ch

Artificial Insemination, *In vitro* Fertilisation , Embryo Transfer, Embryo cloning

7. Transgenic Animals 08 ch

Strategies of Gene transfer; Transgenic mice, - sheep, - fish; Molecular farming

8. Applications of Biotechnology in fisheries - use of PCR in fisheries, monoculture in fishes, polyploid in fishes 04 ch

9. Application in sericulture- introduction of colour genes, sex markers. 04 ch

Text / Reference Books recommended :

5. A Text Book of Biotechnology By R.C. Dubey (S. Chand)
6. Animal Biotechnology M.M. Ranga (Agrobios)
7. Biotechnology By B.D. Singh

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZLC: 03	T.Y.B. Sc.	VI	Practicals: a.Developmental Biology b.Endocrinology	120 i.e.4/week	100

a. Developmental Biology

- 1) Observation of live gametes under microscope.
- 2) Observation of different types of eggs – amphibian egg, hen's egg, insect egg.
- 3) Observation of developmental stages of frog's egg – cleavage, blastula, gastrula.
- 4) Study of morphogenetic movement *invivo* in hen's egg using vital staining technique by preparing a window opening.
- 5) *Invitro* observation of the different extra embryonic membranes in a 6 days old chick embryo.
- 6) Mounting of eye vesicle and limb buds of a 6 day old chick embryo.
- 7) Preparation of permanent slides of chick embryo.
 - i. 24 hrs., ii. 36 hrs., iii. 48 hrs. , iv. 72 hrs.
- 8) To study the regenerative ability in different animals in both invertebrates and vertebrates.
- 9) Primary culture of Chick Embryo – Fibroblast – Warm Trypsinization, Cold Trypsinization.

b. Endocrinology

1. Study of the histological slides of the following endocrine glands of mammals: thyroid, suprarenal pituitary, parathyroid, islets of langerhans, testis and ovary.
2. Demonstration of endocrine glands in cockroach / crustaceans.
3. Demonstration of surgical technique- Adrenalectomy in rats.
4. A general survey of endocrine glands in rats.
5. Study of estruous cycle by vaginal smear preparation.
6. Histological technique: preparation of tissue, fixing embedding, sectioning, staining and mounting of testis of rats.
7. Effect of oestrogen on the ovary and uterus of rat.
8. A visit to a fish breeding farm/Prawn culture or breeding farm and submission of a report.

Suggested References books

- K. C. Ghose and B. Manna :practical zoology new central book agency.
- S. S. Lal ‘ a text book of practical zoology (vertebrates) Rastogi publications.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZLC: 04	T.Y.B. Sc.	VI	Practicals: a. Environmental Biology & Toxicology b. Animal Biotechnology Applications	120 i.e. 4/week	100

a. Environmental Biology & Toxicology

1. Determination of light penetration by Secchi Disc method.
2. Determination of calcium and magnesium in water.
3. Determination of total alkalinity in water.
4. Determination of salinity of water sample.
5. Field estimation of animal population by quadrat method.
6. Qualitative and quantitative estimation of soil fauna.
7. Estimation of total dissolved solids in given water sample.
8. Estimation of phosphorus and nitrates in the given water sample by spectrophotometer method.
9. To determine LC 50 of mosquito larvae using suitable pollutant/toxicant.
10. Effect of pesticide on oxygen consumption in fish/bivalve.

b. Animal Biotechnology Applications

1. Raising of Antibodies.
2. Separation and collection of Serum.
3. Simple Immunodiffusion.
4. Counter Current Immunodiffusion
5. Radial Immunodiffusion. (Ouchterlony)
6. Setting up of suspension culture of spleen cells
7. Setting up a monolayer culture of Macrophages.
8. Viable count of the Given cell sample.

9. Setting up a primary culture of Chick embryo fibroblasts

- i -Warm Trypsinization ii -Cold Trypsinization

General Note on Field Work: In addition to the regular lectures and practicals, the students should undertake 3 local field trips (each of not less than 8 hour duration) and a long study tour of not less than 10 days duration. The total field work is to be treated as 4 contact hours per batch per week.

ZOOLOGY (GENERAL)

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP: 17	T.Y.B. Sc.	V	Comparative Anatomy of Vertebrates & Histology	60 i.e. 4/week	100

Comparative Anatomy of Vertebrates :

Contact Hrs. – 35

Marks : 60

Unit I – Skeletal System

5 ch

Classification, visceral skeleton of Dogfish, comparative account of Jaw suspension, structure of a typical vertebra. Vertebral column of rabbit, pectoral and pelvic girdles of shark, bony fish, frog, varanus, pigeon, rabbit.

Unit II – Vertebrate integument and its derivations

7ch

General structure and functions of skin. Epidermal derivatives and their modifications. Epidermal glands, scales, feather, hair, beaks and bills, claws, nails and hoofs, horns & Antlers. Dermal Derivatives – Scales and Scutes

Unit III – General plan of circulation in various groups **6 ch**
Evolution of heart
Evolution of aortic arches and portal systems

Unit IV – Respiratory System 5 ch
Comparative Account of Respiratory organs in vertebrates.

Unit V – Excretory System 5 ch
- Evolution of urinogential system in vertebrate series.

Unit VI – Nervous System 7 ch

Comparative anatomy of the brain in relation to its functions.
Comparative Anatomy of spinal cord.
Cranial nerves and Spinal nerves in general
Antonomic nervous system in general.

Histology

Contact hrs. 25

Marks : 40

Unit I : A brief overview of general features of Vertebrate Development 3 ch

Early morphogenesis, gastrulation, Differentiation and histogenesis, Major derivations of three germs layers and neural crest. The four primary tissues and their classification.

Unit 2 – Gland Epithelium : Exocrine and Endocrine glands. 2 ch

Unit 3 – Bone : Structural elements (bone cells or bone matrix) 3 ch

Bone architecture or endochondral bone formation and zones.
Fracture repairs
Hormonal or nutritional effects upon bone.

Unit 4 – Muscle – Types & fine structures. 2 ch

Histogenesis and regeneration

Unit 5: Nerves – Histogenesis, degeneration and regeneration 1 ch

**Unit 6 : Structure, function and changes caused by pathological factors of the following
human organs / glands.** 14 ch

Lymphoid organs (tonsils, spleen) (Tonsillitis, splenitis)
Hypophysial pars distalis (Hypo and Hyper pituitarism)
Pancreas (Endocrine) (Pancreatitis, Diabetes)
Thyroid (Grave's Disease, Hyperplasia and Involution)
Adrenals (Cushing's Syndrome, Addisons Disease)
Gonads (Testis and Ovary) (Testicular Tumours)
Stain-leventhat syndrome.

Text / Reference Books recommended :

Comparative Anatomy of Vertebrates

1. Romer, A. S. & Parsons, T.S., The vertebrate body (New Edn.) Holt Saunder International Eds.
2. Weichert, C.K. "Anatomy of the Chordates MC graw hill & Co.
3. Kent, G.C., Comparative Anatomy of Vertebrates, C. V. Mosley & Co.
4. Webster, D & Webster, M., Comparative Vertebrate published by Academic press.

Histology

6. Handbook of Histopathological and Histochemical Techniques CFA Culling, Butterworths, London.
7. Histology T. S. Leeson and Leeson, C. R., W. B. Saundar Philadelphia.
8. A textbook of Histology – W. Bloom & D. W. Faweett, W. B. Saunder's Co.
9. Bailey's Textbook of Histology – W. B. Copenhaver, R. P. Blunge, M. B. Bunge.
The Williams and Williams Co.
10. Practical Zoology K. C. Ghose and B. Manna New Central Book Agency (P) Ltd., Kolkatta.
11. Textbook of Pathology, William Boyd, Lea and Febiger, Philadelphia.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZP : 18	T. Y.B. Sc.	V	Environmental Physiology	60 i.e. 4/week	100

Unit I

Introduction physiological ecology 6 ch

Adaptation- levels of adaptation, mechanism of adaptation, significance of body size.

Unit II

PHYSIOLOGICAL ADAPTATION TO DIFFERENT ENVIRONMENTS 18 ch

Marine, fresh water, extreme aquatic environment (deep sea), pressure difference at various depths, effect of high barometric pressure, N₂ narcosis, decompression sickness.

Terrestrial life, extreme terrestrial environment (desert and arctic), parastic habitats.

Unit III

STRESS PHYSIOLOGY 10 ch

Basic concept of environmental stress and strain, elastic and plastic strain, stress resistance, stress avoidance, stress tolerance. Acclimation and acclimatization.

Unit IV

CONCEPT OF HOMOSTASIS 16 ch

Physiological adaptation to osmotic and ionic stress. Osmoregulation in aqueous and terrestrial environment. Physiological response to oxygen deficit stress. Physiological response to body exercise.

Unit V

6 ch

HIGH ALTITUDE AND ACCLIMATIZATION

Introduction, barometric pressure, partial pressure, oxygen at different altitudes, changes in the body parameters at high altitude, mountain sickness. Acclimatization.

UNIT VI

4 ch

YOGA, MEDITATION AND THEIR EFFECTS.**Text / Reference Books recommended :**

1. Eckert and Randall. Animal physiology CBC publishers.
2. Willmer stone and Johnson. Environmental physiology
Blackwell science.
3. Knut-Schiemdt Nielsen. Animal physiology. Cambridge
4. Louw G. N. Physiological animal Ecology-Longman Harloss.
5. Bases of yoga Shri Aurobindo Ashram Pondichery.
6. Yogendra-yoga in modern life.
7. Mother- Health and healing in yoga. Aurchind Ashram Pondidherry.
8. R. C. Sobti 'medical zoology' Shoban lab. Chand company.

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZLC: 05	T.Y.B. Sc.	V	Practicals: a. Comparative Anatomy of Vertebrates & Histology b. Environmental Physiology	120 i.e.4/week	100

A. Comparative Anatomy of Vertebrates & Histology

I. Observation of skeleton specimens:

1. Visceral skeleton of Dogfish
2. Vertebral column of rabbit
3. Study of girdles :
 - a) Pectoral girdles of – Shark, bony fish, frog, varanus, pigeon, rabbit.
 - b) Pelvic girdles of – shark, bony fish, frog, varanus, pigeon, rabbit.

II. Observation of Hearts: Shark, bony fish, chick / pigeon, rat.

- #### III. Dissections :
- 1) Heart and aortic arches of chick
 - 2) Heart and aortic arches of rat
 - 3) Urinogenital system of chick
 - 4) Urinogenital system of rat

IV. Study of permanent slides (mammalian tissues)

1. T. S. of long bone
2. Study of smooth, skeletal and cardiac muscle
3. T. S. of spleen
4. T.S. of thyroid gland
5. T. S. of pancreas
6. T.S. of adrenal gland
7. T.S. of testis
8. T.S. of ovary.

V. Preparation of fixatives

1. Micro anatomical fixative – Buffered formalin, bouins fluid, gendres fluid.
2. Cytological fixative : Carnoy's fluid, champy's fluid, muller's fluid.

VI.Preparation of stains

3. Ehrlich's Alum Haematoxylin
4. Deafield's Harmatoxyin
5. Acetocarmine
6. Eosin

VII.Temporary mounting of buccal mucosa, skeletal muscle, blood smear.

VIII.Histological preparation : Fixation to section cutting and staining of a suitable mammalian tissue.

B. Environmental Physiology

1. Study of permanent slides of parasitic protozoans (4 types)
2. Study of parasitic helminthes/ arthropods- their preservation staining.(4 types).
3. Ecological adaptation in animal kingdom. Physalia, Arenicola/Chaetopterus, Stick insect, leaf insect, Praying mantis, Perna, Exocoetus, Diodon/Tetradon. Racophorus/tree frog, Phrynosoma, Draco, Crow.
4. Recording of total hardness, alkalinity, total dissolved solids in water.
5. Enumeration of erythrocytes/ leucocytes.
6. Estimation of haemoglobin and preparation of haemin crystal.
7. Recording of atmospheric temperature, pressure, relative humidity and light intensity.
8. Film / VCD's/ Power point show for yoga and meditation.

Text / Reference Books recommended :

- 1 Agarwal and Jindal . Advanced practical zoology, Pragati prakashan.
- 2 T. Rodder ,Mukhopadhaya, Das. An advanced laboratory manual of zoology. McMillen publication.
- 3 S.S.Lal. A text book of practical zoology (invertebrate and vertebrate)-Rastogi publicat
- 4.P. S. Verma. A manual of practical zoology (chordata/ invertebrates) J chand and company.

<i>CODE</i>	<i>CLASS</i>	<i>SEMESTER</i>	<i>TITLE</i>	<i>CONTACT HOURS</i>	<i>MARKS</i>
ZP: 19	T. Y.B. Sc.	V I	Applied Genetics	60 i. e. 4/week	100

1. Population Genetics: Hardy Weinberg equilibrium; factors affecting equilibrium, mutation, gene flow, Genetic selection and genetic drift. 6 ch

2. Quantitative genetics: Inbreeding and Heterosis, Inbreeding depression. Broad sense and narrow senses heritability; Quantitative Trait Loci (QTL) and DNA markers. 6 ch

3. Evolutionary Genetics: Speciation – Reproduction isolation, Quantum speciation; Molecular evolution – Amino acid divergence in proteins, Nucleotide divergence in DNA, molecular clocks. Maintenance of Genetic diversity, phylogenic analysis. 7 ch

4. Gene Mapping: Linkage maps using two and three points, physical mapping (DNA sequencing) using chemicals and enzymatic methods. 6 ch

5. Non-chromosomal Genomes and their inheritance: Mitochondrial and plastid genomes : Mitochondrial inheritance in animals and man; plastid inheritance in plants. 7 ch

6. Human Genetics : Chromosomal and single gene disorders, Genetic counseling and engineering 5 ch

7. Genetics in Medical and Forensic science - Genetic tests, DNA finger printing, human gene therapy. 6ch

8. Genetics in Agriculture and industry: Genetic Pharmacology, land reclamation, genetically modified bacteria for hazardous waste cleanup, Biosynthesis of fuels and industrial products. 7 ch

9. Biostatistics : Probability, Variance, Mean, mode, median, standard deviation, correlation, regression, chi-square, tests- students ‘t’ test, ‘F’ test, Nie distance, Non-parametric tests. 10 ch

CODE	CLASS	SEMESTER	TITLE	CONTACT HOURS	MARKS
ZT 20	T.Y.B. Sc.	VI	Economic Zoology	60 i.e. 4/week	100

Unit 1: Study of insect pests of some crops of economic importance: 8 ch

Pests of paddy Ex. *Leptocorisa varicornis* Fabr. (Rice Gandhi Bug)

Ex. *Pseudaletia separata* Walker (Army worm)

Pests of Sugarcane Ex. *Pyrilla perpusilla* Walker (Sugarcane leaf hopper)

Ex. *Tryporyza novella* Fabr. (Sugarcane top borer)

Pests of vegetables Ex. *Leucinodes orbonalis* Guenee (Brinjal shoot and fruit borer)

Ex. *Aulacophora foveicollis* Lucas (Red Pumpkin Beetle)

Pests of Fruits Ex. *Idiocerus atkinsoni* Lethierry (Mango Leaf Hopper)

Ex. *Cosmopolites sordidus* Germer (Banana Weevil)

Pests of Coconut, Palm Ex. *Oryctes rhinoceros* (Rhinoceros Beetle)

Ex. *Rhynchophorus ferrugineus* Olivier (Red Palm weevil)

(Distribution, food plants, life-history, damage caused, prevention and control measures of the insect pests to be dealt)

Unit 2: Apiculture: 7 ch

Introduction, species of honey bees, social organisation and life history of honey bees; selection of bees for apiculture, methods of bee keeping (indigenous and modern methods), products of bee keeping (honey and bee wax), bee keeping as an industry.

Unit 3: Fish and Fisheries : 13 ch

1. Culture fisheries: - Introduction to fish culture, types of cultivable species. Freshwater fish culture technique and management of fish culture farm, harvesting and marketing.
2. Capture fisheries: - Commercially important fisheries of Goa (Mackerel, Sardines, Seer fish, prawns, cuttle fish). Fishing tools-crafts and gears. Preservation and processing of fish and fisheries.

Unit 4: Poultry:

6 ch

Introduction, habitat of fowl: food and feeding of fowls- breeds of fowls (indigenous and exotic breeds); eggs and hatching, rearing of chickens; poultry products (eggs and meat); by-products of poultry.

Unit 5: Dairy industry:

6 ch

Introduction- breeds of dairy animals (cow, buffalo, goat); Milk: processing of milk, marketing and distribution of milk, milk products (Curd, cream, Butter, Ghee, khoya, cheese).

Unit 6: Role of animals in pharmaceuticals

5 ch

Introduction, Immunization, and serum theory; animal oriented medicines; advancement in pharmaceuticals.

Text / Reference Books recommended :

1. Venkitaraman. Economic Zoology, Sudarshan Publishers.
2. Shukla and Upadhyaya (2002). Economic Zoology, Rastogi Publishers
3. Jabde Pradip V (2005). Textbook of applied Zoology, Discovery Publishing House, New Delhi.
4. Ahsan Jawaid, Sinha Prasad S. (2000). A handbook on Economic Zoology. S. Chand and Co.
5. Yadav Manju (2003). Economic Zoology, Discovery Publishing House.

<i>CODE</i>	<i>CLASS</i>	<i>SEMESTER</i>	<i>TITLE</i>	<i>CONTACT HOURS</i>	<i>MARKS</i>
ZLC : 06	T. Y.B. Sc.	V I	Practicals: A. Applied Genetics B. Economic Zoology	120 i. e. 4/week	100

A. Applied Genetics:

1. Genetic problems :

- a. Population Genetics - Gene frequencies - Blood groups and others
- b. Quantitative Genetics - Heritability (QTL)
- c. Gene mapping - Linkage and physical (DNA sequencing)
- d. Non-chromosomal inheritance

2. Human pedigree analysis

3. Problems based on – standard deviation, correlation, regression, chi-square, Nie distance, ‘t’ test, ‘f’ test, phylogenetic analysis

4. Extraction and estimation of DNA

5. Extraction and estimation of RNA

6. Extraction and estimation of protein

7. Electrophoretic separation of DNA, RNA & Protein

8. Specimens of Genetically modified products - Fruits, vegetable, animals (transgenic animals and plants)

B. Economic Zoology

1. Identification and study of vegetable and fruit pests. (At least two each)
2. Identification and study of coconut and sugarcane pests. (At least two each)
3. Study of modification of legs and mounting of sting apparatus of Honey Bee.

4. Identification of cultivable species (fish, prawn, crab, lobster, clams, mussels and oysters)
5. Study of ornamental fishes.
6. Study of different types of formulated feeds used in poultry.
7. Platform tests for determining quality of milk.
8. Determination of acidity of milk (Lactic acid).
9. Detection of adulterants in milk.
10. Study of medicinal products of animal origin (honey, silkworm chrysalis, termite queen, sacred chank, window pane oyster, cobra venom, cod-liver oil)

General Note on Field Work: In addition to the regular lectures and practicals, the students should undertake 2 local field trips (each of not less than 8 hour duration) and a study tour of not less than 5 day duration. The total field work is to be treated as 2 contact hours per batch per week.

All the corollary courses and the project work recommended by the Newman Fernandes committee/The University will also be the integral part of the curriculum for the undergraduate programme.