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MAHATMA GANDHI UNIVERSITY

Priyadarshini Hills P.O.

Kottayam - 686 560



REVISED SYLLABI FOR B.Sc. DEGREE COURSE IN ZOOLOGY (Model I)

2006 admission onwards

B. Sc. Zoology (Main)

Scheme

Distribution of hours	Theory	Practical
First Year	2	2
Second Year	3	2
Third Year	17	8
Scheme of Examination - Theory		

Year	Paper	Hours	Marks	
			Internal	External
I Year	Paper I - Diversity of Animals I	3	12	48
II Year	Paper II - Diversity of Animals II	3	12	48
III Year	Paper III - Environmental Biology Evolution and Zoogeography	3	13	52
	Paper IV - Animal Physiology, Biochemistry, Ethology and Developmental Biology	3	13	52
	Paper V - Cell Biology, Genetics, Molecular Biology and Biotechnology	3	13	52
	Paper VI - Microbiology, Immunology, Biophysics, Biostatistics and Bioinformatics	3	13	52

Internal Assessment

Attendance	-	4%
Test Paper (2)	-	8%
Assignment	-	4%
Seminar	-	4%

Scheme of examination - Practicals

I and II year practical examinations will be conducted together as one paper during second year.

Year	Paper	Hours	Marks
I & II Year	Paper I - Morphology, Taxonomy and Anatomy	3	35
III Year	Paper II - Physiology, Biochemistry and Developmental Biology	3	35
	Paper III - Cell Biology, Genetics, Molecular Biology, Biostatistics & Computer Applications	3	35
	Paper IV - Environmental Biology, Zoogeography, Microbiology & Investigatory Project viva	3	20+5

External Evaluation

Record (5+5+5+5)	-	20
Workbook (I & II Years)	-	5
Field diary (I & II Years)	-	6
Investigatory Project	-	15
46 Marks		

Internal Evaluation

Record (10+5+5+5)	-	25
Attendance	-	5
Group Activity (I year)	-	6
Work books for practicals I, II, III & IV	-	8
44 Marks		

Records

1. Morphology, Taxonomy and Anatomy.
2. Physiology, Biochemistry and Developmental Biology.

3. Cell Biology, Genetics, Molecular Biology, Biostatistics and Computer Applications.
4. Environmental Biology, Zoogeography, Microbiology and Tour Diary.

Study tour should be conducted for not less than 5 days (Preferably spreading the study in the I, II & III year of the course). Students are expected to visit at least 3 research institutes and various places of zoological importance.

Theory Paper - I

Diversity of Animals - 1 90 hrs.

Objectives

1. To give the students an understanding of the diversity in various phyla and to make them observe the diversity of organisms.
2. To stimulate their curiosity in living things around them.
3. To teach them the taxonomy of the invertebrates which is necessary to know the relation between animals individually and in groups.
4. To make them aware of the process of evolution in appearance and in the anatomy and functioning of the organ systems.

Part A - Taxonomy

Unit I - Introduction. Basic Knowledge of the following 3 hrs.

1. History of classification (in brief)
2. Modern trends in classification (in brief)
3. Importance of classification
4. Five Kingdom classification (in brief)
5. Zoological nomenclature (in brief)
6. Concepts of protozoa and Metazoa

Unit II - Kingdom Protista

4 hrs.

Salient features and classification up to phyla

Phylum Rhizopoda - Eg. Amoeba

Phylum Actinopoda - Eg. Actinophrys

Phylum Dinoflagellate	- Eg. Noctiluca
Phylum Parabasalia	- Eg. Trichonympha
Phylum Metamonada	- Eg. Giardia
Phylum Kinetoplasta	- Eg. Trypanosoma
Phylum Euglenophyta	- Eg. Euglena
Phylum Cryptophyta	- Eg. Cryptomonas
Phylum Opalinata	- Eg. Opalina
Phylum Bacillariophyta	- Eg. Diatoms
Phylum Chlorophyta	- Eg. Volvox
Phylum Choanoflagellata	- Eg. Proterospongia
Phylum Ciliophora	- Eg. Paramecium
Phylum Apicomplexa (Sporozoa)	- Eg. Plasmodium
Phylum Microsporidia	- Eg. Nosema
Phylum Rhodophyta	- Eg. Red Alga

Part B - Animal Diversity

Unit II - Outline Classification of Animal Kingdom

Branches - Mesozoa, Parazoa and Fumetazoa 1 hr.

Levels of organization - cellular, tissue and organ levels (Self study) Taxonomy of basic classification of non chordata and chordata - symmetry, coelom, segmentation and embryogeny (Proctostomy and Deuterostomia)

Classification of invertebrates in to phylum and classes. Characters of classes. Brief account of examples specifying habit and habitat and structural, morphological, evolutionary and or ecological importance. Study of Salient features of all phyla is a prerequisite intended for self study.

Unit III - Mesozoa, General Characters 1 hr.

Phylum Mesozoa - Eg. Rhopalura

Unit IV - Parazoa, General Characters 2 hrs.

Classified into Phylum Porifera and Phylum Placozoa

Phylum Porifera

Salient features (Self study) Classification up to classes.

- Class I Calcarea - Eg. Leucosolenia
- Class II Hexactinellida - Eg. Euplactella
- Class III Desmospongia - Eg. Cliona

Phylum Placozoa

- Salient features - Eg. Trichoplax adhaerens

Unit V - Phylum Coelenterata

2 hrs.

Salient features (Self study) Classification up to classes.

- Class I Hydrozoa - Eg. Obelia
- Class II Scyphozoa - Eg. Aurelia
- Class III Anthozoa - Eg. Adamsia

Unit VI - Phylum Ctenophora

1 hr.

Salient features (Self study) -Eg. Pleurobrachia

Unit VII - Phylum Platyhelminthes

2 hrs.

Salient features. Classification up to classes

- Class I Turbellarian - Eg. Planaria
- Class II Trematoda - Eg. Fasciola
- Class III Cestoda - Eg. Taenia Saginata

Unit VIII - Phylum Nematoda

1 hr.

Salient features (Self study) Classification up to classes

- Class I Secernent (Phasmodia) - Eg. Wuchereria Bancrofti
- Class II Adenophorea (Phasmodia) - Trichinella

Unit IX - Phylum Annelida

2 hrs.

Salient features (Self study) Classification up to classes

- Class I Polychaete - Eg. Nereis
- Class II Oligochaete - Eg. Pheretima
- Class III Hirudinomorpha - Eg. Hirudinaria

Unit X - Phylum Arthropoda

4 hrs.

Salient features (Self study) Classification up to classes. Divided into 3

Subphyla - Trilobitomorpha, Chelicerata, Mandibulata

Sub Phylum Trilobitomorpha.

Salient features (in brief)

Sub Phylum Chelicerata

Salient features (in brief)

Class I Merostomata - Eg. Limulus

Class II Arachnida - Eg. Spider

Class III Pycnogonid - Eg. Nymphon

Sub Phylum Mandibulata

Salient features (in brief)

Class I Crustacea - Eg. Daphnia

Class II Chilopoda - Eg. Centipede

Class III Symphyla - Eg. Scutigera

Class IV Diplopoda - Eg. Millipede

Class V Pauropoda - Eg. Pauropus

Class VI Insecta - Eg. Butterfly

Unit XI - Phylum Onychophora

1 hr.

Eg. Peripatus

Brief account of salient features, morphology, distribution, affinities and systematic position of peripatus.

Unit XII - Phylum Mollusca

3 hrs.

Salient features (Self study) Classification up to classes

Class I Aplacophora - Eg. Neomenia

Class II Monoplacophora - Eg. Neopalina

Class III Bivalvia - Eg. Perna

Class IV Polyplacophora Amphineura - Eg. Chiton

Class V Gastropoda - Eg. Xancus

Class VI Cephalopoda - Eg. Sepia

Class VII Scaphopoda - Eg. Dentalium

Unit XIII - Phylum Echinodermata 2 hrs.

Salient features (Self study) Classification up to classes

- Class I Asteroidea - Eg. Astropecten
- Class II Ophiuroidea - Eg. Ophiothrix
- Class III Echinoidea - Eg. Echinus
- Class IV Holothuroidea - Eg. Cucumaria
- Class V Crinoidea - Eg. Antedon

Unit XIV - Minor Phyla 3 hrs.

Salient features and one example (in brief)

- 1. Phylum Nematomorpha - Eg. Gordius
- 2. Phylum Rotifera - Eg. Brachionus
- 3. Phylum Gastroticha - Eg. Chaetonotus
- 4. Phylum Kinorhyncha - Eg. Echinoderes
- 5. Phylum Priapulida - Eg. Priapulid
- 6. Phylum Echiuroidea - Eg. Bonellia
- 7. Phylum Phoronida - Eg. Phoronis
- 8. Phylum Chaetognath - Eg. Sagitta

Phylum Hemichordate 1 hr.

Salient features

Eg. Balanoglossus

Part C - Morphology and functional anatomy of the following types

Paramecium, Sycon, Hydra, Taenia solium, Ascaris, Megasclolex, Penaeus, Periplaneta, Pila Asterias.

Unit XV - Morphology 3 hrs.

Paramecium - Sycon - Hydra - Taenia Solium - Ascaris - Megasclolex - Periplaneta - Penaeus - Pila - Asterias.

(GROUP DISCUSSION USING SPECIMENS, PHOTOGRAPHS AND VIDEOCLIPPING IF AVAILABLE)

Functional Anatomy

Unit XVI - Exoskeleton

1hr.

Paramecium - Sycon - Cockroach - Penaeus - Pila - Asterias

Unit XVII - Locomotory Organs and Movement

4 hrs.

Paramecium - Hydra - Megascolex - Periplaneta - Penaeus (appendages of prawn are to be dealt with in detail) - Pila - Asterias.

Unit XVIII - Digestive System, Food and Feeding

5 hrs.

Paramecium - Sycon - Hydra - Ascaris - Megascolex - Periplaneta - Penaeus - Pila - Asterias.

Unit XIX - Circulatory System

4 hrs.

Megascolex - Periplaneta - Penaeus - Pila - Asterias.

Unit XX - Respiratory System

3 hrs.

Paramecium - Sycon - Hydra - Taenia solium - Ascaris - Megascolex - Periplaneta - Penaeus - Pila - Asterias.

Unit XXI - Nervous System

5 hrs.

Paramecium - Sycon - Hydra - Taenia solium - Ascaris - Megascolex - Periplaneta - Penaeus - Pila - Asterias

Unit XXII - Excretory and Osmoregulatory Systems

5 hrs.

Paramecium - Sycon - Hydra - Taenia solium - Ascaris - Megascolex - Periplaneta - Penaeus - Pila - Asterias.

Unit XXIII - Reproductive System and Life History

12 hrs.

Paramecium - Sycon - Hydra - Taenia solium - Ascaris - Megascolex - Periplaneta - Penaeus - Pila - Asterias.

Larval forms of sponges (amphiblastula and parenchymula), trochophore larva of annelida, larval forms of crustacea - trochophore, glochidium and veliger larva of Mollusca - larval forms of echinoderms and tornaria larva of balanoglossus.

Part D - General Topics

1. Pathogenic protists (*Entamoeba histolytica*, *Plasmodium*, *Trypanosoma*)
- Self Study
Polymorphism in Coelenterata - Corals and Coral reefs 1 hr.

2. Pathogenic nematodes (*Enterobius*, *Wuchereria bancrofti*, *Ancylostoma duodenale*, *Dracunculus*, *Trichinella* - Self Study

3. Vermiculture and composting - definition - Types of common earth worms cultured - preparation of vermicompost. 1 hr.

Apiculture - definition - species of bees cultured - organization of honey bee colony - bee keeping methods - uses of honey and wax. 3 hrs.

4. Sericulture - definition - Species of silk worms cultured - life history of silk worm - rearing methods - mounting and harvesting - sorting of cocoons. 4 hrs.

Pearl culture and mussel culture - definition - artificial - cultured and natural pearls - culturing of pearls - types of mussel culture. 2 hrs.

5. Insect pests of crop plants

Morphology, damages caused and control measures (brief accounts) 4 hrs.

Pests of stored food grains - *Trogoderma granarium*, *Tribolium castaneum*, *Sitophilus oryzae*

Coconut pests - *Oryctes rhinoceros*, *Rhynchophorus femugineus*, *Nephantis serinopa*, Eriophid mite (*Eriophyes guerronus*)

Pests of Paddy - *Leptocorisa acuta*, *Spodoptera mauritius*

References

1. Barnes R. D. (1987). Invertebrate Zoology. W. B. Saunders. New York
2. Barrington E. J. W. (1967). Invertebrate Structure and Function. (ELBS and Nelson, London)

3. Dhami P. S. and Dhami J. K. (1979). Invertebrate Zoology. R. Chand and Co. New Delhi.
4. Ekamberanatha Ayyar M. (1990). A Manual of Zoology. Volume I. Invertebrata Part I and Part II. S. Viswanathan Printers & Publishers Pvt. Ltd.
5. Hyman L. H. (1942). The Invertebrate Volumes. Mc Graw Hill.
6. Induchoodan (1986). Keralathile Pakshikal. (Kerala Sahithya Academy, Trissur).
7. Jordan E. L. and Verma P. S. (2000). Invertebrate Zoology. S. Chand and Co. Ltd., New Delhi.
8. Kapoor V. C. (1994). Theory and Practice of Animal Taxonomy.
9. Kotpal R. L., Agarwal S. K. and R. P. Khetharpal (2002). Modern Text Book of Zoology. Parker T. J. and Haswell W. A. (1962). Text Book of Zoology Vol. I. Invertebrate (ELBS & Macmillan, London).
10. Ruppert E. E., Fox R. and Barnes R. D. (2004). Invertebrate Zoology. Thomson Books/ Cole, USA.

Internal assessment - Seminar and Assignments

For internal assessment, topics for seminars and assignments should be different. Seminar topics should be written in brief and submitted. Portions from the syllabus or related topics could be given for assignments. Where ever needed, additional topics from syllabus or related topics could be given for seminars. Both of them should be put in files and presented at the time of II year Practical Examination.

Topics for Seminars

Examples from Classification and from general topics are assigned to be taken as seminars in the class.

1. **Protista** - Amoeba, Actionophrys, Noctiluca, Ceratium, Balantidium, Nyctotherus, Opalina, Euglena, Elphidium.
2. **Porifera** - Leucosolenia, Euplectella, Spongilla.
3. **Coelenterata** - Obelia, Physalia, Velella, Porpitta, Aurelia, Zoanthes, Adamsia, Madrepora, Fungia, Meandrina, Pteroides.

4. **Platyhelminthes** - Planaria, Bipalium, Fasciola, Schistosoma, Taenia saginata.
5. **Nematoda** - Enterobius, Wechereria bancrofti, Anculostoma Duodenale, Dracunculus, Trichinella.
6. **Annelida** - Nereis, Pheretima, Polygordius, Chaetopterus, Arenicola, Aphrodite, Pheretima, Hirudinaria, Haemadipsa, Ozobranchus.
7. **Arthropoda** - Limulus, Spider, Scorpion, Ticks and Mites, Nymphon, Lepas, Balanus, Hermit crab, Sacculina, Hippa, Daphnia, Scolopendra, Scutigera, Spirostreptus, Lepisma, Stick insect, Gryllotalpa, Praying mantis, Phyllium, Dragon fly, Butterfly, Moth, Ant lion, Belostoma, Mosquito, Pediculus.
9. **Mollusca** - Perna, Tereido, Pinctada, Chiton, Xancus, Trochus, Cypraea, Aplysia, Nautilus, Sepia, Octopus, Dentalium.
10. **Echinodermata** - Antedon, Astropecten, Ophiorthrix, Echinus, Salmasis, Holothuria.

Paper - II

Diversity of Animals - II

90 hrs.

Objectives

1. To make the student observe the diversity in chordates and their systematic position.
2. To familiarize them with the maximum number of species.
3. To make them aware of the economic importance of some classes.

Introduction

Differences between chordates and non chordates. (Prerequisite)

Part A - Animal Diversity

Unit I - Phylum Chordata

6 hrs.

General characters of the phylum, superclass, class, sub class and order should be taught. All examples should be dealt with in brief giving stress to

morphological, anatomical, economical, ecological or evolutionary importance.

Subphylum Urochordata, Subphylum Cephalochordata, and Subphylum Vertebrata.

Subphylum 1. Urochordata

General Characters

Class Larvacea - Eg. Oikopleura

Class Ascidacea - Eg. Ascidia

(Mention life cycle and retrogressive metamorphosis)

Class Thaliacea - Eg. Salpa

Subphylum 2. Cephalochordata

General Characters

Affinities and Systematic position of Branchiostoma (Amphioxus) is to be taught.

Subphylum 3. Vertebrata

General Characters.

Division 1 Agnatha

General Characters

Class 1. Cyclostomata - Eg. Petromyzon

Class 2. Ostracodermi - Eg. Cephalapis

Division 2 Gnathostomata

General Characters

Superclass Pisces and Superclass Tetrapoda

Unit II - Superclass Pisces

6 hrs.

General Characters

Class Chondrichthyes

Sub Class Elasmobranchi - Eg. Narcine

Sub Class Holocephali - Eg. Chimaera

Class Osteichthyes

Sub Class Choanichthyes

Order 1. Crossopterygii. - Eg. Latimeria

Order 2. Dipnoi - Eg. Protopterus

Sub Class Actinopterygii

Super order 1. Chondrostei

- Eg. Acipenser

Super order 2. Holostei - Eg. Amia

Super order 3. Teleostei - Eg. Sardine

Unit III - Superclass Tetrapoda

2 hrs.

General Characters

Class Amphibia

General Characters

Order 1. Urodela - Eg. Amblystoma (Mention neoteny and axolotl larva)

Order 2. Anura - Eg. Bufo

Order 3. Apoda - Eg. Ichthyophis

Unit IV - Class Reptilia

4 hrs.

General Characters

Sub Class 1. Anapsida

Order Chelonia - Eg. Chelone

Sub Class 2. Parapsida

- Eg. Ichthyosaurus

Sub Class 3. Diapsida

Order 1. Rhynchocephalia

- Eg. Sphenodon

Order 2. Squamata

Suborder 1. Lacertilia

- Eg. Chameleon

Suborder 2. Ophidia

- Eg. Cobra

Suborder 3. Crocodilia

- Eg. Crocodile

Sub Class 4 Synapsida

- Eg. Cynognathus

Unit V - Class Aves

3 hrs.

General Characters

Sub Class 1. Archeornithes

- Eg. Archaeopteryx (Affinities)

Sub Class 2. Neornithes

Super order 1. Palaeognathae

- Eg. Struthio, Dodo (Causes of extinction)

Super order 2. Neognathae

- Eg. Corvus

Unit VI - Class Mammalia

5 hrs.

General Characters

Sub Class 1. Prototheria - Eg. Echidna, Ornithorhynchus

Sub Class 2. Metatheria - Eg. Macropus, Didelphys

Sub Class 3. Eutheria

Order 1. Insectivora - Eg. Parachinus (hedgehog)

- Order 2. Dermoptera - Eg. Galaeopithecus
- Order 3. Chiroptera - Eg. Pteropus
- Order 4. Primate - Eg. Loris
- Order 5. Carnivora - Eg. Canis
- Order 6. Cetacea - Eg. Physeter
- Order 7. Perissodactyla - Eg. Equus
- Order 8. Artiodactyla - Eg. Camelus
- Order 9. Proboscidea - Eg. Elephas
- Order 10. Sirenian - Eg. Manatus
- Order 11. Hyracoidea - Eg. Procavia
- Order 12. Rodentia - Eg. Rattus
- Order 13. Logomorpha - Eg. Oryctolagus
- Order 14. Edentate - Eg. Armadillo
- Order 15. Pholidota - Eg. Manis
- Order 16. Tubulidentata - Eg. Orycteropus

Part B - Morphology and Functional anatomy of the following types

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Habit and Habitat of the types (self study)

Unit VII - Morphology

3 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Functional Anatomy

Unit VIII - Integumentary System

3 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit (Only in brief)

Unit IX - Organs of Locomotion and Movement

3 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Unit X - Skeletal System

10 hrs.

Scoliodon, Rana, Calotes (Skull of varanus instead of calotes), Pigeon,

Rabbit. (No detailed study of limb bones. Students are only expected to know the various bones constituting them).

Unit XI - Digestive System, Food and Feeding 6 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Unit XII - Circulatory System 8 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Unit XIII - Respiratory System 7 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Unit XIV - Nervous System - Mention Sense Organs 7 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

Unit XV - Urinogenital System 7 hrs.

Scoliodon, Rana, Calotes, Pigeon, Rabbit

General Topics 10 hrs.

Aquatic adaptations - Fish, Mammal (Self study)

Accessory respiratory organs in fish

Migration - Fish, Bird (Self study)

Economically important capture fishes of Kerala Coast (Self study)

Culture fisheries - Common culture fishes of India (Catla, Rohu, Mrigal, Silver Carp, Grass carp, Tilapia) (Self study)

Pond culture - Construction, Management and Maintenance (in brief)

Identification of poisonous and nonpoisonous snakes of Kerala.

Common snakes of Kerala (Self study)

Endangered mammals of India (Self study)

Aquatic mammals

Dentition in mammals

Topics for Seminars (For internal evaluation only)

Examples from various classes

Protochordata - Ascidia, Salpa, Doliolum, Oikopleura

Cyclostomata - Petromyzon, Myxine

Superclass Pisces - Narcine, Zygaena, Trygon, Pristis, Scoliodon, Chimaera, Latimeria, Anguilla, Hippocampus, Echeneis, Antennarius, Mugil cephalus, Etroplus suratensis, Labeo rohita, Rastrelliger kanagurta, Sardinella longiceps, Harpodon nehereus, Heteropneustes fossilis, Channa striates, Anabas testudineus.

Class Amphibia - Ambystoma, Axolotl larva, Uraeotyphlus, Bufo, Rhacophorus.

Class Reptilia - Chelone, Draco, Chameleon, Naja naja, Vipera russeli, Bungarus

Class Aves - Ostrich, Kivi (*Apteryx australis*), Common myna (*Acridotheres tristis*), Indian Koel (*Eudynamis scolopacea*), Blue rock pigeon (*Columba livia*), Brahminy Kite (*Haliastur Indus*), Great Indian Hornbill (*Buceros bicornis*), Barn owl (*tyto alba*).

Class Mammalia - Oryctolagus cuniculus, Ornithorhynchus, Echidna, Macropus, Pteropus, Slender loris (*Loris tardigrades*), Phoca greenlandia, Panthera tigris, Hyaena hyaena, Delphinus delphis.

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1. Ekamaranatha Iyer, 2000. A Manual of Zoology Vol. II. S. Viswanathan and Co.
2. Jordan E. L. and P. S. Verma, 2002 Chordate Zoology S. Chand and Co. New Delhi.
3. Kotpal R. L. 2000, Modern Text Book of Zoology, Vertebrates, Rastogi Publications, Meerut.
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7. Jhingran 1977, Fish and Fisheries of India. Hindustan Publishing Co.
8. Nigam and Sobti 2000, Functional Organization of Chordates. Shoban Lal Nagin Chand and Co. New Delhi.
9. Kurien C. V. & Sebastian V. C. Prawns and Prawn Fisheries in India (Hindustan Pub. Corporation, New Delhi).

Paper - III

Environmental biology, Evolution and Zoogeography

120 hrs.

Objectives

1. To make aware the student of the relationship between each and every organism, and between living and nonliving.
2. To give an idea about the relative importance of the different components of an ecosystem.
3. To create a greater awareness about the global and local environmental problems and to act accordingly as the UN says to think globally and act locally.
4. To satisfy one of the basic objectives of education, i.e. to create morally inspired young men and women since environmental education is now considered as the best form of moral education.

Part A - Environmental biology 90 hrs.

Unit - I Introduction 2 hrs.

Definition and relation to humanity, History and development (Ecological awareness from ancient to present cultures should be mentioned) Branches of Ecology Relationship with other branches of science.

Unit - II The Environment and the Concept of Ecosystem

10 hrs.

Physical environment. Brief mention about the origin and development of the universe, earth, life and life forms. Socio-cultural environment of Man : brief mention of the cultural of evolution of man, colonialism, growth of modern science and technology and development of a consumeristic society. Factors of the environment : abiotic factors - Light, Temperature, Soil, Water and Air. Biotic factors - Producers, consumers and decomposers. The structure and study of ecosystem. The concept of interaction and inter-relationship between the abiotic and biotic factors and man citing examples.

The biological control of the geochemical environment. The gaia Hypothesis. The cybernetic nature and stability of ecosystem. Examples of ecosystems - Natural & Artificial.

Unit - III

4 hrs.

Energy in Ecological Systems : Fundamental concepts relating energy. Concepts of productivity, food chain and food web, trophic level, trophic structure, ecological pyramids. Entropy. Energy based classification of the ecosystem, energy, money and civilization.

Unit - IV Bio-Geochemical Cycles

5 hrs.

Pattern and basic types of biogeochemical cycles. The global cycling of carbon and water, the sedimentary cycle. Nutrient cycling in the tropics, recycling pathways and the recycle index.

Unit - V Limiting Factors

3 hrs.

Concepts of limiting factors. Leibig's law of minimum. Brief review of Physical factors of importance as limiting factors. Shelford's law of tolerance and combined concept of limiting factors.

Unit - VI	Population Dynamics	5 hrs.
	Properties of population group (Density, Mortality, Natality, Age distribution, Biotic potential and Environmental resistance and Carrying capacity)	
	Population growth form (J' & S' shaped curves, Emigration, Immigration and Migration) Population structure. Dispersion, Aggregation, Allee's Principle. Refuging, Isolation and Territoriality.	
Unit - VII	Population of Communities :	5 hrs.
	Types of interaction between two species. Interspecific competition and co-existence. Negative interactions (Predation, Herbivory, Parasitism and Allelopathy). Positive interactions (Commensalism. Proto co-operation and Mutualism). Concept of habitat, Ecological niche and guild. Ecotone and concept of edge effect.	
Unit - VIII	Community Ecology	3 hrs.
	Definition and characteristics (Species, Diversity, Stratification, Dominance, Ecological indicators). Ecological succession Community evolution.	
Unit - IX	Diversity of Ecosystems (Habitat Ecology)	8 hrs.
	Classification of Biosphere into various habitats (Hydrosphere, Lithosphere and Atmosphere - Subdivision of each) Hydrosphere (Fresh water and Marine) Lithosphere, Biomes (Tundra, Alpine forests, Savanna, Grassland, Cave biome and desert)	
Unit - X	Environmental Laws	4 hrs.
	Only brief mention of the following laws incorporating latest amendments. Wildlife protection act, 1972. The water (prevention and control of pollution) Act-1974, 1977, 1988. The Environmental Protection Act 1986, Patents Act 1970 and	

its amendments, Brief mentioning of GATT, WTO, TRIPs. The Forest (conservation) Act, 1980. The Air (Prevention and Control of Pollution) Act, 1981. Provisions in Fundamental Duties of Constitution for the protection of environment.

Unit - XI Organizations and Movements 5 hrs.

Only very brief mention of the following organizations and their activities expected. Pollution control boards, their functions and reasons for their ineffectiveness. International Bodies : Man and the biosphere programme, International Atomic Energy Agency, International Union for Conservation of Nature and Natural resources, World Commission of Environment and development, South Asia Co-operative Environmental programme, United Nations Environment Programme, National Agencies Department of Environment, Forest and Wild life (Govt. of India). Chipko Movement, Narmada Bachao Andolan.

Unit - XII Global Environmental Issues 6 hrs.

Energy Production and Associated Problems. Deforestation, Soil erosion, Desertification and drought. (Brief mention of earth summit at Reo de Janero and decision on protection of tropical forests and world summit at Johannesburg. Pollution, Green house effect. Ozone depletion, acid rains, waste disposal, oil spills, resource depletion- (with reference to depletion of Biological Diversity, Genetic variability and non-renewable resources). Chemical and Biological warfare, problems related to modern agriculture.

Unit - XIII Potable Water Quality Monitoring and Waste Water Management 8 hrs.

Significance of Bio-indicators -faecal bacteriae and pathogenic micro organisms - Determination of the sanitary quality of potable water, water purification techniques. Characteristics of Sewage

and Waste water - chemical characteristics, microbial Characteristics. Methods of waste water - treatment and disposal. Physical, Biological treatment - Anaerobic digesting system - septic tank method. Aerobic processes - oxidation ponds, trickling filters, Activated sludge processes.

Unit - XIV Disaster Management 15 hrs.

Definition - types : slow, sudden. Characteristics of disaster. Types - Natural, anthropogenic, Hybrid. Common natural disasters - Volcanoes, Earthquake, Landslides, Flood, Tornado, Drought, Avalanche, Tsunami Cyclone Factors contributing to Vulnerability - 18 category of disasters based on Indian context 5 groups and 31 types. Hazard, risk and vulnerability analysis, vulnerability assessment, planning, prevention and mitigation institutional framework, warning systems, response mechanisms, Hazard risk management, comprehensive disaster management plan.

Unit - XV National and Local Issues 4 hrs.

Major National issues including threat to Himalayan Ecology, Major Environmental issues of Kerala such as deforestation, drought, river pollution, monoculture. Vembanadu lake and Thannirmukku bund, Monsoon trawling. Problems of Eloor, Kalamassery, Ambalamughal industrial belt and Mavoor. Impact of sand mining on the ecosystem. Importance of mangroves in coastal ecosystem, depletion of biodiversity of local fauna.

Unit - XVI Education & Conservation 3 hrs.

Environmental education and information (Goal, Classification, Formal and non - formal Education, Environmental Education for professional group. Wild life management and conservation with special reference to endangered Fauna and Flora. Sustainable development. Environmental ethics.

Part B - Evolution		20 hrs.
	Knowledge about evidences of organic evolution is a prerequisite.	
Unit - I	Origin of life on earth	2 hrs.
	Theories (Self study). Modern approaches.	
Unit - II	Theories of Organic Evolution	5 hrs.
	Lamarck's theory, its criticism (Weismann's Germplasm theory), Darwin's theory of Natural Selection (Mention the contribution of wallace), Mutation theory.	
Unit - III	Modern concepts of Organic Evolution	7 hrs.
	(Neo-Darwinism) Genetic basis of variation. Hardy - Weinberg equilibrium. Changes in gene frequencies - role of population size, non random mating, mutations, genetic drift, selection migration Natural selection in nature and in laboratory (brief account of the observation on Biston betularia) Hypothesis of Punctuated equilibrium.	
Unit - IV	Nature of evolution	4 hrs.
	Isolation and isolating mechanisms. Speciation - Sympatric speciation and allopatric speciation. Adaptive radiation.	
Unit - V	Evolution of man	2 hrs.
Part C - Zoogeography		10 hrs.
Unit - I	General Topics	3 hrs.
	Factors and means of animal distribution, Barriers in distribution. Origin of continent.	
Unit - II	Zoogeographical realms	6 hrs.
	Only brief account of each realm is expected. Mention the area included. Brief details of the physical features and fauna.	

Palaearctic region, Ethiopian region, Oriental region Australian region, Nearctic region, Neotropical region. Mention Biogeography of India. Western Ghats, Eastern Ghats and Himalayas.

Unit - III Insular Fauna **1 hrs.**
Brief account of oceanic islands and continental islands.

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Paper - IV

Animal Physiology, Biochemistry Ethology and Developmental Biology

120 hrs.

Objectives

1. To instill in students the relationship between structure and function.
2. To make them aware of the chemistry of life.
3. To impart the knowledge of how a single cell becomes a full grown being.
4. To relate the science behind behavior.

Part A - Animal Physiology**40 hrs.****Unit - I Introduction (Prerequisites)****6 hrs.**

History of Physiology, broad fields of physiology, scope and relevance of physiology.

Nutrition (Self study)

Nutritional requirements - outline classification of food components. Food fuels (carbohydrates, proteins and fats) and their biological importance - calorific value. Dietary fibre - balanced diet - recommended dietary allowance (RDA). Defects of modern food habit. Malnutrition disorders - PEM, Vitamin deficiency, mineral deficiency (iron, calcium, iodine). Over nutrition - Obesity, Hypercholesteremia.

Digestion

Structure of digestive system (self study). Mechanical and Chemical digestion of carbohydrates, proteins and lipids at various parts of the alimentary canal. Absorption - bulk transfer (phagocytosis and pinocytosis) - active and passive absorption - absorption of carbohydrates, proteins and lipids, water and electrolytes. Assimilation - storage and mobilization - defecation. Nervous and hormonal control.

Unit - II Respiration**4 hrs.**

Physiology of gaseous exchange in lungs and tissues. Transport of gases (oxygen and carbon dioxide - structure of haemoglobin) (HbA, HbF, HbS). Transport of oxygen - O₂ dissociation curve - Bohr effect - effect of temperature and pH on O₂ dissociation curve - Affinity O₂ to myoglobin and foetal haemoglobin. Transport of carbon dioxide - carbonic acid, bicarbonate and carbaminohaemoglobin - chloride shift. Respiratory disorders (Self study) - Apnoea, dyspnoea, hypoxia, hyper and hypocapnia, asphyxia - carbon monoxide poisoning - smoking and its physiological effects.

Unit - III Body fluids and Circulation 6 hrs.

Blood - composition and functions of blood plasma and formed elements (RBC, WBC and blood platelets) - (Self study). Coagulation of blood - clotting factors - mechanism of clotting (intrinsic and extrinsic factors) - anticoagulants - clotting disorders - (haemophilia, cerebral and pulmonary thrombosis, cerebral haemorrhage. Heart beat - conducting system of heart - pace maker (S-A node, A-V node, Purkinje system). Cardiac cycle - systole and diastole - heart rate - pulse - blood pressure (Self study). Cardiovascular diseases - myocardial infarction (Self study). Electrocardiogram - electrocardiogram in myocardial infarction. Lymphatic system - lymph - lymph nodes - major vessels in lymphatic system - role of lymph nodes in immunity.

Unit - IV Excretion 4 hrs.

Structure of nephron (Self study). Formation of urine - ultrafiltration - tubular resorption - tubular secretion - micturition - countercurrent mechanism - hormonal control of renal function - juxtaglomerular apparatus. Composition of urine - normal and abnormal (Self study). Kidney disorders (Self study) - myelonephritis, glomerular nephritis, nephrotic syndrome dialysis - artificial kidney - kidney transplantation.

Unit - V Nervous Coordination 6 hrs.

Neuron - Structure of typical neuron - types of neurons (unipolar, bipolar, multipolar) (Self study). Myelinated and nonmyelinated nerve fibres - giant nerve fibre. Synapse - Structure of electrical and Chemical (cholinergic and adrenergic) synapses - neuromuscular junction. Nerve impulse - initiation and propagation of nerve impulse - all or none law - refractory period - saltatory conduction - synaptic transmission - neurotransmitters. Brains waves - Electroencephalogram (EEG). Neural disorders - Parkinson's disease, epilepsy, schizophrenia, Alzheimer's syndrome, dyslexia.

Unit - VI Muscle physiology 4 hrs.

Types of muscles - striated, non-striated and cardiac muscles (Self study). Skeletal muscle - ultra structure and molecular organization. Muscle proteins - theories of muscle contraction - energetics of muscle contraction - muscle twitch - isotonic and isometric contractions - summation - tetanus - tonus - fatigue - rigor mortis.

Unit - VII Chemical Coordinations and endocrine glands 7 hrs.

Hypothalamo - hypophyseal system - structure - neurosecretory cells - hormones secreted by hypothalamus and hypophysis (pituitary) - mode of action - neural control of adenohypophysis. Thyroid gland - structure - hormones secreted - mode of action - feed back mechanism. Parathyroid gland - structure - hormones secreted - mode of action. Adrenal cortex and medulla - structure - hormones secreted - mode of action. Pancreas - structure - hormones secreted - metabolic regulation. Testis and ovary - structure - hormones secreted - hormonal control of reproduction and birth control - infertility - placental hormones. Disorders due to hormonal imbalance (Self study).

Unit - VIII Sports Physiology 3 hrs.

Muscular system and exercise (in brief). Respiratory and cardiovascular system during exercise (in brief) First aid, drop test, drug abuse.

Part B - Biochemistry 30 hrs.

Unit - I Introduction 5 hrs.

Biochemical basis of life - protoplasm - macro and micromolecules (In brief) - bonds (covalent, ionic, electrovalent and weak bonds or secondary bonds - water as a universal solvent, biological functions of water - concept of pH - buffer systems (bicarbonate and phosphate buffer systems) Henderson - Hasselbach equation.

Unit - II	Biofuels (Carbohydrates, Proteins and Lipids)	10 hrs.
	Carbohydrates - Structure and Classification - Monosaccharides (Trioses, tetrose, pentoses, hexoses, aldoses, ketoses) disaccharides and polysaccharides (homo and hetero polysaccharide) - biological functions of carbohydrates. Proteins - aminoacid- basic structure of aminoacid - Classification of aminoacids - structure of proteins - primary, secondary, tertiary and quaternary - biological functions of proteins. Lipids - classification - simple lipids (natural fats and waxes). Conjugated lipids (phospholipids, sphingolipide, glycolipids, lecithins, cephalins, cerebrosides, gangliosides) and derived lipids (fattyacids, steroids, prostaglandins) - Biological functions of lipids.	
Unit - III	Metabolism	10 hrs.
	Carbohydrate metabolism - glycogenesis - glycogenolysis - gluconeogenesis - glycolysis - hexose monophosphate shunt - Kerb's cycle - electron transport system - oxidative phosphorylation - hormonal control of carbohydrate metabolism. Protein metabolism - deamination - transamination - transdeamination - degradation of purines and pyrimidines - ornithine cycle. Lipid metabolism - hydrolysis of lipids - oxidation of glycerol - β oxidation - biosynthesis of fatty acids - hormonal control of lipid metabolism.	
Unit - IV	Enzymes	5 hrs.
	Chemical nature of enzymes - mechanism of enzyme action - factors influencing enzyme action (temperature, pH, enzyme concentration, substrate concentration) - Michaelis - Menten kinetics and substrate concentration - control of enzyme action (enzyme activation and enzyme inhibition).	
Part C - Ethology		10 hrs.
Unit - I	History and scope of ethology	1 hr.

Unit - II	Motivation, learning and imprinting (in brief)	2 hrs.
Unit - III	Biological rhythms - biological clock, circadian, tidal, lunar, and annual rhythms (brief accounts)	2 hrs.
Unit - IV	Social organization	3 hrs.
	Dominant hierarchies - social competition - territoriality - social stress (in brief). Social organization in insects and mammals	
Unit - V	Reproductive behaviour - courtship - mating - parental care (in brief). Hormones and behaviour.	2 hrs.
Part D - Developmental Biology		40 hrs.
Unit - I	Introduction and Historical perspective	2 hrs.
	Definition of Embryology, Classical Descriptive, Comparative, Experimental periods and main contributions of each period - Epigenesis vs. Reformation, Basic questions and approaches, Scope and significance.	
Unit - II	Germ cells	2 hrs.
	Gametogenesis - comparison between spermatogenesis and Oogenesis, significance of meiosis in gametogenesis. Structure of mammalian sperm and ovum - Classification of eggs based on the amount of yolk, position and distribution of yolk, Polarity and symmetry of egg. Egg envelopes. Structure of Chick egg.	
Unit - III	Fertilization	1 hr.
	Approach and binding of spermatozoa, activation of the egg, amphimixis, parthenogenesis (brief account only).	
Unit - IV	Cleavage	2 hrs.
	Types of cleavages - Radial and spiral with examples, Short account of cell lineage study - significance, Holoblastic cleavage - equal and unequal, Meroblastic cleavage - discoidal and superficial, Influence of yolk on cleavage.	

Unit - V	Blastulation	1 hr.
	Coeloblastula - equal and unequal, Stereo blastula, Disco blastula.	
Unit - VI	Gastrulation	4 hrs.
	Morphogenetic movements - definition, Different types - Invagination, Involution, Infiltration, Delamination, Epiboly, etc. Germ layer concept - primary and secondary germ layers, derivatives of germ layers.	
Unit - VII	Fate maps	1 hr.
	Concept of fate map, construction of fate maps - vital staining, radio active tracers, typical vertebrate fate map, role of fate maps in embryological research.	
Unit - VIII	Organogeny and Differentiation	4 hrs.
	Organ rudiments - primary and secondary Brief account of the development of neural tube, notochord, mesoderm - somite, lateral plate, coelom (Enterocoelic and Schizocoelic patterns) and gut. Differentiation - definition, types, significance.	
Unit - IX	Comparative account of early developmental process	8hrs.
	Sea urchin, Amphioxus, Frog and Chick, etc. as type organisms for embryological studies (brief accounts only), Characteristics of a good embryological type, Compare Cleavage pattern, Blastulation, Gastrulation in Amphioxus, Frog and Chick - emphasize reasons for similarities and differences. Frog Tadpole, 24 Hrs. Chick embryo. (Brief accounts).	
Unit - X	Development of nervous system and sense organs with reference to Frog	15 hrs.

Neurula, Development of brain regions, Development of the eye
- Development of the ear mention role of embryonic induction
in nervous system development, Neural crest cells, types and
fate (brief accounts only).

Unit - XI Human Development 6 hrs.

Blastocyst, Implantation, Foetal membranes (extra embryonic
membranes) and Placenta, Types of placenta in mammals (brief
account only), Pregnancy and Parturition (brief accounts only).
Abortion - Ethical Issues.

Unit - XII Developmental Biology at Molecular level 2 hrs.

Developmental Genetics, scope, significance, Drosophila and
Caenorhabditis elegans as model organisms in developmental
genetic studies (brief accounts only).

Unit - XIII Applied Embryology 2 hrs.

In vitro Fertilization (Test tube baby), Embryo transfer technology,
Cloning, Stem cell research. Ethical issues related to the above
techniques.

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Paper - V

Cell Biology, Genetics, Molecular Biology and Biotechnology

120 hrs.

Objectives

1. To emphasize the central role that molecular biology and biotechnology plays in the life of all organisms.
2. To introduce the student to some of the present and future applications of biosciences.
3. To develop critical thinking skill and research aptitudes, among students.

Part A - Cell Biology

30 hrs.

Unit - I Introduction

2 hrs.

History of cell and molecular biology. Branches of cell biology with special emphasis on submicroscopic and molecular biology. Suborganismal level of organization - Brief mentioning of prokaryotes, Actinomycetes, Mycoplasmas, Virus, Prions, Viroids and Virions, Differences between prokaryotes and eukaryotes.

Unit - II Histological Techniques (Principle and procedure only) 3 hrs.

Fixation: Mention common fixative - eg. Formalin, Ethanol, Bouins fluid, Carnoy's fluid. Preparation of whole mounts and serial sections. Staining - Brief accounts of auxochrome and chromophore groups. Mention histological stains such as hematoxylin, eosin, borax carmine and vital stains such as neutral red, Janus green, methylene blue, stains for blood cells (Wright's stain, Leishmania's stain and Giemsa stain).

Unit - III Cell Structure and Function: Cell Organelles 12 hrs.

Plasma membrane - Structure (unit membrane and fluid mosaic model) - modifications of plasma membranes (Desmosomes, Plasmodesmata, Microvilli and gap junctions). Cell permeability - Passive and active transport, transport of proteins, cell coat and cell recognition. Cytoskeleton. Brief account of morphology, chemistry and functions of microtubules and microfilaments. Endoplasmic reticulum. Structure and functions. Ribosomes in prokaryotes and eukaryotes. Golgi complex. Structure and function. Lysosomes, Polymorphism. GERL concept and functions. Microbodies, Peroxisomes and Glyoxisomes. Mitochondria - Structure, elementary particles and matrix. Biogenesis, bioenergetics including respiratory chain and electron transport system. Nucleus, Interphase nucleus, nuclear membrane, pore complex, nucleolus - structure and function, nucleolar organizer.

Unit - IV Chromosomes - Physical and Chemical structure 4 hrs.

Chromatin - heterochromatin and euchromatin, structure of centromere and kinetochore, telomeres and their importance. Nucleosomes and histones. Structure and functions of polytene and lamp brush chromosomes. Mention puffs, bands, endomitosis.

Unit - V Cell Division 3 hrs.

Cell cycles, G1, S, G2 and M phases. Amitosis, Mitosis. Achromatic and mitotic apparatus Meiosis. Synaptonemal complex, DNA metabolism in meiosis. Comparison and contrast - Mitosis and Meiosis. Spermatogenesis and Oogenesis.

Unit - VI Cell Communication 3 hrs.

Cell signalling - signal hypothesis, signalling molecules (neurotransmitters, endocrine hormones, growth factors and cytokine, vitamin A and D derivatives). Intracellular receptor mediated responses - steroid hormone response. Membrane receptor mediate signal transduction pathways. (eg. Cyclic AMP mediated pathway).

Unit - VII Cytology of Cancer and Ageing 3 hrs.

Types of cancer. Characteristics of cancer cells, differentiation of cancer cells, carcinogens. Hypotheses about cancer (mutation, viral, defective immunity). Oncogenes and tumour suppressor genes. Cytology of Ageing.

Part B - Genetics 30 hrs.

Unit - I Introduction 3 hrs.

Scope and importance of genetics. Mendelism. Students are expected to have a basic awareness about Mendel and his experiments. Brief explanation of the following terms - gene, alleles, genotype and phenotype, genome, homozygous and heterozygous, wild type and mutant alleles, dominant and recessive traits, test cross and back cross, reciprocal cross.

Cytological explanation for the law of segregation and independent assortment. Chromosome theory of heredity. Relevance of Mendel's principles in modern genetics.

Unit - II Interactions of Genes**7 hrs.**

Gene interaction - allelic and nonallelic. Allelic - Incomplete dominance, Co-dominance. Non-allelic interactions - complementary gene action, supplementary, epistasis - dominant (feather colour in fowl) and recessive (g. Coat colour in mice). Supplicate gene action. Polygenes (skin colour inheritance in man) pleiotropism, modifying genes, Lethal genes. (Brief account with one example each.) Multiple alleles (eg. Coat colour in rabbits, Man - ABO blood group system Rh factor, Rh Blood group and its inheritance). (Problems from each type).

Unit - III Linkage, Crossing over and Recombination 4 hrs.

Linkage and recombination of genes based on Morgan's work on *Drosophila*. (Complete and incomplete linkage). Crossing over and recombination, mechanism of crossing over, kinds of crossing over. Linkage map - chromosome mapping - two point and three point test cross mapping - elementary knowledge of mapping principles.

Unit - IV Sex Determination 4 hrs.

Chromosome theory of sex determination. (Sex chromosomes and autosomes). Chromosomal mechanism (XX-XO, XX-XY, ZW-ZZ). Bar bodies and Lyon hypothesis. Sex determination in man - role of Y chromosome, sex determination in honey bees. Genic balance theory. *Drosophila* - intersex and Gynandromorphism. Hormonal influence on sex determination. Environmental influence. Hermaphroditism.

Unit - V Mutations 5 hrs.

Definition - Mutation theory of Devries. Types of mutations - somatic, germinal sex linked etc. Muller's CIB method for detecting sex-linked recessive lethal mutations in *drosophila*.

Chromosomal mutations - structural and numerical changes.
Gene mutation (point mutation). Molecular basis of gene mutations - tautomerism, induced mutation, physical and chemical mutagens.

Unit - VI Extra Nuclear Inheritance (Cytoplasmic inheritance) 1 hr.

Characteristics: Organella DNA (mitochondrial and plastid DNA)
Kappa particles in paramecium. Maternal effects (eg. Shell coiling in snails).

Unit - VII Human Genetics 6 hrs.

Karyotyping - Normal chromosome complement. Pedigree Analysis. Aneuploidy and Non - disjunction. Genetic disorders in Man. Chromosomal anomalies. Autosomal (eg. Down syndrome, Edward's syndrome and cri-du chat syndrome). Sex chromosomal anomalies (Klinefelter's syndrome, and Turner's syndrome), Single gene disorders - Gene mutation and disorders (Brief mention). Autosomal single gene disorders - (Sickle cell anemia, brachydactyly, inborn errors in metabolism such as phenyl ketonuria, alkaptonuria). Sex linked inheritance - Definition - Characteristics - Criss - cross inheritance Haemophilia and colour blindness. Pseudoautosomal genes (incompletely sex-linked genes and holandric genes. Multifactorial Disorders - Polygenic traits - cleft lip and cleft palate. Sex limited and sex influenced traits in man with examples. Prenatal Diagnosis (Amnia centesis). Genetic Counselling. Eugenics and Euthenics.

Part C - Molecular Biology 30 hrs.

Unit - I Nature of Genetic Materials 5 hrs.

Discovery of DNA as the genetic material. Experimental evidence. Griffith's transformation experiment. Composition and structure of nucleic acids - Different types of DNA and RNA. DNA

replication - Semi conservative method - experimental evidence (Meselson and Stahl experiment).

Unit - II Modern concept of gene 8 hrs.

Subdivisions of gene-cistron-recon-muton. Viral genes, HIV genes. Prokaryotic genome - bacterial genes, plasmids and episomes. Eukaryotic genomes - split genes (introns and exons). Junk DNA (introns and intergenic sequences including unique and repetitive sequences). Pseudogenes, overlapping genes (brief description only). Transposable elements in bacteria, basic components and mechanisms of transposition in bacteria, Transposons in plants and animals.

Unit - III Gene Expression and regulation 10 hrs.

Central dogma of molecular biology - one gene - one enzyme, one-gene-one polypeptide hypothesis. Colinearity of genes and gene products. Genetic code - deciphering the genetic code - Mention the contributions of Har Gobind Khorana - Characteristics of Genetic Code.

Protein synthesis (Gene action). Transcription - RNA polymerase and transcription factors - Mechanism of transcription, difference between prokaryotic and eukaryotic transcription mechanism. Post translational modification of mRNA, rRNA and tRNA. Reverse transcription, Translation, Machinery and mechanism of translation, Post transactional modifications Gene regulation. Prokaryotic (inducible - repressible systems - Operon concept - Lac operon trip operon). Eukaryotic gene regulation mechanisms.

Unit - IV Recombination in Bacteria 7 hrs.

Bacterial transformation. Transduction - Generalized transduction and specialized. Transduction conjugation F - mediated Sex-diction. Resistance transfer factor (RTF) - Mechanism of drug resistance in bacteria.

Part D - Biotechnology

30 hrs.

Unit - I Definition and scope of Biotechnology 8 hrs.

Gene cloning. Genetic engineering and recombinant DNA technology Major steps - Cutting and joining of DNA. Role of restriction endonucleases. Ligases, and plasmid or phage vectors (Characteristic and different types). DNA amplification, PCR technique.

Unit - II Techniques in Gene Cloning 6 hrs.

Gene libraries - Construction of genomic library and cDNA library Hybridoma technology and monoclonal antibodies. Colony hybridization, DNA hybridization, DNA finger printing.

Unit - III Practical Applications of Biotechnology 10 hrs.

Tissue culture - Principle and uses, Technology of mammalian and plant cell culture, Single cell protein (SCP). The economic implications of SCP. Biotechnology and medicine. Pharmaceuticals and biopharmaceuticals (insulin, somatostatin, interferon, lymphokines). Antibiotics Vaccines and monoclonal antibodies. Biotechnology in agriculture and forestry. Microbial insecticides improved resistance to insect pest and microbial diseases. Animal biotechnology - Genetic engineering for transgenic animals. Genetically engineered hormones and vaccines. Fermentation technology, Down stream processing, Food and beverage fermentations - Alcoholic beverages - Vinegar, organic acids, Amino acids and Vitamins, Polysaccharides.

Unit - IV Potential Hazards of Biotechnology 6 hrs.

Advantages and hazards of genetic engineering - problems of biologically active biotechnology products. Problems of biotechnological inventions - Patent protection. Trade secrets. Plant breeders rights Biowar and biopiracy.

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Paper - VI

Microbiology, Immunology, Biophysics, Biostatistics and Bioinformatics

120 hrs.

Objectives

1. To equip the students with the knowledge of modern developments and recent trends and techniques in biological sciences.
2. To inspire the student in learning the new uses of technology.
3. To make them aware of the health related problems, their origin and treatment.

Part A - Microbiology

35 hrs.

Unit - I Introduction

3 hrs.

Scope of Microbiology - Outline classification of Bacteria, fungi,

viruses, Actinomycetes and mycoplasma. Morphology and fine structure of bacteria, size, shape and arrangements. Flagella, Pili, Capsule, Cell wall and its composition. Cytoplasmic Membrane, Protoplasts, Spheroplasts, Intracellular membrane systems, Cytoplasm, Vacuoles, Nuclear material, Pores and Cysts, Cell inclusions.

Unit - II Structure and Classification 3 hrs.

Human, Animal, Plant and Bacterial viruses. Replication of viruses, Cultivation of viruses.

Unit - III Bacterial Growth 3 hrs.

Eg. (E. Coli) Modes of cell division, New cell formation, Nutritional requirements.

Unit - IV Microbial Metabolism 3 hrs.

Glycolysis, Pentose phosphate pathway, Fermentation, TCA Cycle, Glyoxylate cycle.

Unit - V Method in Microbiology 8 hrs.

Sterilization and disinfection. Different methods - Physical and Chemical. Sterilization by moist and dry heat, by filtration, by irradiation. Preparation of culture media (aerobic and anaerobic cultivation) Selective media, Enrichment media, and Differential media, Plating techniques and isolation of pure colonies. Culture preservation techniques - refrigeration, deep freezing, freezing under liquid nitrogen and lyophilizations. Safety precautions in a clinical microbiology laboratory.

Unit - VI General Principles underlying Spoilage of food 5 hrs.

Chemical changes caused by microorganisms. Causes of spoilage. Factors affecting kinds and numbers and growth of microorganisms in food. Microbes causing contamination and spoilage of milk and meat products, fish and prawn.

Unit - VII Diseases caused by different pathogens, Epidemiology, Symptomatology, Diagnosis and treatment 5 hrs.

Bacterial: Mycobacterium (M. Tuberculosis, M. Lepra) (TB and Leprosy), Salmonella (Typhoid), Clostridium (Tetanus and Botulism), Spirochete diseases (Leptospirosis, Syphilis). Viral. Herpes Viruses (Chicken Pox), HIV - AIDS virus, Polio virus (Polio). Fungal. Tinea or ring worm (Dermatophytoses), Candida Albicans (Candidiasis).

Unit - VIII Infections 5 hrs.

Types, Primary and Secondary infections. Cross infection, nosocomial infection, endogenous and exogenous infection, different sources of infections. Contagious diseases (Epidemic, Endemic and Pandemic) Modes of transmission of diseases (by food, water, air, vectors and carriers). Mention different types of carriers, healthy carriers, convalescent carriers, temporary and chronic carriers, contact carriers - paradoxical carriers, bacteraemia, Septicaemia.

Part B - Immunology 25 hrs.

Unit - I Primary lymphoid organs 15 hrs.

Type of immunity, innate, acquired, passive and active, mechanism of innate immunity (Eg. Barriers, Phagocytosis, Inflammation). Basic structure of immunoglobulins (Eg. IgG, Different classes of immunoglobulins and functions. Antigens: Types, haptens, antigenic determinants. Antigen - antibody reactions. Precipitation, agglutination and flocculation and complement fixation test. Clinical application of antigen-antibody reaction. Eg. Widal, VDRL, HIV test (ELISA).

Unit - II 5 hrs.

Theories of antibody synthesis. Monoclonal and Polyclonal antibodies. Immune responses, Primary response, Secondary response. Cells of immune system. Leukocytes - lymphocytes, T & B cells, Macrophages, Plasma cells.

Unit - III **Hypersensitivity** 3 hrs.

Different types. Mechanism of allergic reaction, Mechanism of immune complex diseases (Eg. Arthus reaction, Serum sickness). Autoimmune disease (Pernicious anaemia, Erythroblastosis foetalis, Rheumatoid arthritis). Transplantation immunity and tumor immunity.

Unit - IV **Vaccines** 2 hrs.

Their principle and use. (Eg. BCG, DPT, Polio Myelitis and TAB) Toxoids.

Part C - Biophysics 20 hrs.

Tools and techniques. Basic principles, techniques and uses of the following instruments.

Unit - I **Microscopy** 6 hrs.

Light microscope, Bright field and Dark field microscopes. Phase contrast and Fluorescent microscopes. Transmission and Scanning electron Microscopy. Camera lucida, Micrometry.

Unit - II **Instruments** 6 hrs.

pH meter - pH measurement, Calorimetry and Spectrophotometer - principles and its applications. Centrifuges, Principles and types of centrifuges, different methods of cell fractionation and centrifugation.

Unit - III	Techniques	8 hrs.
	Chromatography, Principle - Brief account of paper chromatography and gas chromatography. Electrophoresis. Principle of paper and gel electrophoresis. X-ray Crystallography, Principles and application in biology. Autoradiography, Principles and application in biology. Radiation biology - Units of radiation, ionizing and nonionizing radiations - biological effects.	
Part D - Biostatistics		20 hrs.
Unit - I	Basic idea of probability distribution patterns	5 hrs.
	Normal, Binomial and Poisson distribution Population, Sample, Sampling, Sampling errors, Frequency distribution tables, construction of bar diagram, pie diagram, histogram and frequency curves.	
Unit - II	Measurement of Central Tendency	5 hrs.
	Mean, Median and Mode, Standard deviation, Standard error. (Merits and Demerits)	
Unit - III	Correlation and Regression	5 hrs.
	Definition. Positive and Negative correlation, regression analysis, regression lines, regression equation.	
Unit - IV	Tests of Significance	5 hrs.
	Basic concept. Levels of significance, Chi-square test, Goodness of fit. Analysis of variance, transformation. Exponential and logarithmic functions.	
Part E - Bioinformatics		20 hrs.
Unit - I	Introduction	15 hrs.
	Computers and their application to biology. Microprocessors - RAM, ROM, EPROM, Floppy disk and hard disk types. Memory	

systems, Input - Output devices, Disk operating system, Booting, Formatting.

Operating system: Dos, Windows, Linux (only basics). MS Office (MS Word, Excel, Access and Powerpoint). Computer Programming, Networking (LAN, WAN), Internet, World Wide Web. Data bases and information retrieval.

Unit - II Genome Projects 5 hrs.

Strategies of genome projects - Status of Human genome project - Data banks as example. Elementary sequential analysis - homology and analogy - phylogenetic analysis. Brief description of Genomics and Proteomics.

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3. Dr. Jayaram Panicker. Text of Microbiology.
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9. P. Cruickshank et. Al Medical Microbiology.
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2. Narayanan P. 2003. Essentials of Biophysics. New Age International Pvt. Ltd.
3. Salil. Bose 1982. Elementary Biophysics. Jyothi books.
4. Welson and Gouldy 1982. Tools of techniques in biology.

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1. Agarwal B. L. 1996, Basic Statistics, New Age International (P) Ltd. Publishers, New Delhi.
2. Campell R. C. 1990. Statistics for Biologists. CBS Publishers and Distributors.
3. Finney D. J. 1980. Statistics for Biologists. Chapman and Hall, London.

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1. Atwood T. K. & Parry Smith D. J. 1999. Introduction to bioinformatics.
2. Ignacimuthu S. 2005 Basic Informatics Narrosa Publishing House, New Delhi.
3. Rastogi S. Madiratta N. and Rastogi P. 2004. Bioinformatics Methods & Applications.
4. Westhead D. R., Parish J. H. (2003) Instant notes in Bioinformatics. Viva books Pvt. Ltd.

Practical - I (I and II years)

Paper - I

Morphology, Taxonomy and Anatomy

Section A (I Year)

Unit - I Morphology : Scientific Drawing

Explain the significance, methodology of scientific drawing, characteristics of a good scientific drawing, also introduce calligraphic techniques.

Make scientific drawings of 5 locally available invertebrate specimens belonging to different phyla.

Unit - II Taxonomy

A. Classification

Explain principles and significance of classification. Students should study classification up to species (at least 20% of total specimen) along with morphological characters/adaptations of the examples specified in the Non chordata portion of the theory syllabus and additional examples from the museum collection of the college.

1. **Protista** - Amoeba, Euglena, Paramecium, Nuctiluca, Elphidium, Actinophrys, Ceratium, Opalina, Balantidium, Nyctotherus (any five)
Porifera - Leucosolenia, sycon, spongilla, Euplectella (any two)
2. **Coelenterata** - Hydra, Obelia, Aurelia, Physalia, Velella, Porpitta, Zoanthes, Adamsia, Madrepora, Fungia, Favia, Meandrina, Pteroids (any eight)
3. **Ctenophore** - Pleurobrachia
4. **Plathelminthes** - Planaria, Bipalium, Fasciola, Schistosoma. Taenia solium, Taenia signata (Any five)

5. **Nematoda** - *Enterobius vermicularis*, *Wuchereria bancrofti*, *Ancylostoma duodenale*, *Dracunculus medinensis*, *Trichocephalus trichuris*, *Trichinella spiralis* (Any Five)
6. **Annelid** - *Nereis*, *Pheretima*, *Polygordius*, *Chaetopterus*, *Arenicola*, *Aphrodite*, *Pheretima*, *Hirudinaria*, *Haemadipsa*, *Ozobranchus* (Any Six)
7. **Arthropoda** - *Limulus*, Spider, Scorpion, Nymphon, *Lepas*, *Balanus*, Hermit crab, *Sacculina*, *Hippa*, *Daphnia*, *Scolopendra*, *Scutigera*, *Spirostreptus*, *Lepisma*, Stick insect, *Gryllotalpa*, Praying mantis, *Phyllium*, Dragon fly, Butterfly, Moth, Ant-lion, *Belastoma*, Mosquito, *Pediculus* (Any Twelve)
8. **Mollusca** - *Perna*, *Teredo*, *Pinctada*, *Chiton*, *Xancus*, *Trochus*, *Cypraea*, *Aplysia*, *Nautilus*, *Sepia*, *Octopus*, *Dentalium* (Any Eight)
9. **Echinodermata** - *Antedon*, *Astropecten*, *Ophiothrix*, *Echinus*, *Echinodiscus*, *Salmasis*, *bicolor*, *Holothuria*, *Cacumaria* (Any Six)
10. **Minor phyla/Hemichordat** - *Balanoglossus*, *Brachionus*

Unit - III Preparation of Taxonomic Key :

Each centre should maintain a general collection of 50 insect specimens and students should be given practice to prepare simple Dichotomous Key to identify a minimum of 6 of those specimens up to order.

(A **laboratory work book** should be maintained for I and II years showing details like date, time, morphological feature of animals observed in the laboratory, sketches of both identifications and dissections in separate pages. A separate fair practical record should be maintained containing neat sketches and neatly written notes.

The certified **laboratory work book** containing details of first and second years practicals should be submitted during second year practical examination for evaluation and viva. Fair practical record also should be submitted during second year practical examination.)

Unit - IV Field Study (any three)

Different groups of students may carry out different works.

- 1) Study of invertebrate biodiversity of campus /any local area with reference to climate changes.
- 2) Biodiversity of pond - with reference to climatic changes.
- 3) Biodiversity of a near by rocky/ sandy/ muddy shore
- 4) Biodiversity of Sacred Grove - with reference to climatic changes
- 5) Collection of indigenous knowledge on animals from local area
- 6) Pest control practices adopted by local farmers especially indigenous methods
- 7) Visit to an apiary
- 8) Visit to a sericulture unit
- 9) Visit to a vermiculture unit
- 10) Visit to a paddy cum prawn culture field during harvesting.
- 11) Visit to a butterfly garden

(Maintain a **field diary** including details like date, time, observations as data tables/descriptions/photographs (if possible) conclusions, check-lists, field guides and other references used for the study, Students should present their study reports in the class and organize an exhibition using photographs/posters/paper reports, etc. as a whole class activity and include the report of it in the **field diary** with supporting evidences. Submit the certified field diary during second year practical examination for evaluation)

Unit - V Group activity (any one)

Different groups should carry out different works and all the works should be done in the college. The report of the group activity should be included in the field diary. There will be viva from this part)

1. Maintenance and observation of laboratory cultures- paramecium/ daphnia/ Cyclops/ Artemia/ Drosophila etc.
2. Preparation of Scarp book album including recent paper/weekly/ magazine cuttings and materials downloaded from internet on zoology themes, photographs etc.
3. Preparation and presentation of posters on various animals/ conservation issues, etc. (At least 10 poster from a group).
4. Alizarin preparation of dead specimen.
5. Three dimensional model of any thing related to biology.
6. Maintenance of a small vermiculture unit.
7. Maintenance of a small butterfly garden.
8. Life history study of mosquito/moth/butterfly/any other insect.

Section B (II Year)

Unit - I Morphology : Scientific Drawing

Make scientific drawing of 5 locally available **vertebrate** specimens belonging to different phyla.

Unit - II Taxonomy

A. Classification

Students should study classification up to species wherever possible (minimum 20%) along with morphological characters / adaptations of the examples specified in **Chordate** portion of the theory syllabus

and syllabus and additional examples from the museum collection of the college.

1. **Protochordata** - Amphioxus, Ascidia, Salpa, Doliolum, Oikopleura (Any Three)
2. **Cyclostomata** - Petromyzon, Myxine (Any One)
3. **Pisces** - Narcine, Zygaena, Trygon, Pristis, Scoliodon (any two) Chimaera, Latimeria, a lung fish (any two), Anguilla, Hippocampus, Echeneis, Antennarius (any two), Mugil cephalus, Etroplus suratensis, Labéo rohitha (any one), Rastrelliger kanagurta, Sardinella longiceps (any one) Harpodon nehereus, Heteropneustes fossils, Channa striates, Anabas testudineus.
4. **Amphibia** - Amblystoma, Axolotl larva, Uraeotyphlus, Bufo, Rhacophorus.
5. **Reptilia** - Chelone, draco, chamaeleon, Naja naja, Vipera russeli, Bungarus.
6. **Aves** - Ostrich, Kiwi (Apteryx australis), Eudytes antipodium (any one) Common myna (Acridotheres tristis), Indian Koel (Eudynamis scolopacea), Blue rock pigeon (Calumba livia), Brahminy kite (Haliastur Indus), Great Indian Hornbill (Buceros bicornis), Barn owl (Tyto alba) (any five).
7. **Mammalia** - Oryctolagus cuniculus, Ornithorhynchus, Echidna (any one), Macropus, Pteropus, slender loris (Loris tardigradus), Phoca greenlandia, Panthera tigris, Hyaena hyaena, Delphinus delphis (Any five)

Unit - III Anatomy

Mounting

- a. Locomotory organelles - Cockroach leg - Study how these structures act as adaptations.

- b. Prawn appendages - Observe and make comments on division of labour among appendages/structural modifications according to function.
- c. Mouth Parts - Cockroach. Honey bee, plant bug (Demonstration only) - Make observations on how the basic structure is modified according to mode of feeding.
- d. Cockroach salivary glands - correlate the structure with food habits.

Dissections

Cockroach - Nervous system

Prawn - Nervous system

Frog (Demonstration only) - Brain, Vth Cranial nerve, IXth & Ist spinal, Xth Cranial nerve, arterial system on one side.

Unit - IV Osteology

Study of vertebrae of frog

Cervical vertebrae of bird and mammal

Turtle - plastron and carapace

Comparative study of skulls - varanus, pigeon, rabbit

Comparative study of pectoral and pelvic girdles - frog, calotes, pigeon and rabbit.

(The same laboratory workbook and fair record of the first year practical should be continued during second year. The certified laboratory workbook and Fair Record should be submitted for Second year Practical Examination for evaluation.

Unit - V Field Study

Different groups may carry out different works (any one)

1. Visit to a food fish culture unit
2. Visit to a ornamental fish culture unit

3. Visit to a river and collection of indigenous ornamental fishes
4. Visit to a zoo
5. Visit to a bird sanctuary
6. Vertebrate biodiversity in the campus

(Maintain the same **field diary** of the year of study for second year. Submit the certified field diary along with scrapbook album/posters/preparations/models, etc. if any during II year practical examination).

Note: General Guidelines for the maintenance of laboratory workbook

The laboratory workbook must be permanently bound, no loose-leaf. Handwriting must be legible. All notes should be taken in pen with the exception of colored drawings that may be done with pencils. Errors should be crossed through with a single line, not erased or obliterated. All information in the note book must be hand written or present actual results, such as drawing/photographs. Do not place any photocopied material into your notebook unless specifically directed to do so. Everything the student does in the laboratory should be recorded in the laboratory work book, including notes, drawings, data, speculations, etc. Keep all laboratory related notes, including laboratory lecture notes, in the same book.

Practical - II

Physiology, Biochemistry and Developmental Biology

1. Blood smear preparation of frog and man.
2. Total count of RBC and WBC.
3. Estimation of haemoglobin.
4. Estimation of microhaematocrit.
5. Detection of carbohydrate, protein and fat.

6. Determination of O_2 uptake by cockroach / frog.
7. Gut enzymes in cockroach. (Three enzymes in any one region)
8. Effect of temperature on the heart beat of frog.
9. Chromatography and calculation of R_f value (demonstration)
10. Chick embryo - vital staining 24/33 hours (demonstration)
11. Placenta - Pig, man (Identification)
12. Embryological slides - Gastrula, blastula, 18, 24, 33 and 48 hours.

Practical - III

Cell Biology, Genetic, Molecular Biology, Biostatistics and Computer Applications

1. Micrometry - Estimation of the breadth of hair using a micrometer.
2. Phase contrast microscope, pH meter, Camera lucida (demonstration).
3. Preparation of permanent whole mount.
4. Squash preparation of onion root tip for study mitosis.
5. Testis squash preparation of grass hopper for studying meiosis (demonstration). Identification of at least two stages.
6. Salivary gland chromosome in the larvae of drosophila / chironomus (Demonstration).
7. Study of barr body in human buccal epithelium.
8. Genetic problems - Mono and dihybrid ratios, back cross, multiple alleles.
9. Syndromes - Turners, Klinefelters.
10. Study of DNA and RNA using models.

Bio Statistics

11. Mean, Median, Mode
12. Construction of pie and bar diagram

Computer applications

13. Computation of mean
14. Drawing of pie and bar diagram using excel
15. Power point - demonstration

Practical - IV

Environmental Biology, Zoogeography and Microbiology

1. Estimation of Oxygen and Carbon dioxide
2. Extraction of soil organisms (any one method) - Demonstration
3. Identification of fresh water and marine plankton
4. Construction of food chain/food web
5. Study of desert, Forest and Volant adaptations
6. Study of Zoogeographical realms using the maps

Microbiology

7. Instruments - autoclave, hot air oven, Incubator
8. Gram staining - Identification, Preparation and procedure
9. Motility - preparation
10. Streak plating - preparation
11. Antibiotic sensitivity - demonstration

Along with the examination for this practical, Viva of the project will be conducted

PATTERN OF THEORY QUESTIONS & DISTRIBUTION OF MARKS

Paper - I & II

Animal Diversity I & II

Section A - Taxonomy and Animal Diversity

- I. 8 questions out of 12 to be answered (1 Mark Each) - 8 Marks
- II. 4 questions out of 7 to be answered (2 Marks Each) - 8 Marks

Section B - Morphology and Functional Anatomy

- III. 5 questions out of 8 to be answered (1 Mark Each) - 5 Marks
- IV. 2 questions out of 4 to be answered (5 Marks Each) - 10 Marks
- V. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Section C - General Zoology

- VI. 3 questions out of 5 to be answered (1 Mark Each) - 3 Marks
- VII. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Total - 48 Marks

Paper - III

Environmental Biology, Evolution and Zoogeography

Section A - Environmental Biology

- I. 7 questions out of 12 to be answered (1 Mark Each) - 7 Marks
- II. 5 questions out of 8 to be answered (2 Marks Each) - 10 Marks

III. 2 questions out of 4 to be answered (5 Marks Each) - 10 Marks

IV. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Section B - Evolution and Zoogeography

V. 5 questions out of 8 to be answered (1 Mark Each) - 5 Marks

VI. 3 questions out of 5 to be answered (2 Marks Each) - 6 Marks

VII. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Total - 52 Marks

Paper - IV

**Animal Physiology, Biochemistry
Ethology and Developmental Biology**

Section A - Animal Physiology, Biochemistry and Ethology

I. 4 questions out of 7 to be answered (1 Mark Each) - 4 Marks

II. 4 questions out of 8 to be answered (2 Marks Each) - 8 Marks

III. 3 questions out of 6 to be answered (5 Marks Each) - 15 Marks

IV. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Section B - Developmental Biology

V. 2 questions out of 5 to be answered (1 Mark Each) - 2 Marks

VI. 2 questions out of 5 to be answered (2 Marks Each) - 4 Marks

VII. 1 question out of 3 to be answered (5 Marks Each) - 5 Marks

VIII. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Total - 52 Marks

Paper - V

Cell Biology, Genetics, Molecular Biology and Biotechnology

Section A - Cell Biology and Genetics

- I. 3 questions out of 6 to be answered (1 Mark Each) - 3 Marks
- II. 3 questions out of 6 to be answered (2 Marks Each) - 6 Marks
- III. 2 questions out of 5 to be answered (5 Marks Each) - 10 Marks
- IV. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Section B - Molecular Biology and Biotechnology

- V. 3 questions out of 6 to be answered (1 Mark Each) - 3 Marks
- VI. 3 questions out of 6 to be answered (2 Marks Each) - 6 Marks
- VII. 2 questions out of 5 to be answered (5 Marks Each) - 10 Marks
- VIII. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Total - 52 Marks

Paper - VI

Microbiology, Immunology, Biophysics

Biostatistics and Bioinformatics

Section A - Microbiology and Immunology

- I. 5 questions out of 8 to be answered (1 Mark Each) - 5 Marks
- II. 3 questions out of 5 to be answered (2 Marks Each) - 6 Marks
- III. 2 questions out of 4 to be answered (5 Marks Each) - 10 Marks
- IV. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Section B - Biophysics, Biostatistics and Bioinformatics

- V. 4 questions out of 7 to be answered (1 Mark Each) - 4 Marks
- VI. 4 questions out of 7 to be answered (2 Marks Each) - 8 Marks
- VII. 1 question out of 3 to be answered (5 Marks Each) - 5 Marks
- VIII. 1 question out of 3 to be answered (7 Marks Each) - 7 Marks

Total - 52 Marks

B. Sc. Zoology (Subsidiary)

Scheme

Distribution of hours

First Year

2

2

Second Year

2

3

Scheme of Examination - Theory

Year	Paper	Hours	Marks	
			Internal	External
I	Paper I - Diversity of Animals	3	12	48
II	Paper II - General Zoology	3	12	48

Internal Assessment

Attendance - 4%

Test Paper - 8%

Assignment - 4%

Seminar - 4%

Theory Paper I and II

Section No. I - 10 out of 15 - One Mark Each $10 \times 1 = 10$ Marks

Section No. II - 5 out of 8 - Two Marks Each $5 \times 2 = 10$ Marks

Section No. III - 2 out of 4 - Five Marks Each $2 \times 5 = 10$ Marks

Section No. IV - 1 out of 3 - Eight Marks Only $1 \times 8 = 8$ Marks

Section No. V - 1 out of 3 - Ten Marks Only $1 \times 10 = 10$ Marks

Total = 48 Marks

Scheme of Examination - Practical

Year	Paper	Hours	Marks
I	Morphology and Taxonomy	2	80
II	Anatomy and Physiology	2	(Exam 3 hours)

External Evaluation

(64 Marks)

Dissection and Physiology Experiments - 32 Marks

Identification and Spotting - 16 Marks

Mounting - 10 Marks

Scientific Drawing - 6 Marks

Total 64 Marks

Internal Evaluation

(16 marks)

Record - 12 Marks

Attendance - 4

Total 16 Marks

B. Sc. Zoology (Subsidiary)

Paper I

Diversity of Animals

90 hrs.

Students who are studying zoology as a subsidiary subject are expected to have an understanding of the diversity in various Protists and Animal Phyla. Classification up to phylum and classes for invertebrates and up to order for vertebrates is to be studied. Characters of classes should be dealt with in detail. Accounts of examples should specify habit and habitat and structural, morphological, evolutionary and/or ecological importance. Study of Salient features of phyla is a prerequisite intended for self study wherever mentioned. Type study is restricted to a few animals. All systems including larval stages if any should be studied.

Unit I - Introduction

Five Kingdom Classification - Zoological nomenclature

1 Hr.

Unit II - Kingdom Protista

Salient features and classification upto phyla

Phylum Rhizopoda	- Eg. Amoeba
Phylum Actinopoda	- Eg. Actinophrys
Phylum Dinoflagellata	- Eg. Noctiluca
Phylum Parabasalia	- Eg. Trichonympha
Phylum Metamonada	- Eg. Giardia
Phylum Kinetoplasta	- Eg. Trypanosoma
Phylum Euglenophyta	- Eg. Euglena
Phylum Cryptophyta	- Eg. Cryptomonas
Phylum Opalinata	- Eg. Opalina
Phylum Bacillariophyta	- Eg. Diatoms
Phylum Chlorophyta	- Eg. Volvox
Phylum Choanoflagellata	- Eg. Proterospongia

- | | | |
|-------------------------------|---|----------------|
| Phylum Ciliophora | - | Eg. Paramecium |
| Phylum Apicomplexa (Sporozoa) | - | Eg. Plasmodium |
| Phylum Microsporida | - | Eg. Nosema |
| Phylum Rhodophyta | - | Eg. Red alga |

4 hrs.

Unit II - Outline Classification of Animal Kingdom

Branches - Mesozoa, Parazoa and Eumetazoa

1 hr.

Unit III - Mesozoa

General Characters

Phylum Mesozoa - Eg. Rhopalura

1hr.

Unit IV - Parazoa

General Characters

Classified into Phylum Porifera and Phylum Placozoa

Phylum Porifera

Salient features (Self study) Classification up to classes

- | | | |
|-------------------------|---|------------------|
| Class I Calcarea | - | Eg. Leucosolenia |
| Class II Hexactinellida | - | Eg. Euplactella |
| Class III Desmospongia | - | Eg. Cliona |

Mention Gemmule, Amphiblastula, Parenchymula

Phylum Placozoa

Salient features - Eg. Trichoplax adhaerens

3 hrs.

Unit V - Phylum Coelenterata

Type - Hydra

Salient features of Phylum Coelenterata. (self study) Classification up to classes.

- | | | |
|--------------------|---|-------------|
| Class I Hydrozoa | - | Eg. Obelia |
| Class II Scyphozoa | - | Eg. Aurelia |

Class III Anthozoa - Eg. Adamsia 5 hrs.

Unit VI - Phylum Ctenophora 1hr.

Salient features (Self study)

Eg. Pleurobrachia

Unit VII - Phylum Platyhelminthes 2 hrs

Salient features. Classification upto classes

Class I Turbellaria - Eg. Planaria

Class II Trematoda - Eg. Fasciola

Class III Cestoda - Eg. Taenia Saginata

Unit VIII - Phylum Nematoda 1hr.

Salient features (self study) Classification upto classes

Class I Secernentea (Phasmodia) - Eg. Wuchereria bancrofti

Class II Adenophorea (Phasmodia) - Trichinella

Unit IX - Phylum Annelida

Salient features (self study). Classification upto classes

Class I Polychaeta - Eg. Nereis

Class II Oligochaeta - Eg. Pheretima

Class III Hirudinomorpha - Eg. Hirudinaria 2 hrs.

Unit X - Phylum Arthropoda

Type - Prawn

Salient features of Phylum Arthropoda (Self study) Classification upto classes. Divided into 3 Subphyla - Trilobitomorpha, Chelicerata, Mandibulata

Sub Phylum Trilobitomorpha - Salient features (in brief)

Subphylum Chelicerata - Salient features (in brief)

Class I Merostomata - Eg. Limulus

Class II Arachnida - Eg. Spider

Class III Pycnogonida - Eg. Nymphon

Subphylum Mandibulata - Salient features (in brief)

Class I Crustacea - Eg. Daphnia

Class II Chilopoda - Eg. Centipede

Class III Symphyla - Eg. Scutigera

Class IV Diplopoda - Eg. Millipede

Class V Pauropoda - Eg. Pauropus

Class VI Insecta - Eg. Butterfly 8 hrs.

Unit XI - Phylum Onychophora

Eg. Peripatus. Brief account of salient features and distribution of Peripatus.

1 hr.

Unit XII - Phylum Mollusca

Salient features (self study) Classification upto classes

Class I Aplousobranchia - Eg. Neomenia

Class II Monoplacophora - Eg. Neopilina

Class III Bivalvia - Eg. Perna

Class IV Polyplacophora (Amphineura) - Eg. Chiton

Class V Gastropoda - Eg. Xancus

Class VI Cephalopoda - Eg. Sepia

Class VII Scaphopoda - Eg. Dentalium 4 hrs.

Unit XIII - Phylum Echinodermata

Salient features (self study) Classification upto classes.

Class I Asterozoa - Eg. Astropecten

Class II Ophiurozoa - Eg. Ophiothrix

Class III Echinozoa - Eg. Echinus

Class IV Holothuroidea

Eg. Cucumaria

Class V Crinoidea

Eg. Antedon

2 hrs.

Unit XIV - Phylum Hemichordata - Salient features

1 hr.

Eg. balanoglossus

General topics

1. Pathogenic protists (Entamoeba histolytica, Plasmodium, Trypanosoma)
- Self Study
2. Polymorphism in coelenterata - Corals and Coral reefs
3. Pathogenic nematodes (Enterobius, Wuchereria bancrofti, Ancylostoduodenale, Dracunculus, Trichinella)
4. Mouth parts of Insects - Honey bee, Plant Bug, Mosquito, House Fly
Mouth parts of Insects.
5. Insect pests of crop plants

4 hrs.

Morphology, damages caused and control measures (Brief accounts)

Pests of stored food grains - *Trogoderma granarium*, *Tribolium castaneum*, *Sitophilus oryzae*

Coconut pests - *Oryctes rhinoceros*, *Rhynchophorus ferrugineus*, *Nephantis serinopa*, Eriophid mite (*Eriophyes guerreronus*)

Pests of paddy - *Leptocorisa acuta*, *Spodoptera mauritius*

3 hrs.

Differences between chordates and non chordates (prerequisite)

Unit I - Phylum Chordata

General characters of the phylum, superclass, class, sub class and order should be taught.

Subphylum Urochordata, Subphylum Cephalochordata, and Subphylum Vertebrata

Subphylum 1. Urochordata

General characters

Class Larvacea Eg. Oikopleura

Class Ascidiacea. Eg. Ascidia. (mention life cycle and retrogressive metamorphosis).

Class Thaliacea. Eg. Salpa

Subphylum 2. Cephalochordata

General characters . Eg. Branchiostoma

Affinities and systematic position of Branchiostoma (Amphioxus) is to be taught

Subphylum 3. Vertebrata

General Characters

Division I Agnatha

General Characters

Class 1. Cyclostomata Eg. Petromyzon

Class 2. Ostracodermi Eg. Cephalapis

Division 2. Gnathostomata

General characters

Superclass Pisces and Superclass Tetrapoda

Unit II. Superclass Pisces

General Characters

Class Chondrichthyes

Subclass Elasmobranchi. Eg. Narcine

Subclass Holocephali. Eg. Chimaera

Class Osteichthyes

Subclass Choanichthyes

Order 1. Crossoptergii. Eg. Latimeria

Order 2. Dipnoi Eg. Protopterus, Lepidosiren, Neoceratodus

Subclass Actinopterygii

Super order 1. Chondrostei Eg. Acipenser

Super order 2. Holostei. Eg. Amia

Super order 3. Teleostei. Eg. Sardine, Mackerel, Etroplus, Labeo rohitha, Anabas, Channa, Echeneis, Hippocampus, Anguilla 8 hrs.

Unit III - Superclass Tetrapoda

General Characters

Class Amphibia

Type-Rana hexadactyla

General Characters

Order 1. Urodela Eg. Ambystoma (mention neoteny and axolotl larva)

Order 2. Anura Eg. Bufo

Order 3. Apoda Eg. Ichthyophis 10 hrs.

Unit IV Class Reptilia

General Characters

Subclass 1. Anapsida

Order Chelonia Eg. Chelone

Subclass 2. Parapsida Eg. Ichthyosaurus

Subclass 3. Diapsida

Order 1. Rhynchocephalia Eg. Sphenodon

Order 2. Squamata

Suborder 1. Lacertilia Eg. Chameleon

Suborder 2. Ophidia Eg. Cobra or any other snake

Suborder 3. Crocodilia Eg. Crocodile 4hrs.

Unit V Class Aves

General characters

Subclass 1. Archeornithes Eg. Archaeopteryx (Affinities)

Subclass 2. Neornithes

Super order 1. Palaeognathae Eg. Struthio, Dodo (causes of extinction)

Super order 2. Neognathae Eg. Corvus

Unit VI Class Mammalia

3 hrs.

General Characters

Subclass 1. Prototheria Eg. Echidna, Ornithorhynchus

Subclass 2. Metatheria Eg. Macropus, Didelphys

Subclass 3. Eutheria

Order 1. Insectivora Eg. Parachinus (hedgehog)

Order 2. Dermoptera Eg. Galaeopithecus

Order 3. Chiroptera Eg. Pteropus

Order 4. Primata Eg. Loris

Order 5. Carnivora Eg. Canis

Order 6. Cetacea Eg. Physeter

Order 7. Perissodactyla Eg. Equus

Order 8. Artiodactyla Eg. Camelus

Order 9. Proboscidea Eg. Elephas

Order 10. Sirenia Eg. Manatus

Order 11. Hyracoidea Eg. Procavia

Order 12. Rodentia Eg. Rattus

Order 13. Logomorphha Eg. Oryctolagus

Order 14. Edentata Eg. Armadillo

Order 15. Pholidota Eg. Manis

Order 16. Tubulidentata.

Eg. Orycteropus

8 hrs.

General Topics

1. Accessory respiratory organs in fishes
2. Poisonous and non-poisonous snakes of Kerala
3. Flight adaptations of birds
4. Migration in birds
5. Common birds of Kerala
6. Aquatic mammals
7. Endangered mammals of India

7 hrs.

Topics for Seminars

Examples from Classification and from general topics are assigned to be taken as seminars in the class.

1. Protista - Amoeba, Actinophrys, Noctiluca, Euglena, Elphidium
2. Porifera - Leucosolenia, Euplectella, Spongilla
3. Coelenterata - Obelia, Physalia, Aurelia, Adamsia, Madrepora, Meandrina, Pteroides
4. Platyhelminthes - Planaria, Fasciola, Schistosoma
5. Nematoda - Ascaris, Enterobius, Wuchereria bancrofti, Ancylostoma duodenale, Dracunculus, Trichinella
6. Annelida - Nereis, Pheretima, Polygordius, Chaetopterus, Arenicola, Aphrodite, Pheretima, Hirudinaria, Haemadipsa, Ozobranchus
7. Arthropoda - Limulus, Spider, Scorpion, Ticks and Mites, Nymphon, Lepas, Balanus, Hermit crab, Sacculina, Hippa, daphnia, Scolopendra, Scutigera, Spirostreptus, Lepisma, Stick insect, Gryllotalpa, Praying mantis, phyllium, dragon fly, Butterfly, Moth, Ant lion, Belostoma, Mosquito, Pediculus

8. **Mollusca** - Perna, Teredo, Pinctada, Chiton, Xancus, Trochus, Cypraea, Aplysia, Nautilus, Sepia,
9. **Octopus, Dentalium**
10. **Echinodermata** - Antedon, Astropecten, Ophiothrix, Echinus, salmasis, Holothuria

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8. Kapoor V.C. (1994). Theory and Practice of Animal Taxonomy.
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10. Ruppert E.E., Fox R and Barnes R.D. (2004). Invertebrate Zoology. Thomson Books/Cole USA.

Paper II

General Zoology

90 hrs.

The paper, General Zoology is expected to give an insight into various branches of Zoology for students who are studying Zoology as a subsidiary subject.

Part A Physiology

30 hrs.

Unit I Nutrition

2 hrs.

Classification of food components. Brief mention of malnutrition disorders - PEM- Vitamin deficiencies, Mineral deficiencies (Iron, Calcium and Iodine).

Unit II Respiration

4 hrs.

Transport of Oxygen and carbon dioxide in blood. Respiratory disturbance- very brief mention of Apnoea, Dyspnoea, Hypoxia, Hyper and Hypo capnia, Asphyxia and Carbon Monoxide Poisoning. Smoking and its Physiological effects.

Unit III Circulation and Heart

5 hrs.

Blood - composition and functions (self-study). Mechanism of blood clotting (Intrinsic and extrinsic Pathways). Disorders of blood clotting (Haemophilia, Cerebral and Pulmonary Thrombosis, Cerebral Hemorrhage). Blood pressure and factors Controlling it. Electro cardiogram, Cardio vascular disorders - Arteriosclerosis, Occlusion, Angina Pectoris, Myocardial infarction. Angiogram and Angioplasty.

Unit IV Excretion and Osmoregulation

5hrs.

Structure of Human nephron (self study). Composition of urine - normal and abnormal constituents (self study) Urine formation (ultra filtration, selective reabsorption, tubular secretion and countercurrent mechanism). Hormonal control of renal function. Kidney disorders-myelonephritis, glomerular nephritis, nephrotic syndrome. Dialysis, artificial kidney, kidney transplantation.

Unit V Neuro Physiology

5 hrs.

Structure of typical neuron, myelinated and non-myelinated nerve fibres. Giant fibres (self study) Nerve impulse : initiation and propagation of nerve impulse, all or none law, refractory period, saltatory conduction. Synaptic transmission, neuro transmitters. Brain waves, electroencephalogram. Neural disorders - Parkinson's disease, epilepsy, schizophrenia, Alzheimer's syndrome dyslexia.

Unit VI Muscle physiology

4 hrs.

Striated, non striated and cardiac Muscle (self study). Ultra structure of striated muscle fibre. Mechanism of muscle contraction. Threshold and spike potential. All or none law, Fatigue, Oxygen debt and rigor mortis.

Unit VII Endocrinology

5 hrs.

Endocrine glands and their hormones, mode of action (in brief) : Hypothalamus, Pituitary, Thyroid, Parathyroid, Thymus, Islets of Langerhands, Adrenal, Testis and ovary. Hormonal disorders.

Part B Developmental Biology and Human Genetics

14 hrs.

Unit I Developmental Biology

7 hrs.

Types of eggs types and pattern of cleavages. Blastulation : Blastula formation, types of blastula. Gastrulation : Morphogenetic movements (In brief)- invagination involution, epiboly and delamination. Very brief descriptions of organizers, embryonic induction, cloning experiments in animals and man, embryonic stem cell research.

Unit II Human genetics

7 hrs.

Normal chromosomal compliment, karyotype study. Syndromes - autosomal anomalies (down syndrome, Edwards syndrome), sex chromosomal anomalies (Turner's syndrome, Klinefelter's syndrome). Genetic disorders - single gene (sickle cell anaemia, phenyl ketonuria), multifactional (cleft lip and palate).

Prenatal diagnostic techniques-Amniocentesis, chronic villus sampling, ultrasound scanning. Brief accounts of Genetic counselling, Human Genome Project, human gene therapy, AIDS, test tube babies, cytogenetics of cancer.

Part C Applied Zoology 24 hrs.

Unit I Aqua Culture 10 hrs.

Traditional methods of aquaculture (in brief). Common culture fishes of Kerala (self study). Pond culture (construction, maintenance). Brief descriptions of Carp Culture, Mussel Culture, composite fish culture, paddy cum prawn culture, induced breeding, fish diseases. Fish preservation and processing.

Unit II Aquarium Management 2 hrs.

Setting up of an aquarium tank, biological filter and aeration, common species of aquarium fishes.

Unit III Apiculture 5 hrs.

Species of honey bees, organization of honey bee colony, bee keeping equipments, apiary management and maintenance, bee pasturage, composition of honey and wax, their uses.

Unit IV Sericulture 4 hrs.

Species of silkworms, life history of silkworm. Silk worm rearing techniques, diseases and pests of silkworms (in brief). Processing of cocoon.

Unit V Vermiculture 3 hrs.

Species of earth worms suitable for vermiculture, reproduction and life cycle, chemical effects vermiculture and composting: site selection, cement pit, soil pit, preparation of pit, selection of worms, maintenance and monitoring.

Part D Molecular Biology and Biotechnology 10 hrs.

Unit I Genes and gene action : 4 hrs.

Concept of genes. DNA and RNA Gene action through protein synthesis (in brief). One gene one enzyme hypothesis. Lac operon concept. gene regulation.

Unit II Biotechnology 6 hrs.

Definition and scope. DNA finger Printing. Genetic engineering: transformation and transduction. DNA hybridization identification, slicing, cloning and splicing of gene (mention the role of restriction endonucleases, ligases and phasmid or phage vector). Modern trends : virus mediated gene transfer, DNA mediated gene transfer, gene therapy. Mention briefly practical application of biotechnology.

Part E Evolution and Zoogeography 12 hrs.

Unit I Organic Evolution 3 hrs.

Theories of organic evolution : Lamark's theory, Darwin's theory of Natural selection. Mutation theory.

Unit II Modern concepts of organic evolution (Neo Darwinism) 5 hrs.

Genetic basis of variation, Hardy-Weinberg equilibrium. Changes in gene frequencies-role of population size, nonrandom mating, mutation, genetic drift, selection and migration. Punctuated equilibrium.

Unit III Nature of evolution 2 hrs.

Isolation and isolating mechanisms. Speciation - sympatric and allopatric speciation. Adaptive radiation (in brief).

Unit IV Zoogeographical realms : 2 hrs.

Only brief account of the area included, physical features and fauna. Palaearctic, Ethiopian, Oriental, Australian, Nearctic, Neotropical. Barriers in animal distribution.

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Zoogeography The Geographical Distribution of Animals, Rober K. Krieger Publications, New York.

PRACTICALS

1. Morphology (Scientific Drawing)

The Student is expected to make scientific sketches of any TEN specimens (belonging to the various phyla) which are locally available.

2. Anatomy

Study of section : Fasciola T.S., Earthworm T.S.

Dissections

Rana - Demonstration only

Blood Vascular System	:	Rana Arterial System
Nervous System	:	Rana Vth & IXth Cranial nerves and 1st Spinal nerve, Brain
Skeletal System	:	Rana Hyoid apparatus in situ

Prawn - Nervous System

Cockroach - Nerve System

3. Taxonomy

Identification

Simple Identification

Identify the group-wise number of animals by their generic names and 25% of them by their specific names Protozoa - 2, Coelenterata - 4, Helminthes-2, Annelida-2, Arthropoda-10, Mollusca-4, Echinodermata-2, Prochordata-2, Pisces-10, Amphibia-3, Reptilia-5, Aves-2, Mammalia-2

General Identification

A few culturable fishes, 4 species of bees, different types of bees (worker, drone and queen) 2 species of earthworms, bee keeping equipment.

Taxonomic Identification

A few common snakes (Naja, Bungarus Vipera, Tropidonotus, Ptyas, Python, Typhlops, Eryx, Dryophis) using a key.

Osteology

Frog vertebrae and girdles.

Physiology

1. Blood smear of man.
2. Qualitative analysis of reducing sugar, protein and lipid (no mixtures).
3. Action of salivary amylase on starch.
4. Estimation of haemoglobin (demonstration only).

Record

The record must have an attendance certificate showing the percentage of attendance as per the register maintained in the department.