



MAHATMA GANDHI UNIVERSITY
Priyadarshini Hills, Kottayam 686 560

CURRICULUM OF
CHOICE BASED CREDIT SYSTEM
FOR
UNDERGRADUATE
ZOOLOGY PROGRAMME
2017 ADMISSION ONWARDS

SEMESTER 1. ZY1CRT01. CORE COURSE 1.

GENERAL PERSPECTIVES IN SCIENCE & PROTISTAN DIVERSITY

36 Hrs

Credits 2

Objectives:

- To create an awareness on the basic philosophy of science, concepts and scope
- To understand different levels of biological diversity through the systematic classification
- To familiarize taxa level identification of animals
- To make interest in Protistan diversity
- To impart knowledge on parasitic forms of lower invertebrates.

PART I PERSPECTIVES IN SCIENCE

8Hrs

Module I Introduction to Scientific Studies

4Hrs

Types of knowledge: practical, theoretical, and scientific knowledge. What is science, features of science, Deductive and inductive models, scientific temper, empiricism vocabulary of science.

Module II What is Biology?

4 Hrs

Life and its manifestations, History of Biology: Biology in ancient times Landmarks in the progress of Biology. Branches of Zoology , Scope of Zoology

PART II SYSTEMATICS

10 Hrs

Module III–Taxonomical Principles and tools

Systematic, Taxonomy, Phylogeny [Brief account] , Approaches to taxonomy, Molecular taxonomy, .Bar coding. Zoological nomenclature, International Code of Zoological Nomenclature (ICZN), Law of Priority. Five Kingdom Classification; Linnaean classification, Basis for Animal kingdom classification [Levels of organization, Symmetry, Coelom]

Identification tools

Taxonomic key. Types: Single access key- Dichotomous [linked and nested] and Polytomous key, Multi access key, Computer aided Interactive Key

Advantages and Disadvantages

PART III: PROTISTAN DIVERSITY

18 Hrs

Module IV – Kingdom Protista Type: *Paramecium*

5 Hrs

Salient features of Kingdom Protista

10 Hrs

Classification of Protista up to phyla

1. Phylum Rhizopoda :Eg. *Amoeba*
2. Phylum Actinopoda : Eg. *Actinophrys*
3. Phylum Dinoflagellata : Eg. *Noctiluca*
4. Phylum Parabasalia : Eg. *Trychonympha*
5. Phylum Metamonada : Eg. *Giardia*
6. Phylum Kinetoplasta : Eg. *Trypanosoma*
7. Phylum Euglenophyta : Eg. *Euglena*
8. Phylum Cryptophyta : Eg. *Cryptomonas*
9. Phylum Opalinata : Eg. *Opalina*
10. Phylum Bacillariophyta :Eg. Diatoms
11. Phylum Chlorophyta :Eg. *Volvox*
12. Phylum Choanoflagellata :Eg. *Proterospongia*
13. Phylum Ciliophora : Eg. *Balantidium coli*
14. Phylum Sporozoa : Eg. *Plasmodium*
15. Phylum Microsporidia :Eg. *Nosema*
16. Phylum Rhodophyta :Eg. Red Alga

(Mention any five general characters for each phylum. Detailed accounts of examples are not necessary.)

General Topics:

3 Hrs

1. Parasitic protists (diseases mode of transmission and prophylactic measures) -
Entamoeba, Trypanosoma, Plasmodium (detailed account of life cycle), Leishmania .

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SEMESTER 1

CORE COURSE PAPER 1

PERSPECTIVES IN SCIENCE & PROTISTAN DIVERSITY

(PRACTICAL)

36 Hrs

2 Credits

1. Taxa, identification techniques
Bird body parts
Butterfly/ dragonfly body parts
2. Identification using keys
Insect, Fish, Snake (Poisonous & Non Poisonous)
(Any 3 specimens from each category)
3. General identification - The students are expected to identify any 6 Protiatans studied by their generic names and write the general characters of their Phylum.
4. Identification of any 4 economically important protists/parasitic protists
(Slides/figures may be used for identification)
5. Identification of two Protistan from pond water

SEMESTER 11. ZY2CRT02

CORE COURSE 11: ANIMAL DIVERSITY - NON CHORDATA

36 Hrs

Credits 2

Objectives:

- To create appreciation on diversity of life on earth
- To understand different levels of biological diversity through the systematic classification of invertebrate fauna
- To familiarize taxa level identification of animals
- To understand the evolutionary significance of invertebrate fauna

- To instill curiosity on invertebrates around us
- To impart knowledge on parasitic forms of lower invertebrates.

MODULE I Kingdom Animalia

7 Hrs

Outline classification of Kingdom Animalia

Three branches - **Mesozoa, parazoa and Eumetazoa**

Mesozoa: Phylum Orthonectida - eg. *Rhopalura* (mention 5 salient features)

Parazoa:

1. Phylum Placozoa – Eg. *Trycoplax adherens*

2. Phylum Porifera – Classification upto classes; Mention gemmules

Class I- Calcarea. Eg. *Sycon*.,

Class II – Hexactinellida .Eg. *Euplectella*.

Class III - Demospongia Eg. *Cliona*.

General Topics

1. Canal system in sponges.

Phylum Coelenterata -Classification upto classes

Class I - Hydrozoa Eg. *Obelia* - mention Metagenesis

Class II- Scyphozoa Eg. *Rhizostoma*.

Class III- Anthozoa Eg. *Metridium*.

General Topics:

1. Coral and coral reefs with special reference to conservation of reef fauna.

2. Polymorphism in Coelenterates

Phylum Ctenophora - Eg. *Pleurobrachia*.

MODULE II

Phylum Platyhelminthes Salient features; classification up to classes **3 Hrs**

Class I - Turbellaria. Eg. *Planaria*.

Class II –Trematoda Eg. *Fasciola*

Class III- Cestoda Eg. *Taenia saginata*.

General Topics:

1. Life history of *Fasciola hepatica*.

2. Platyhelminth parasites of Man and Dog (*Schistosoma*, *Taenia solium*, *Echinococcus*).

Phylum Nematelminthes(Nematoda)

2 Hrs

Salient features, classification up to classes

Class: Phasmidia Eg. *Enterobius*,

Class: Aphasmidia Eg. *Trichinella*

General Topic

Pathogenic nematodes in man. (*Wuchereria bancrofti*, *Ascaris lubricoides*, *Ancylostoma duodenale*, *Trichinella*).

Phylum Annelida:

2 Hrs

Salient features, Classification upto classes.

Class I- Archiannelida Eg. *Polygordius*

Class II -Polychaeta Eg. *Chaetopterus*

ClassIII- Oligochaeta Eg. *Megascolex*.

Class IV- Hirudinea Eg. *Ozobranchus*, *Hirudinaria*

MODULE III

14 Hrs

Phylum Onychophora

Eg. *Peripatus* (Mention its affinities).

Phylum Arthropoda Salient features, Classification upto classes

Type: Prawn –*Fenneropenaeus (Penaeus)*

1. Sub Phylum - Trilobitomorpha

Class -Trilobita (mention the salient features).

Eg. *Triarthrus* – A trilobite (extinct)

2. Subphylum –Chelicerata

Class 1 Merostomata (Xiphosura) (Eg. *Limulus*)

Class 2. Arachnida (Eg., *Palamnaeus*- Scorpion)

Class 3 Pycnogonida (Eg. *Pycnogonum* – Sea spider)

3. Subphylum- Crustacea

Class 1 Branchiopoda Eg. *Daphnia*

Class 2 Ostracoda Eg. *Cypris* -seed shrimp

Class 3 Copepoda Eg. *Cyclops*

Class 4 Remipedia Eg. *Speleonectes* (eyeless crustacean seen in caves)

Class 5. Branchiura Eg., *Argulus* (common fish louse)

Class 6 Cirripedia Eg. *Sacculina* (parasitic castrator of crabs)

Class 7 Malacostraca Eg. *Squilla* (spot tail mantis shrimp)

4. Subphylum- Uniramia

Class 1 Chilopoda Eg. *Scolopendra* – (Centipede)

- Class 2 Symphyla Eg. *Scutigereella* – (garden centipedes or pseudocentipedes)
- Class 3 Diplopoda Eg. *Spirostreptus*- (Millipede)
- Class 4 Pauropoda Eg. *Pauropus*
- Class 5 Hexapoda (Insecta) Eg. *Bombyx mori* – (silk moth)

MODULE IV

Phylum Mollusca

3 Hrs

Salient features, Classification upto classes

- Class I- Aplousobranchia Eg. *Neomenia*
- Class II- Monoplacophora Eg. *Neopilina*
- Class III Amphineura Eg. *Chiton*
- Class IV Gastropoda Eg. *Aplysia*
- Class V Scaphopoda Eg. *Dentalium*
- Class VI Pelecypoda (Bivalvia) Eg. *Pinctada*
- Class VII Cephalopoda Eg. *Sepia*

Phylum Echinodermata

3 Hrs

Classification upto classes

- Class I- Asterozoa Eg. *Astropecten*
- Class II- Ophiurozoa Eg. *Ophiothrix*
- Class III- Echinozoa Eg. *Echinus*
- Class IV- Holothurozoa Eg. *Holothuria*
- Class V – Crinozoa Eg. *Antedon*

General Topics

1. Water vascular system in Echinodermata

Phylum Hemichordata:

2 Hrs

Eg. *Balanoglossus*

Minor Phyla

1. Chaetognatha Eg. *Sagitta*
2. Sipunculida Eg. *Sipunculus*

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PRACTICAL

ANIMAL DIVERSITY- NON CHORDATA

36 Hrs.

Credit 1

Scientific Drawing:-

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

Anatomy:-

Study of sections. (Any two)

1. Hydra.
2. Ascaris(male and female)
3. Earthworm
4. Fasciola

Dissections

1. Prawn - Nervous system
2. Cockroach - Nervous system

Mounting:-

1. Prawn appendages.
2. Mouth parts - Cockroach/ Plant bug/ House fly / Mosquito. (Any Three)

Identification:-

General identification &classification - The students are expected to identify, classify and describe the following Phylum -wise number of animals by their common names, generic names and 30% of these by their scientific names. Porifera-1, Coelenterata-3, Platyhelminthes-2, Annelida-2, Arthropoda-5, Mollusca- 4, Echinodermata-3

Identification of (a) Parasitic protest – any 2 (b) larval forms of *Fasciola*- any 2 (c) Nematode parasites of man- any 3 (Slides/figures may be used for study)

Taxonomic identification with key:-

Identification of insects up to the level of Order (any Four).

SEMESTER 111. ZY3CRT03

CORE COURSE 111: ANIMAL DIVERSITY –CHORDATA

54 Hrs

3 Credits

Objectives

- To acquire in depth knowledge on the diversity of chordates and their systematic position.
- To make them aware of the economic importance of some classes.
- To understand the evolutionary importance of selected chordate groups

MODULE I

Introduction

1 Hr

General Characters and outline classification of Chordata up to class, Origin of Chordates – mention theories in brief

Protochordates: General characters and Classification

2 Hrs

1. Sub phylum: Urochordata

Class I Larvacea Eg. *Oikopleura*

Class II Ascidiacea Eg: *Ascidia* (Mention Retrogressive Metamorphosis)

Class III Thaliacea Eg: *Doliolum*

2. Sub phylum: Cephalochordata

2 Hrs

Example - *Amphioxus* (Structure and affinities)

MODULE II

3. Sub phylum: Vertebrata General characters and Classification

2 Hrs

4. Division 1– Agnatha

Class I Ostracodermi Eg: *Cephalaspis*

Class II Cyclostomata Eg: *Petromyzon*

Division 2 – Gnathostomata

10 Hrs

Super class Pisces General Characters and Classification

Class: Chondrichthyes - General Characters

Sub class – Elasmobranchi Eg: *Narcine*

Sub class - Holocephali Eg: *Chimaera*

Class: Osteichthyes - General Characters

Sub class – Choanichthyes

Order 1 Crossopterigii(Coelocanth) Eg: *Latimeria*(Evolutionary Significance)

Order 2 Dipnoi Eg: *Lepidosiren* - Distribution, affinities and systematic position of lung fishes.

Sub class: - Actinopterygii

Super order 1. Chondrostei Eg: *Acipenser*

Super order 2. Holostei Eg: *Amia*

Super order 3. Teleostei Eg: *Sardine*

General topics

1. Accessory respiratory organs in fishes.
2. Parental care in fishes.
3. Scales in fishes.
4. Migration in fishes

MODULE III

Super class: Tetrapoda General characters, Classification up to Orders **11 Hrs**

Class Amphibia - Type Frog (*Euphlyctis hexadactylus*)

Order I Anura Eg: *Hyla*

Order II Urodela Eg: *Amblystoma* (mention axolotl larva and Paedomorphosis /neotony)

Order III Apoda Eg: *Ichthyophis*.

Class Reptilia

4 Hrs

Sub class I: Anapsida

Order Chelonia Eg: *Chelone*

Sub class II: Parapsida Eg: *Ichthyosaurus*

Sub class III: Diapsida

Order I Rhynchocephalia Eg: *Sphenodon*

Order II Squamata Eg: *Chamaleon*

Order III. Crocodilia Eg: *Crocodylus*

Sub class IV: Synapsida Eg: *Cynognathus*

General topic

Identification of poisonous and non-poisonous snakes

Class Aves

5 Hrs

Sub class I: Archeornithes Eg: *Archaeopteryx* (Affinities)

Sub class II: Neornithes

Super order I: Palaeognathe Eg: *Struthio*

Super order II: Neognathe Eg: Brahminy kite

General topics

1. Migrations in birds
2. Flight adaptations in birds

MODULE IV

Class Mammalia Type: Rabbit (*Oryctolagus cuniculus*)

17 Hrs

Brief mention of general characters and classification up to order with example. (Mention any five salient features of each order, detailed accounts of examples are not necessary)

Sub class I: Prototheria Eg: Echidna, *Ornithorhynchus*

Sub class II: Metatheria Eg: *Macropus*

Sub class III: Eutheria

Order 1 Insectivora	Eg: <i>Talpa</i>
Order 2 Dermoptera	Eg: <i>Galeopithecus</i>
Order 3 Chiroptera	Eg: <i>Pteropus</i>
Order 4 Primates	Eg: <i>Loris</i>
Order 5 Carnivora	Eg: <i>Panthera</i>
Order 6 Edentata	Eg: <i>Armadillo</i>
Order 7 Pholidota	Eg: <i>Manis</i>
Order 8 Proboscidea	Eg: <i>Elephas</i>
Order 9 Hydracoidea	Eg: <i>Procavia</i>
Order 10 Sirenia	Eg: <i>Dugong</i>
Order 11 Perissodactyla	Eg: <i>Rhinoceros</i>
Order 12 Artiodactyla	Eg: <i>Camelus</i> -mention ruminant stomach
Order 13 Lagomorpha	Eg: <i>Oryctolagus</i>
Order 14 Rodentia	Eg: <i>Hystrix</i> (Porcupine)
Order 15 Tubulidentata	Eg: <i>Orycteropus</i>
Order 16 Cetacea	Eg: <i>Delphinus</i>

General topics

1. Dentition in Mammals
2. Aquatic Mammals and their adaptations.

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PRACTICAL

ANIMAL DIVERSITY - CHORDATA

36 Hrs

Credit 1

1. Scientific Drawing

Make scientific drawing of 5 locally available vertebrate specimens belonging to different classes

2. Dissections

Frog: Photographs/diagrams/one dissected & preserved specimen each/models may be used for study.

1. Frog Viscera
2. Frog Digestive System
3. Frog Arterial System
4. Frog 9th & 1st Spinal nerve
5. Frog Sciatic Plexus
6. Frog Brain

3. Mounting of placoid scales; study of cycloid and ctenoid scales

4. Osteology

Frog vertebrae - typical, atlas, 8th and 9th

Rabbit – Atlas, Axis and typical vertebra

Pectoral and pelvic girdles of Frog and Rabbit

Bird - Keel and Synsacrum

Turtle/Tortoise - plastron and carapace

5. Study of sections.

Amphioxus T. S. through pharynx/T.S. through intestine

6. Identification:-

General identification-

Identify, classify and describe the following animals by their generic names and 30 % of them by their scientific names.

Protochordata-1, Pisces-5, Amphibia-5, Reptilia- 5, Aves-2, Mammalia-2.

Taxonomic identification with key:-

- i) Identification of fishes up to the level of order.
- ii) Identification of snakes up to family.

SEMESTER IV. ZY4CRT04

CORE COURSE IV

RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS

54 Hrs

3 Credits

Objectives

1. To familiarise the learner the basic concept of scientific method in research process.
2. To have a knowledge on various research designs.
3. To develop skill in research communication and scientific documentation.
4. To create awareness about the laws and ethical values in biology.
5. To equip the students with the basic techniques of animal rearing collection and preservation
6. To help the student to apply statistical methods in biological studies.

RESEARCH METHODOLOGY

Module I

13 Hrs

Basic concepts of research: Meaning, Objectives, Approaches, Types of research.

Research Process: Scientific method in research (eight steps).

Importance of literature reviewing in defining a problem,

Identifying gap areas from literature review.

Research Communication and scientific documentation: Project proposal writing,

Research report writing, (Structure of a scientific paper), Thesis, dissertation, research article.

Presentation techniques: Oral presentation, Assignment, Seminar, Debate, Workshop,

Colloquium, Conference

Sources of Information: Primary and secondary sources. Library- Books, Journals,

Periodicals, Reviews, Internet.

Search engines Online libraries, e-Books, e-Encyclopedia, Institutional Websites.

Plagiarism

Module II

12 Hrs

Animal Collection – Tools & techniques

Sampling techniques

 Quadrat

 Line transect

Measurements

 Density

 Abundance

 Frequency

Biodiversity indices – concepts

 Simpson index

Collection methods, techniques and equipments

 Plankton

 Insects

 Fish

Bird

Preservation techniques – Taxidermy

Rearing techniques

Laboratory and field.

Units of measurements- units, SI system, Equivalent weight, normality, molarity

BIOPHYSICS

Module III

14 Hrs

Basic understanding on principle and uses of the following:

Microscopy

(a) Light microscopy, Bright field (Compound Microscope), Phase contrast, Dark field microscopy, Fluorescence, Polarization microscopy, Video microscopy.

(b) Electron - Scanning (SEM), Transmission (TEM) and STEM

Micrometry – Stage and Eyepiece micrometers

Camera Lucida

Instrumentation

pH Meter

Separation Techniques: Centrifuge, Chromatography, Electrophoresis

Analytical techniques: Colorimeter, Spectrophotometer, X-ray crystallography

BIOETHICS

Module IV

5 Hrs

Bioethics : Introduction, Animal rights and animal laws in India, Prevention of cruelty to animals Act 1960, Biodiversity Act 2003.

Concept of 3 R – conservation (Refined- to minimize suffering, Reduced – to minimize animals, Replaced – modern tools and alternate means), Animal use in research and education.

Laboratory animal use, care and welfare, Animal protection initiatives- Animal Welfare Board of India, CPCSEA, ethical commitment. Working with human: Consent, harm, risk and benefits.

Module V

Sample & Sampling techniques: Collection of data, classification of data, frequency distribution tables, graphical representation: - Bar diagrams, Histogram, Pie diagram and Frequency curves - Ogives.

Measures of Central Tendency: Mean, Median, Mode (Problem - Direct method only)

Measures of dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Standard error. (Merits & demerits and problems on SD).

Correlation: Definition, Types of correlation.(mention in brief)

Test of Hypothesis and Test of Significance: Basic concept, Levels of significance, test of significance, Procedure for testing hypothesis, types of hypothesis- Null hypothesis and Alternate hypothesis.

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CORE COURSE IV

RESEARCH METHODOLOGY, BIOPHYSICS AND BIOSTATISTICS

(PRACTICAL)

2 credits

PART A. RESEARCH METHODOLOGY

Animal collection Tools, Techniques & Estimation

1. Quadrature study
2. Transect study
3. Sampling Methods
4. Species area curve
5. Simpson index

PART B - BIOPHYSICS

1. Study of simple and compound light microscopes
2. Micrometry –calibration and measurement of microscopic objects –low power
3. Camera Lucida (draw a few diagrams using Camera Lucida)
4. Paper chromatography (demonstration only)
5. Instrumentation – demonstration (write notes on principle, equipment and its use)
pH Meter, Colorimeter/ Spectrophotometer, Centrifuge

PART C BIOSTATISTICS

1. MS Excel : To create mean and median, Construction of bar diagram, Pie diagram and Line graphs.
2. MS Access: To create grade of students
3. Internet: Access a web page on any biological topic.
4. Frequency distribution of the given samples to find out arithmetic mean, median, mode.
5. Range and standard deviation for a biological data
6. Correlation using any biological data.

7. Graphical representation of data. Construction of bar diagrams, Histograms, Pie diagram and Line graphs.

SEMESTER V. ZY5CRT05

CORE COURSE V

ENVIRONMENTAL BIOLOGY AND HUMAN RIGHTS

54 Hrs

Objectives

To instill the basic concepts of Environmental Sciences, Ecosystems, Natural Resources, Population, Environment and Society

To make the students aware of natural resources, their protection, conservation, the factors polluting the environment, their impacts and control measures.

To teach the basic concepts of toxicology, their impact on human health and remedial measures

To create a consciousness regarding Biodiversity, environmental issues & conservation strategies

To develop the real sense of Human rights – its concepts & manifestations

MODULE 1 ECOSYSTEM

12 Hrs

Basic concepts of ecosystem Components of ecosystem: Abiotic (Sunlight, temperature, soil, water, atmosphere) and Biotic components (Producers, consumers, decomposers), Ecological pyramid- number, biomass, energy, **Functions of ecosystem:** Productivity-Food chain-Food web-Energy flow-Laws of Thermodynamics.Types of Ecosystem: Terrestrial-Forest-Grassland-Desert, Aquatic-Marine-Fresh water, Wetland &Biome **Concept of limiting factors:** Liebig's and Shelford's laws of limiting factors.

Biogeochemical cycles: Concept, gaseous and sedimentary cycles, Carbon cycle, Nitrogen cycle.
Renewable resources (solar, wind, hydroelectric, biomass and geothermal) **and Non renewable resources** (mineral and metal ore, fossil fuels)

MODULE 2 CONCEPTS OF POPULATION AND COMMUNITY 8 Hrs

Concept of population: Population attributes- Population growth forms, Basic concepts of growth rates, density, natality, mortality, growth curves

Animal interactions: Positive- Commensalism- Mutualism-Protocooperation, Negative-Predation- Parasitism-Competition-Antibiosis

Characteristics of a community: Species diversity- richness, evenness, stratification, dominance, ecological indicators, Ecotone and Edge effect, Keystone species, Concepts of Ecological Niche and Guild, Ecological succession, community evolution- climax.

MODULE 3 BIODIVERSITY AND ENVIRONMENTAL ISSUES 16 Hrs

Introduction to Biodiversity: Types of biodiversity- Alpha, Beta and Gamma diversity. **Concept and importance of Biodiversity:** Levels of Biodiversity-Species diversity, Genetic diversity, Microbial, Ecosystem diversity, India as a mega-diversity nation, Biodiversity hotspots

Global Environmental Issues: Ozone depletion, Greenhouse effect, Global warming, Climate change, Carbon trading, carbon credit; Carbon sequestration, Acid rain, Oil spills, Nuclear accidents, IPCC/UNFCCC.

National Environmental issues: Deforestation, forest fire, pollution (air, water, soil, noise thermal, nuclear- brief account only) solid waste management, sewage, drinking water crisis and water logging,

Toxic products and disaster: Types of toxic substances – degradable, non degradable, Impact on human – case studies: Endosulphan tragedy, Bhopal disaster

Flood, drought, cyclone, earthquake and landslide (Management and mitigation)

Local Environmental issues: Landscape alteration, sand mining, quarrying, changing crop pattern, conversion of paddy lands,

Threats to water resources of Kerala: Degrading Mangrove and wetland ecosystems of Kerala,

RAMSAR sites, Marine ecosystem crisis- pollution, overfishing etc. Impact of tourism on Environment.

MODULE 4 CONSERVATION OF BIODIVERSITY

12 Hrs

Protected area concept – Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept. Conservation reserves

Concept of threatened fauna – IUCN categories - extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern and data deficient. Red and Green Data Books.

Man–animal conflict (Tiger, Elephant, Dog, Monkey) – causes and concern

Water conservation- rainwater harvesting, watershed management

Environment education

Environmental laws (Brief account only): The Water (Prevention and Control of Pollution) Act, 1974, The Air (Prevention and Control of Pollution) Act, 1981, Indian Forests Act (Revised) 1982. The Environment (Protection) Act, 1986, Hazardous Wastes (Management and Handling) Rules, 1989, The Forest (Conservation) Act, 1980, The Wildlife Protection Act, 1972, Biodiversity Act, 2002.

MODULE 5 HUMAN RIGHTS

6 Hrs

Introduction, main concepts associated with Human Rights, Different types of human rights, Manifestations & phenomena, Role of agencies in promoting human rights, Mechanisms for checking violations of human rights, National human right commission, Constitutional provisions related to Human rights.

References

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3. Misra S.P., Pandey S.N. 2009 Essential Environmental Students, Ane books Pvt. Ltd.
4. P.D Sharma (2012), Ecology and Environment' - 11th Ed. Rastogi Publications

5. R.B Singh & Suresh Mishra PaulamiMaiti (1996), Biodiversity – Perception, Peril and Preservation’ — PHI Learning , Environmental Law in India: Issues and Responses
6. Rajagopalan,R. 2005.*Environmental Studies from Crisis to Cure*. Oxford University Press, New Delhi.
7. Paul R.C., 2000.Situations of Human Rights in India. Efficient offset printers. .
8. Arun kumar Palai(1999) National Human Rights Commission of India, Atlantic publishers
9. Sharma P.D. (2005)Environmental biology and Toxicology, Rastogi publication
10. Meera Asthana and Astana D.K.1990 Environmental pollution and Toxicology Alka printers.
11. Odum, E.P. 1971.Fundamentals of Ecology.W.B. Saunders College Publishing,Philadelphia
12. Alan Beeby, 2006 Anne – Maria Brennan First Ecology, Ecological principles and Environmental issues . International students edition Sec. edition Oxford University Press.
13. Robert Ricklefs (2001). The Ecology of Nature. Fifth Edition. W.H. Freeman and Company.
14. Stiling Peter (2002). Ecology: Theories and applications. Prentice Hall of India pvt.Ltd. New Delhi.
15. Landis, Wayne and Hing-hoYu, Baca Raton, 1995. Introduction to Environmental Toxicology: Impacts of chemicals upon Ecological systems: Lewis Publishers.

PRACTICAL ENVIRONMENTAL BIOLOGY & TOXICOLOGY

**36 HRS
CREDIT 1**

1. Estimation of dissolved Oxygen
2. Estimation of carbon di oxide
3. Estimation of soil organic carbon (Demonstration only)
4. Identification of marine/ fresh water planktons
5. Counting of plankton using plankton counting chamber
6. Study of equipments - Sechi disc, Plankton net
7. Study of sandy shore fauna, rocky shore fauna.
8. Study of animal Association
9. Visit to any two important areas of bio diversity: 1. Forest, 2.Sea shore, 3. Mangrove, 3.

Wet lands, 4. Bird sanctuary, 5. Wild life sanctuary, 6. Sacred groves
Field study (compulsory)

SEMESTER V. ZY5CRT06

CORE COURSE VI CELL BIOLOGY AND GENETICS

**54 Hrs
Credits 3**

Objectives

1. To understand the structure and function of the cell as the fundamentals for understanding the functioning of all living organisms.
2. To make aware of different cell organelles, their structure and role in living organisms.
3. To develop critical thinking, skill and research aptitudes in basic and applied biology
4. To emphasize the central role of genes and their inheritance in the life of all organisms.

CELL BIOLOGY

22 HRS

Module I

6 Hrs

Introduction of cell and Diversity of cells: History, Cell theory, Prokaryotes, Eukaryotes, Mycoplasmas, Virus, Virions and Viroids, Prions.

Cell membrane & Permeability: Molecular models of cell membrane (Sandwich model, Unit membrane model, Fluid mosaic model). Cell properties - permeability, Transport [Diffusion, Osmosis, Passive transport, Active transport, bulk transport], Cell coat and Cell recognition.

Module II

10 Hrs

Cell Organelles : Structure and functions of following cell organelles: Endoplasmic reticulum - Structure and functions. Ribosomes (Prokaryotic and Eukaryotic) Golgi complex - Structure and functions. Lysosomes - Polymorphism - GERL concept, functions.

Mitochondria - Structure and functions. Nucleus: Structure and functions of interphase nucleus, Nuclear membrane, pore complex, structure and functions of nucleolus

Chromosomes – Structure & organization, Heterochromatin, Euchromatin, Nucleosomes, Polytene chromosomes-Balbiani rings, Endomitosis, Lamp brush chromosomes.

Module III

6 Hrs

Cell Communication: Basic principles of cell communications, Cell signaling (in brief), Types of signaling, Mention signaling molecules (neurotransmitters, hormones, Growth Factors, Cytokines Vitamin A and D derivatives),

Cell Division: Cell cycle - G₁, S, G₂ and M phases, Mitosis and Meiosis. The difference between Mitosis and Meiosis.

References

- 1 Zoological Society of Kerala Study material. 2002. *Cell Biology, Genetics and Biotechnology*
2. Karp, G. (2010). *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
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14. James Darnell. (1998) *Molecular Biology*. Scientific American Books Inc
15. Ariel G Loewy Philip Sickevitz, John R. Menninger and Jonathan A.N. Gallants (1991) cell structure and function. Saunder's College Publication
16. James Darnell. (1998) *Molecular Biology*.Scientific American Books Inc.

GENETICS

32 Hrs

Module I

10 Hrs

Mendelian Genetics: Mendel's experiments- Monohybrid Cross, Dihybrid Cross, Mendel's Laws, Test Cross, Back Cross and Reciprocal Cross. Chromosome Theory of Inheritance

Interaction of genes: Allelic: Incomplete Dominance (Four O Clock Plant). Co- Dominance (Skin colour in Cattle) Lethal Alleles: Dominant lethal gene[Creeper chicken] and recessive lethal gene [cystic fibrosis].

Non Allelic: Complementary (Flower colour in Sweet Pea), Supplementary (Coat colour in mice), Epistasis - dominant (Plumage in poultry) and recessive (Coat colour in mice). Polygenes (Skin colour inheritance in man), Pleiotropism (Vestigial wing gene in *Drosophila*).

Multiple alleles – ABO Blood group system, Rh group and its inheritance. Erythroblastosis foetalis.

Module II

12 Hrs

Sex determination: Chromosome theory of sex determination (Autosome and Sex chromosomes), male heterogamy and female heterogamy, (xx-xy, xx-xo, ZZ-ZW, ZZ-ZO), Genic Balance theory of Bridges. Barr bodies, Lyon's hypothesis, Gynandromorphism, sex

mosaics, intersex (*Drosophila*), Hormonal [free martin in calf] and Environmental (Bonelia) influence on Sex determination

Recombination and Linkage: Linkage and recombination of genes based on Morgan's work in *Drosophila*, Linked genes, Linkage groups, Chromosome theory of Linkage, Types of linkage- complete and incomplete. Recombination, cross over value, chromosome mapping. [Definition]

Sex Linked inheritance : Characteristics of Sex Linked inheritance, X Linked inheritance of man (Hemophilia), Y linked inheritance [Holandric genes] , Incompletely Sex Linked genes or pseudoautosomal genes (Bobbed bristles in *Drosophila*), Sex limited genes (Beard in man) and Sex influenced genes (inheritance of baldness in man).

Module III

10 Hrs

Mutation: Types of mutations - Somatic, germinal, spontaneous, induced, autosomal and allosomal, chromosomal mutations, structural and numerical changes. Gene mutations. [Addition, Deletion and substitution].

Human Genetics: Karyotyping, Normal Human chromosome Complement, Pedigree analysis, Aneuploidy and Non- disjunction. Autosomal abnormalities (Down syndrome, Cry du chat syndrome) Sex chromosomal abnormalities (Klinefelters syndrome, Turner's syndrome) Single gene disorder (Brief mention) Autosomal single gene disorder [sickle cell anaemia), Inborn errors of metabolism such as phenylketonuria, alkaptonuria, , Albinism. Multifactorial traits – polygenic disorder- cleft lip and cleft palate.

Genetic Counseling, Eugenics and Euthenics -Brief account only

References

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2. Klug, W.S and Cummings,M.R. (2011). *Concepts of Genetics* (7th edn).Pearson Education Inc.India.
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SEMESTER V

CORE COURSE VI CELL BIOLOGY AND GENETICS (PRACTICAL)

36 Hrs

2 Credits

PART A: CELL BIOLOGY

1. Squash preparation of onion root tip for mitotic stages
2. Mounting of polytene chromosome (*Drosophila*/Chironomous.) Demonstration
3. Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone)
4. Identification of cell organelles
5. Preparation of temporary whole mount.
6. Preparation of permanent whole mount (demonstration)
7. Preparation of human blood smear and identification of Leucocytes

PART B : GENETICS

1. Genetic problems on Monohybrid, Dihybrid Crosses and Blood group inheritance
2. Study of normal male and female human karyotype (use photographs or Xerox copies)
3. Abnormal human karyotypes - Down, Edwards , Klinefelter and Turner syndromes

(use photographs or Xerox copies)

4. Sexing of *Drosophila*.

5. Study of Barr body in human buccal epithelium

SEMESTER V. ZY5CRT07

CORE COURSE - V11: EVOLUTION, ETHOLOGY & ZOOGEOGRAPHY

54 Hrs

Credits 3

Objectives:

- To acquire knowledge about the evolutionary history of earth - living and nonliving
- To acquire basic understanding about evolutionary concepts and theories
- To study the distribution of animals on earth, its pattern, evolution and causative factors
- To impart basic knowledge on animal behavioural patterns and their role

Prerequisite:

- Basic knowledge on principles of inheritance and variation
- Knowledge on molecular basis of inheritance
- Basic understanding on the mechanism and factors affecting evolution
- Knowledge on origin and evolution of man

PART I - EVOLUTION

30 Hrs

Module I - Origin of life

8 Hrs

Theories - Panspermia theory or Cosmozoic theory, Theory of spontaneous generation (Abiogenesis or Autogenesis), Special creation, Biogenesis, Endosymbiosis.

Chemical evolution - Haldane and Oparin theory, Miller-Urey experiment;

Direct evidences of evolution – Recapitulation Theory of Haeckel, Fossilization, Kinds of fossils, fossil dating, Homologous organs and analogous organs.

Module II - Theories of organic evolution

9 Hrs

Lamarckism and its Criticism, Weismann's Germplasm theory, Darwinism and its Criticism, Neo-Darwinism, Theory of De Vries,

Population genetics and evolution: Hardy-Weinberg Equilibrium, gene pool, gene frequency. Factors that upset Hardy-Weinberg Equilibrium, Effects of genetic drift on population: Bottleneck effect and founder effect

Module III – Nature of evolution

13 Hrs

Species and Speciation: Species concept, subdivisions of species (sub species, sibling species, cline and deme), Speciation: Types of speciation, Phyletic speciation (autogenous and allogenous transformations), True speciation, Instantaneous and gradual speciation, allopatric and sympatric speciation

Isolation: Types of isolating mechanisms-Geographic isolation (mention examples) and Reproductive isolation. Role of isolating mechanisms in evolution

Microevolution, Macroevolution (Adaptive radiation -Darwin finches) Mega evolution, Punctuated equilibrium, Geological time scale, and Mass extinction (brief account only). Evolution of Horse

PART II- ETHOLOGY

14 Hrs

Module IV – Introduction

1 Hr

Definition, History and scope of ethology

Module V – Learning, imprinting and behaviour

9 Hrs

Types of learning with examples; patterns of behaviors – types of rhythms, navigation, homing instinct, hibernation, aestivation; pheromones- types and their effect on behavior, hormones and their action on behavior (aggressive and parental behavior)

Module VI – Social organization

4 Hrs

Social organization in insects (ants) and mammals (monkey), Courtship behaviour and reproductive strategies

PART III- ZOOGEOGRAPHY

10 Hrs

Module VII – General Topics

4 Hrs

Continental drift theory, Types and means of animal distribution, Factors affecting animal distribution; insular fauna – oceanic islands and continental islands,

Module VIII - Zoogeographical realms

6 Hrs

Palearctic region, Nearctic region, Neotropical region, Ethiopian region, Oriental region, Australian region (brief account with physical features and fauna, Wallace's line, Weber's line, Biogeography of India with special reference to Western Ghats

References:

EVOLUTION

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ETHOLOGY

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2. Bonner, J.T. (1980). The Evolution of Culture in Animals. Princeton University Press. NJ, USA.
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5. Dunbar, R. (1988). Primate Social Systems. Croom Helm, London.
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- American Scientist 3rd Edn. Sinauer Associates Inc. MA,USA. (Module 10 & 11).
9. Wilson, E.O. (1975). Sociobiology. Harvard University Press, Cambridge, Mass. USA. (Module 9).

ZOOGEOGRAPHY

1. Briggs, J.C. (1996). Global Biogeography. Elsevier Publishers. (Module VI and VII).
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3. Chundamannil Mammen. 1993, History of Forest management in Kerala. Report No.89. Kerala Forest Research Institute, Peechi, India.
4. Daniels, R.J.R and Vencatesan J. (2008), Western Ghats Biodiversity. People Conservation; Rupa & Co. New Delhi. India.
5. Mani, M.S. (1974). Ecology and Biogeography of India; The Hague: .Dr. W. Junk b.v. Publishers,
6. Nair, C.S. (1991). The Southern Western Ghats: A Biodiversity Conservation Plan. INTACH, New Delhi.
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8. Tiwari, S. (1985), Readings in Indian Zoogeography (vol.1). Today & Tomorrow Printers & Publishers

PRACTICAL EVOLUTION, ETHOLOGY AND ZOOGEOGRAPHY

36 Hrs

Credit 1

1. Identification of Zoogeographical realms using map
2. Study on endemic species of each realm
3. Show the discontinuous distribution of (lung fishes, camel, elephant)
4. Providing a map trace the route of HMS Beagle
5. Providing a map mark any two continental/oceanic islands.: Greenland, Madagascar, New Zealand, New Guinea, Maldives, Iceland, Hawaii – any two
6. Contributions of scientists (showing photos) - Any four
7. Identification of different stages of horse evolution
8. Study on Homology and Analogy
9. Study on connecting links (*Peripatus*, *Archaeopteryx*, *Protopterus*, *Echidna*)

10. Pheromone traps
11. Skinner box & T Maze
12. Experiment to demonstrate phototaxis and chemotaxis using *Drosophila*/House fly
13. Identification of behaviour (Grooming/courtship dance of flamingos/stickle back fish/
Tail wagging dance/ Aggressive behaviour/ Auto/Allo grooming, Flehmen response)
showing pictures (Any five)

SEMESTER V. ZY5CRT08

CORE COURSE VIII

HUMAN PHYSIOLOGY, BIOCHEMISTRY, AND ENDOCRINOLOGY

54 Hrs

Credits 3

Objectives:

1. This course will provide students with a deep knowledge in biochemistry, physiology and endocrinology.
2. Defining and explaining the basic principles of biochemistry useful for biological studies for illustrating different kinds of food, their structure, function and metabolism.
3. Explaining various aspects of physiological activities of animals with special reference to humans.
4. Students will acquire a broad understanding of the hormonal regulation of physiological processes in invertebrates and vertebrates.
5. By the end of the course, students should be familiar with hormonal regulation of physiological systems in several invertebrate and vertebrate systems.
6. This also will provide a basic understanding of the experimental methods and designs that can be used for further study and research.

7. The achievement of above objectives along with periodic class discussions of current events in science, will benefit students in their further studies in the biological/physiological sciences and health-related fields, and will contribute to the critical societal goal of a scientifically literate citizenry.

HUMAN PHYSIOLOGY

31 Hrs

Module I

8 Hrs

Nutrition: Nutritional requirements – carbohydrates, proteins, lipids, minerals (Ca, P, Fe, I), vitamins (sources and deficiency disorders). Importance of dietary fibre and antioxidants. Balanced diet, Recommended Dietary Allowance (RDA). Nutrition during pregnancy and lactation, Infant nutrition, Malnutrition (PEM).

Digestion: Anatomy and histology of digestive glands (liver, pancreas, salivary, gastric and intestinal). Digestion and absorption of carbohydrates, proteins and fats. Nervous and hormonal control of digestion.

Module II

8 Hrs

Respiration: Phases of respiration (external respiration, gas transport and internal respiration). Respiratory pigments: Haemoglobin, Myoglobin (Structure and Function). Transport of respiratory gases - transport of oxygen, oxyhaemoglobin curve, factors affecting oxyhaemoglobin curve, transport of carbon dioxide, (chloride shift). Control of respiration. Respiratory disturbances (Hypoxia, Hypercapnia, Asphyxia). Physiological effect of smoking, carbon monoxide poisoning, Oxygen therapy and artificial respiration.

Circulation: ESR, Haemopoiesis, blood pressure, ECG. Haemostasis (blood coagulation) – clotting factors, intrinsic and extrinsic pathways, anticoagulants and its mechanism of action. Cardiovascular diseases (Jaundice, Atherosclerosis, Myocardial infarction, Thrombus, Stroke). Angiogram and angioplasty.

Module III

5 Hrs

Excretion: Histology of Bowman's capsule and tubular part. Urine formation – glomerular filtration, tubular reabsorption, tubular secretion. Urine concentration – counter current mechanism. Acid – base balance, hormonal regulation of kidney function. Renal disorders (kidney stone, acute and chronic renal failure, and dialysis). Homeostasis: Definition,

concept and importance in biological system. Thermal regulation and thermal adaptation in homeotherms.

Module IV

10 Hrs

Nerve physiology: Ultra structure of neuron. Nerve impulse production (resting membrane potential, action potential), transmission of impulse along the nerve fiber, interneuron (synaptic) transmission, neuromuscular junction and transmission of impulses. Neurotransmitters (acetyl choline, adrenalin, dopamine). EEG. Memory, Neural disorders (brief account on Dyslexia, Parkinson's disease, Alzheimer's disease, Epilepsy).

Muscle physiology: Ultra structure of striated muscle, muscle proteins (myosin, actin, tropomyosin, troponin), Muscle contraction and relaxation-Sliding Filament Theory, cross bridge cycle, biochemical changes and ATP production in muscle, Cori cycle. Kymograph, Simple muscle twitch, muscle fatigue, tetanus, rigor mortis.

BIOCHEMISTRY

15 Hrs

Module V

5 Hrs

Carbohydrates: Basic structure, biological importance and classification of monosaccharides, oligosaccharides, polysaccharides with examples.

Proteins: Basic structure and classification of amino acids; structure, biological importance and classification of proteins with examples.

Lipids: Structure of fatty acid, saturated and unsaturated fatty acid, biological importance and classification of lipids with examples.

Vitamins and minerals: Major fat soluble and water soluble vitamins. Important minerals and trace elements required for living organisms. Biological importance of vitamins and minerals.

Enzymes: Chemical nature of enzymes, enzyme activation, enzyme inhibition, allosteric enzymes, isoenzymes, co-enzymes. Michaelis–Menten enzyme kinetics.

Module VI

10 Hrs

Carbohydrate metabolism: Glycogenesis, Glycogenolysis, Gluconeogenesis, Hexose monophosphate Shunt, Glycolysis, Citric Acid Cycle, Electron Transport Chain and ATP synthesis. Ethanol metabolism.

Protein metabolism: Deamination, Transamination, Transmethylation, Decarboxylation, Ornithine cycle.

Lipid metabolism: Biosynthesis of fatty acids, Beta oxidation, physiologically important compounds synthesized from cholesterol.

ENDOCRINOLOGY

Endocrinology and reproduction **8 Hrs**

Module VII **8 Hrs**

Endocrine physiology: Hormones – classification and mechanism of hormone action. Major endocrine glands(Histology is not included) their hormones, functions and disorders (hypothalamus, pituitary gland, pineal gland, thyroid gland, parathyroid gland, islets of Langerhans, adrenal gland),. Homeostasis and feedback mechanism.

References

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Rastogi, S. C.; 2007; Outlines of Biochemistry . CBS Publishers, New Delhi.

Robert K. Murray and Victor W. Rodwell; 2012; Harper's Illustrated Biochemistry, Harper;. 29th edition (Lange basic science.)

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PRACTICAL

HUMAN PHYSIOLOGY, BIOCHEMISTRY, AND ENDOCRINOLOGY

36 Hrs

Credit1

HUMAN PHYSIOLOGY

- 1). Determination of haemoglobin content of blood
- 2). Total RBC count using Haemocytometer
- 3). Total WBC count using Haemocytometer
- 4). Estimation of microhaematocrit
- 5). Effect of hypertonic, hypotonic and isotonic solutions on the diameter of RBC.
- 6). Instruments: Kymograph, Sphygmomanometer and Stethoscope (principle and use)
- 7). Measurement of blood pressure using sphygmomanometer (demonstration only)

BIOCHEMISTRY

1. Qualitative analysis of protein, glucose, starch and lipids.
2. Chromatography – Determination of R_f value of amino acids and identification of amino acids (Identify the Amino Acids using different solvent front and solute front)

ENDOCRINOLOGY

1. Cockroach – Corpora cardiaca & Corpora allata (Demonstration)
2. Effect of adrenalin on heart beat of Cockroach (Demonstration)

SEMESTER VI. ZY6CRT09

CORE COURSE IX DEVELOPMENTAL BIOLOGY

54 Hrs

3 Credits

Objectives:

1. To achieve a basic understanding of the experimental methods and designs that can be used for future studies and research.
2. To provide the students with the periodic class discussions of current events in science which will benefit them in their future studies in the biological/physiological sciences and health-related fields
3. To contribute to critical societal goal of a scientifically literate citizenry.

Module 1

10 Hrs

Introduction: Definition, Scope of developmental biology, sub-divisions (descriptive, comparative, experimental and chemical), historical perspectives, basic concepts and theories.

Reproductive Physiology: Gonads- anatomy of testis and ovary, spermatogenesis, oogenesis, gonadal hormones and their functions. Hormonal control of human reproduction - Female reproductive cycles (Estrous cycle, Menstrual cycle). Structure of mammalian sperm and egg, Pregnancy, parturition and lactation. Reproductive health and importance of sex education.

Egg types: Classification of eggs based on the amount, distribution and position of yolk. Mosaic and regulative, cleidoic and noncleidoic eggs. Polarity and symmetry of egg.

Fertilization: Mechanism of fertilization-(Encounter of spermatozoa and Ova, Approach of the Spermatozoon to the Egg, Acrosome Reaction and Contact of Sperm and Ovum, Activation of Ovum, Migration of Pronuclei and Amphimixis,), Significance of fertilization, Polyspermy, Parthenogenesis- Different types and significance.

Module II

14 Hrs

Cleavage: Types, planes and patterns of cleavage, Cell lineage of Planaria. Influence of yolk on cleavage.

Blastulation: Morula, blastula formation, types of blastula with examples.

Fate maps: Concept of fate maps, construction of fate maps (artificial and natural), structure of a typical chordate fate map. Significance of fate map.

Gastrulation: Major events in gastrulation. Morphogenetic cell movements. Influence of yolk on gastrulation. Exogastrulation. Concept of germ layers and derivatives.

Cell differentiation and gene action: Potency of embryonic cells (Totipotency, Pleuripotency, Unipotency of embryonic cells). Determination and differentiation in embryonic development, Gene action during development with reference to Drosophila (maternal effect genes), Zygotic genes.

Module III

20Hrs

Embryology of Frog: Gametes, fertilization, cleavage, blastulation, fatemap, gastrulation, neurulation, notogenesis. Differentiation of Mesoderm and Endoderm, Development of eye. Metamorphosis of frog, Hormonal and environmental control.

Embryology of chick: Structure of egg, fertilization, cleavage, blastulation, fate map, gastrulation. Development and role of Primitive streak, Salient features of 18hour, 24 hour, 33 hour & 48 hour chick embryo. Extra embryonic membranes in chick.

Human development: Fertilisation, cleavage, blastocyst, implantation, placenta. Gestation, parturition and lactation. Human intervention in reproduction, contraception and birth control. Infertility, In vitro fertilization (test tube baby)

Module IV

5Hrs

Experimental embryology: Spemann's constriction experiments, Organizers and embryonic induction. Embryo transfer technology, cloning, stem cell research. Ethical issues.

Teratology / Dysmorphology, Developmental defects: Teratogenesis, important teratogenic agents.(Radiations, chemicals and drugs, infectious diseases) genetic teratogenesis in human beings,

Developmental defects: Prenatal death (miscarriage and still birth). Intrauterine Growth Retardation (IUGR).

Module V

5 Hrs

General topics: Classification and functions of placenta in mammals. Prenatal diagnosis (Amniocentesis, Chorionic villi sampling, Ultra sound scanning, Foetoscopy, Maternal serum alpha-fetoprotein, Maternal serum beta-HCG).Regeneration in animals.

References

Anthony S. Fauci, Eugene Braunwald, Dennis L. Kasper,Stephen L. Hauser, Dan L. Longo, J. Larry Jameson and Joseph Loscalzo; 2008; Harriosns Principles of Internal Medicine;

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Balnisky B.I.; 1981 An Introduction to Embryology, W.B. Saunders and Co.

Berril, N..J.; and Kars, G.; 1986. Developmental biology, Mc Graw Hills

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Majumdar N. N -1985 Vetebrate embryology; Tata McGraw-Hill, New Delhi

Melissa A & Gibbs, 2006; A practical Guide to Developmental Biology, Oxford university press (Int. student edition)

Scott F. Gilbert; 2003; Developmental biology; Sinauer Associates Inc.,U.S.; 7th Revised edition.

Vijayakumarn Nair, K. & George, P. V. 2002. A manual of developmental biology, Continental publications , Trivandrum

Taylor D J, Green NPO & G W Stout. (2008) Biological Science third edition. Cambridge

PRACTICAL
DEVELOPMENTAL BIOLOGY

36 Hrs

Credit 1

Model/Chart/ Slide may be used

1. Embryological studies- Blastula (frog, chick)
2. Embryo transfer, cloning, gastrula (frog, chick)
3. Amniocentesis
4. Embryotransfer technology, cloning
5. Study of placenta- pig and man
6. 18 hour, 24 hour, 33 hour and 48 hour chick embryo.
7. Candling method.
8. Vital staining- demonstration.
9. Male and female reproductive organs in cockroach
10. Calculate the fecundity of fish.
11. Calculate the gonado-somatic index of given fish.

SEMESTER VI. ZY6CRT10

CORE COURSE X. MICROBIOLOGY AND IMMUNOLOGY

54 Hrs

3 Credits

MICROBIOLOGY

Module I

10 Hrs

Introduction: History and scope of microbiology. Outline classification of Microbes.
(bacteria, fungus & virus)

Methods in Microbiology: Sterilization and disinfection - physical and chemical methods.

Culture media – selective media, enrichment media, differential media. Plating techniques and isolation of pure colony. Culture preservation techniques: refrigeration, deep freezing,

freezing under liquid nitrogen, lyophilization.

Module II

15 Hrs

Morphology and fine structure of bacteria: Size, shape, cilia, pili, flagella, capsule, cell wall and its composition. Cytoplasmic membrane, protoplast, spheroplast, intracellular membrane systems, cytoplasm, vacuoles, genetic material, cell inclusions, bacterial spores.

Bacterial growth Curve, Staining techniques – gram staining.

Bacterial Reproduction Sexual – (conjugation, transduction) and Asexual (budding, fragmentation). Virology: Structure of virus; Human, animal, and bacterial virus. Viral replication, cultivation of animal viruses.

Module III

8 Hrs

Infections & Diseases: Types of infections – primary, secondary and nosocomial infections.

(Brief Account only) Contagious diseases – epidemic, endemic and pandemic, mode of

Transmission – food, water, air, vectors and carriers.

Diseases: Epidemiology, symptomology, diagnosis and treatment. Bacterial - Clostridium tetany (tetanus), Viral – HIV virus (AIDS), fungal – *Candida albicans* (candidiasis).

IMMUNOLOGY

Module IV

9Hrs

Introduction to Immunology: Innate and acquired immunity, passive (natural and artificial) and active immunity (Natural and Artificial). Mechanisms of innate immunity - barriers, inflammation, phagocytosis.

Lymphoid organs: Primary (Thymus, Bone marrow) and secondary lymphoid organs (lymph nodes, spleen).

Lymphocytes: T and B cells, Natural killer cells, memory cells, macrophages.

Module V

9 Hrs

Antigens, Types of antigens, haptens, adjuvants, immunoglobulin structure, classes and functions of immunoglobulins.

Types of Immunity- , humoral & cell mediated immunity Monoclonal & polyclonal antibodies

Antigen – antibody reactions, Precipitation test, Agglutination test, VDRL WIDAL, ELISA. Auto immune diseases: Pernicious Anemia, Rheumatoid Arthritis. Immunodeficiency -

AIDS. Hyper sensitivity- Type I, (E.g. Anaphylaxis) II(Transfusion reaction) , III (Arthus reaction) and IV (Mantoux Test) (in brief).

Vaccines

3 Hrs

Introduction Types of vaccines, Current Vaccines, Recent trends in vaccine preparation

References

1. Ananthanarayan R & Jayaram Paniker C K. (2009) Text Book of Microbiology Orient Longman Private Ltd.
2. Gladys Francis & Mini K.D., (Editors) (2012), Microbiology, Zoological Society of Kerala, Kottayam.
3. Kuby J, Kindt T., Goldsby R. and Osborne B. (2007). Kuby immunology
4. Sharma K. (2005) Manual of Microbiology: Tools and Techniques, Ane books
5. Susan Panicker & George Abraham (Editors) (2008), Micro Biology and Immunology, Zoological Society of Kerala, Kottayam.
6. Coleman: (2002). Fundamentals of Immunology
7. Darla J. Wise & Gordon R. Carter: (2004): Immunology A Comprehensive Review Iowa state University Press. A Blackwell science company,
8. Hans G. Sch, Legal General Microbiology, Seventh Ed. Cambridge Low Price Ed.

9. Helen Hapel, Maused Harney Siraj Misbah and Next Snowden: (2006) Essentials of Clinical Immunology Fifth Ed. Blackwell Publishing Company,
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6. Ivan Roitt I (2002) Essentials of Immunology ELBS.

PRACTICAL

MICROBIOLOGY AND IMMUNOLOGY

72 Hrs

2 Credits

1. Instruments –Autoclave, Hot air oven, Bacteriological incubator – Laminar air flow
2. Preparation of solid and liquid media for microbial cultures.
(Ingradients, pH and method of preparation) (Demonstration)
(a) Solid media (1) Nutrient agar (2) Mac Conkey's agar
(b) Liquid Media(1) Nutrient broth (2) Peptone water.
3. Culture methods (Demonstration)
(a) Streak plate technique and isolation of pure colonies.
(b) Lawn culture (c) Pour plate culture (d) Liquid culture
4. Examination of microbes in living condition
Hanging drop method for demonstrating motility of bacteria.
5. Gram staining – preparation, procedure, identification of Gram + ve and Gram –ve bacteria.
6. Antibiotic sensitivity test (demonstration only)
7. Streak plating (individual performance)
8. Preparation of a fungal smear – Lactophenol cotton blue staining and mounting
9. Determination of ABO blood groups and Rh factor (Antigen – antibody Reaction)
10. Study through photographs/ illustration, the primary immune (Bone marrow and thymus) and secondary immune (spleen and lymph nodes) organs in Rat/Man

SEMESTER VI. ZY6CRT11

CORE COURSE XI.

BIOTECHNOLOGY, BIOINFORMATICS AND MOLECULAR BIOLOGY

BIOTECHNOLOGY

20 Hrs

Module I

11Hrs

Introduction: Scope, Brief History, Scope and Importance

Tools and Techniques in Biotechnology: Enzymes (restriction endonucleases, ligases, linkers & adapters), Vectors-[Plasmids, Phage vectors, Cosmids, Artificial Chromosomes] Host cells. Basic steps & techniques in rDNA technology

Gene Libraries, Construction of genomic library and cDNA Library. PCR technique and DNA amplification, Brief description of screening methods – Probes, Nucleic Acid hybridization, In situ Hybridization, Fluorescence in situ Hybridization (FISH), Colony hybridization. Methods of transfer of desired gene into target cell. Blotting Techniques- Southern, Northern, Western blotting. DNA Finger printing (DNA Profiling) and its application. Molecular markers - RFLP

Module II

9 Hrs

Animal Cell Culture: Brief account on methods, substrates, media and procedure of animal cell culture, Stem Cells, types and potential use, Organismal Cloning- reproductive & therapeutic- brief account only.

Applications of Biotechnology: Applications in Medicine (insulin, growth hormone, gene therapy), Agriculture (GM plants and biopesticides), Environment (bioremediation), Industry (Single Cell Protein) and applications of Fermentation Technology- lactic acid, vitamins, food and beverages.

Potential Hazards of Biotechnological Inventions: Risks related to genetically modified organisms (GMO) and biologically active products, Biological warfare & Biopiracy. Protection of biotechnological inventions. Intellectual Property Rights, Patenting and patent protection.

References

1. Singh B.D Biotechnology 2002. Kalyan Publishers New Delhi.
2. Brown C.H., Campbell I & Priest F, G. 1987. Introduction of Biotechnology (Blackwell scientific publishers Oxford).
3. Colin Ratledge Bjorn Kristiansen, 2008. Basic Biotechnology 3 rd ed. Cambridge University.
4. Janarathanan S & Vincent S. 2007. Practical Biotechnology, Method of Protocols. University Press.
5. John E. Smith. Biotechnology Cambridge Low priced ed. (Third Ed) 2005 Madigan, Martinko and Parker 2002, Biology of Microorganisms, Brock Eighth Ed. Prentice Hall.
6. Singh B.D. Biotechnology 2002, Kalyan Publishers New Delhi.
7. Sudha Gangal 2007. Biotechnology Principles and & practice of Animal Tissue culture, Universities Press.

BIOINFORMATICS

14 Hrs

Module III

8 Hrs

Introduction: Definition, importance and role of bioinformatics in life sciences. Computational Biology.

Biological databases: Nucleotide sequence databases (NCBI- GENBANK, DDBJ and EMBL). Protein databases - structure and sequence databases (PDB, SWISSPROT and UNIPROT). Introduction to Sequences alignments: Local alignment and Global alignment, Pair wise alignment (BLAST and FASTA] and multiple sequence alignment. Phylogenetic Tree construction and Analysis

Module IV

6 Hrs

Molecular visualization software - RASMOL. Basic concepts of Drug discovery pipe line, computer aided drug discovery and its applications. Human Genome Project.

MOLECULAR BIOLOGY

20 Hrs

Module V

8 Hrs

Nature of Genetic Materials: Discovery of DNA as genetic material – Griffith's transformation experiments. Avery Macarty and Macleod, Hershey Chase Experiment of Bacteriophage infection, Prokaryotic genome; Eukaryotic genome. Structure and types of DNA & RNA. DNA replication. Modern concept of gene (Cistron, muton, recon, viral genes)., Brief account of the following-- Split genes (introns and exons), Junk genes, Pseudogenes, Overlapping genes, Transposons.

Module VI

12 Hrs

Gene Expressions: Central Dogma of molecular biology and central dogma reverse, one gene-one enzyme hypothesis, One gene-one polypeptide hypothesis Characteristics of genetic code, Contributions of Hargobind Khorana.

Protein synthesis [prokaryotic]: Transcription of mRNA, Reverse transcription, post transcriptional modifications, Translation, Post translational modifications.

Gene regulations: Prokaryotic(inducible & repressible systems) Operon concept -Lac operon and Tryptophan operon, Brief account of Eukaryotic gene regulation.

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1. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James
(2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Gupta, P. K (2002) Cell and Molecular Biology, (2ed), , Rastogi Publications., Meerut
4. James Darnell. (1998) Molecular Biology. Scientific American Books Inc
5. Thomas AP(Editor). 2011 Cell &Molecular Biology The Fundamentals. Green leaf publications .TIES Kottayam
6. Zoological Society of Kerala Study material. (2011) Cell and Molecular Biology

PRACTICAL .

BIOTECHNOLOGY, BIOINFORMATICS & MOLECULAR BIOLOGY

BIOTECHNOLOGY

1. Identify and comment on the item provided: (Western blotting / Southern blotting / Northern blotting / PCR)
2. Write down the procedure involved in DNA isolation

BIOINFORMATICS

1. Download/use print out/pictures of genome sequences of any 2 organisms. Identify and mention the characteristic features of both.
2. Download/ use print out/pictures of a protein sequence , identify it & comment on its amino acid composition
3. Download / use print out/pictures of a macromolecule. Write a brief note on the bioinformatics tool used to visualize its structure.

MOLECULAR BIOLOGY

1. Identify and comment on its molecular composition / structural orientation / functional significance (Any tissue / Cell organelles/ DNA, DNA replication, RNA different types using models or diagrams)

V1 SEMESTER. ZY6CRT12

CORE COURSE XII

OCCUPATIONAL ZOOLOGY .

(APICULTURE, VERMICULTURE, QUAIL FARMING & AQUACULTURE)

54 Hrs

Credits 3

Objectives:

1. To equip the students with self employment capabilities.
2. To provide scientific knowledge of profitable farming.

3. To make the students aware of cottage industries.

Module 1. APICULTURE

18 Hrs

Definition, Different species of honey bees, Organization of honey bee colony, Social life and adaptation of honey bees. Communication among honey bees. Bee keeping methods and equipments, Management and maintenance of an apiary, Growth period, honey flow period and dearth period Division of the colony, uniting two colonies, , replacing old queen with new queen, swarming management, monsoon management. Enemies of bees. Diseases of bees,.Bee pasturage. Uses of honey bees, By-products of honey bees, Honey and wax composition. Testing the quality of honey.Extraction of wax, Uses of honey and wax.Royal jelly, Propolis. Apitherapy, Agencies supporting apiculture.

Activity :Visitto an apiculture unit.

Field visit and report submission - 10 Hrs

Field visit and report submission on any two items are taken for internal evaluation.

MODULE: 2. VERMICULTURE

8 Hrs

Introduction, Ecological classification of earth worms. Species of earth worms used for vermicultre, Reproduction & life cycle, Role of earth worm in solid waste management, in agriculture, in medicine etc. Preparation of vermibed, Maintenance & monitoring, Preparation of vermicompost, Preparation of vermiwash.

Activity : Submission of a report after preparing a vermiculture unit or visiting a vermicomposting unit.

MODULE: 3.QUAIL FARMING (*Coturnix coturnix*)

4 Hrs

Introduction, care of quail chicks, care of adult quails, care of breeding quails, ration for quail, care of hatching eggs, health care, use of quail egg and meat.Sources of quality chicks.

MODULE: 4. AQUACULTURE.

24 Hrs

Advantages and salient features of aquaculture, Types of Aquaculture, Biotic and abiotic features of water, Importance of algae in aquaculture, Common cultivable fishes of Kerala, Fish diseases, Composite fish culture, Integrated fish culture, Carp culture, Prawn culture Mussel culture Pearl culture. Processing & Preservation.

Aquarium management - Setting up of an aquarium, Biological filter & Aeration, Breeding of gold fish, gourami (*Osphronemus*), fighter and Guppy (live bearer). Nutrition and types of feed for aquarium fishes, Establishment of commercial ornamental fish culture unit. Fish Transportation - Live fish packing and transport Common diseases of aquarium fishes and their management. Aquaponics (a brief introduction only).

Activity – Setting up of an Aquarium

Field visit – Visiting an Aquaculture farm

References

NPCS Board, The complete book on Bee keeping and honey processing, NIIR Project consultancy services, 106E, Kamala nagar, Delhi- 110007.

Shukla G.S, & Updhyay V.B, Economic zoology ,Rastogi Publ. Meerut.

Pradip.V.Jabde , Text book of applied zoology, 2005

Applied Zoology, Study Material Zoological Society of Kerala , CMS college Campus

Clive. A Edwards, Norman. Q. & Rhonda. 2011. Vermitechnology: earthworms, organic waste & environmental management.

Chauhan, H.V.S. Poultry, Disease, diagnosis and treatment, Wiley eastern Ltd Delhi.

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Amber Richards. 2014. Aquaponics at home.

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Venkitaraman, P.R,1983, Text book of Economic zoology(SudharsanaPuubl. Kochi)

Addison Webb, Bee Keepingfor profit and pleasure, Agrobios Ltd.

Edwards.C.A.&Lafty, J.R.1972 Biology of earthworms(Chapman & Hall Led.London)

Applied Zoology, Study Material Zoological Society of Kerala , CMS college Campus

George cust& Peter Bird, Tropical Fresh water Aquaria, Hamlyn London.

Verreth J. Fish larval nutrition, Chapman & Hall Publ.

Bone Packer. 2014. Aquaponic system

PRACTICAL OCCUPATIONAL ZOOLOGY

36 Hrs

Credit 1

1. General Identification, Economic importance, Morphology, scientific names and common names of the following

- a) Economic important and morphology of culturable fishes (Catla, Rohu, Grass carp, Common carp, Silver carp, *Etiropus suratensis*, *Oreochromis /Tilapia*, *Mugil cephalus* and *Anabas Testudineus*)
- b) Identification and morphology of ornamental fishes (gold fish, fighter, Gourami, Angel fish, Guppy
- c) Two species of earthworms used in Vermiculture
- d) Four species of honey bees
- e) Economic importance and morphology of shell fishes (Any three species of prawn, two marine mussels, two oysters one rock oyster - *Crasostria* and pearl oyster - *Pinctada fucata* and freshwater mussel - *Lamellidens marginalis*).

2. Castes of bees

3. Principle & uses of - Aquarium filters, Aquarium aerator, Aquarium plants,Oven, Pelletiser, Screw Press, die plate

4. Identification and study of fish parasites and diseases (five numbers each) using slides/pictures

5. Bee keeping equipments, Beehive, Smoker, honey extractor, Queen Cage,

6. Bees wax, Honey, Vermicompost (Identification-Uses)

7. Formulation of artificial feed for aquarium fishes – demonstration

8. Tests for determining the adulteration in honey.

9. Mounting of pollen basket
10. Mounting of mouth parts of honey bee
11. Separation of cocoon from worm castings.

SEMESTER V. OPEN COURSES (FOR OTHER STREAMS)

ZY5OPT01

1. VOCATIONAL ZOOLOGY

72 Hrs

4 Hrs/Week, Credits 3

Objectives of the Course

- To develop critical thinking skill and research aptitude among students, by introducing the frontier areas of the biological science.
- To emphasize the central role that biological sciences plays in the life of all organisms.
- To introduce the student to some of the present and future applications of bio-sciences
- To acquire basic knowledge and skills in aquarium management, Quail farming, vermicomposting and apiculture for self-employment
- To learn the different resources available and to develop an attitude towards sustainability
- Give awareness to society about need for waste management and organic farming

Module 1 Aquarium management

12 Hrs

General introduction to Aquarium, Aims and types of aquarium (material, size and shape), Requirements of an aquarium - filtration of waste, physical, chemical and biological; Setting an aquarium (self-sustainable with biological filters), Major indigenous aquarium fishes of Kerala.

Activity: Setting up of a freshwater aquarium and rearing of aquarium fishes

Module 2 Ornamental Fish Culture

20 Hrs

Introduction to ornamental fishes: Present status of ornamental fish culture in India with special reference to Kerala, Breeding of Gold fish, Fighter, Gourami (*Osphronemus*), and Guppy (live bearer). Nutrition and types feed for aquarium fishes, Use of live fish feed

organisms in Ornamental fish culture. Methods and techniques involved in the formulation of fish feed. Fish Transportation: Live fish packing and transport, Common diseases of aquarium fishes and their management. Establishment of commercial ornamental fish culture unit,

Activity: field visit to an ornamental fish breeding Centre to understand breeding practices of various aquarium fishes.

Module 3 Quail farming (*Coturnix coturnix*)

10 Hrs

Introduction, care of quail chicks, care of adult quails, care of breeding quails ,ration for quail, care of hatching eggs, health care, use of quail egg and meat, Sources of quality chicks.

Activity: Visit to a quail farm or viewing a quail documentary to familiarize the quail farming practices

Module 5 Vermiculture and composting

12 Hrs

Introduction, ecological classification of earth worms, Life history, Species of earth worms used for vermiculture, Preparation of vermibed; Preparation of vermicompost, Preparation of vermish, Maintenance and management of vermicomposting unit, Role of vermiculture in solid waste management.

Activity: - Preparation of a vermiculture unit or visit to a vermicomposting unit.

Module 6 Apiculture

18 Hrs

Definition, Uses of bees, species of bees cultured, organization of honey bee colony, bee keeping methods (modern method only) and equipments, management and maintenance of an apiary-growth period, dividing the colony, uniting two colonies, replacing old queen with new queen, honey flow period, Bee pasturage, Death period, Enemies of bees, Bee diseases, uses of honey and wax, Apitherapy, Propolis, Royal jelly, Agencies supporting apiculture.

Activity: Identify different types of honey bees and rearing equipments

Field visit and report Submission

Field visit and report writing on any two items are taken for internal evaluation, instead of assignment and seminar. Conduct a workshop on various cultural practices and the preparation of byproducts.

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1. Applied Zoology, Study Material Zoological Society of Kerala, CMS College Campus, Kottayam.
2. Addison Webb (1947), Bee Keeping- for profit and pleasure, Museum Press, agro bios India Ltd.

3. Alka Prakash (2011), Laboratory Manual of Entomology, New age International, New Delhi.
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10. George Cust and & Peter Bird. (1978). Tropical Fresh water Aquaria, Published by Hamlyn London. illustrated by George Thompson.
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14. Michael B. New; Alber G.J. Tacon (1994) Farm made aquafeeds FAO fisheries technical paper No.343, Rome, FAO. 1994
15. Nalina Sundari, M.S and Santhi, R (2006) Entomology. MJP Publishers
16. NPCS Board of Consultants & Engineers, Chennai.(2015) The complete book on Bee keeping and honey processing, 2nd Edition, NIIR Project consultancy services, 106- E kamala Nagar Delhi – 110007.
17. Ronald j. Roberts (1978) Fish pathology , Cassel Ltd London .
18. Vijayakumaran Nair, K, Manju, K.G. and Minimol, K. C.(2015) Applied Zoology, Academia press, Thiruvananthapuram

**e. SYLLABUS
(VOCATIONAL SUBJECTS)
– MODEL II**

THEORY & PRACTICAL

1. AQUACULTURE

SEMESTER 1

VOCATIONAL COURSE 1

PRINCIPLES AND METHODS IN AQUACULTURE

36 Hrs
Credits 2

Objectives:

1. To make the student understand the basic concepts of the science and practice of aquaculture.
2. To introduce the student to the diverse practices of culturing of aquatic organisms.
3. To encourage the student to take up aquaculture practices as a vocation.

Module 1

4 Hrs

Scope and importance of Aquaculture. Significance of aquaculture compared to other agricultural systems and commercial fisheries. Types of aquaculture – Freshwater, Brackish water and Mariculture. Shell fish culture, Finfish culture, Monoculture, Polyculture.

Module 2

3 Hrs

Integrated farming – The concept of recycling of organic waste for maximum production. Rice cum fish culture. Culture practices of duck cum fish, poultry cum fish and pig cum fish culture. Sewage fed Fish Culture.

Module 3

7 Hrs

Site selection parameters for a pond site. Soil quality parameters –physical, soil type, porosity, percolation, shear strength, rate of compaction etc. Chemical –salinity, pH, nutrients, toxic gases etc. Water quality parameters-Chemical- salinity, pH, dissolved oxygen, Carbon dioxide, Nutrients, Ammonia. Physical – Temperature, suspended solids, . Biological parameters-presence of juveniles/seedlings, predators/ competitors, plankton, nekton .

Module 4

10 Hrs

Pond construction – Selection of site. Preparation of bunds and dykes. Calculation of earth works, sluice gates- Different types and fixing of sluice gates.**Pond preparation**-Drying, elimination of pests and predators. Preparation of nursery and stocking ponds.Manuring, Production of plankton. Stocking and acclimatization. Use of hapa. Stocking density. Harvesting and Harvesting methods

Module 5

10 Hrs

Fresh water cultivable fishes and their external characters-Indian Major Carps, Catfish, Eel, Tilapia, Etroplus, Trouts, Mahseer, Channa, Clarius, Anabas, Larvivorous and Weed fishes. Cultivable species of crustaceans and mulluscs: Identification and external characters. Shrimp, freshwater prawn, crab, lobster, pearl oyster, edible oyster, mussel and clams.

Module 6

2 Hrs

Brackish water aquaculture-Introduction, the tidal range, salinity and biota.

Major reservoirs of India and their fishery- Constarints in reservoir fisheries.

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SEMESTER I

VOCATIONAL COURSE 2

HATCHERY AND CULTURE TECHNIQUES

36 hrs
Credits 2

Objectives

1. Introduce the student to the culture practices of various indigenous edible and ornamental finfishes and edible shellfishes.
2. To create an understanding of the different technologies of seed production of common cultivable species
3. Introduce the student to various live feeds available for aquatic organisms and understand their culture methods.

Module 1

6 Hrs

Hatchery systems – Different types- fin fish (Carp), Mollusc (Edible oyster)- Seed collection, Spat collectors. Crustacean (Penaeid prawn)- Different Components and operation, Description of Larval stages.

Module 2

8 Hrs

Culture Practices of major groups of finfishes. Indian Major Carps- Nursery, Rearing and stocking ponds. Preparation of ponds. Stocking and post stocking management. Harvesting.

Culture of air breathing fishes(eg. Channa) .

Culture of Tilapia and Milk Fish, (Mention lablab and its preparation) production of Monosex in Tilapia.

Culture of Trouts.

Module 3

8 Hrs

Culture of Crustaceans - Penaeid prawns- Seed resources, prawn filtration practices, (Pokkali, Bheries Ghazan lands) ,extensive, semi intensive and intensive, prawn farming.

Crab culture- Crab fattening and growout.

Module 4

8 Hrs

Culture of Bivalve mollusks.- Mussels, Pearl oysters, Edible oysters, Clams. On Bottom and Off bottom culture methods- Stake culture (Bouchot culture), Rack culture (Rack and ren, Rack and tray), Long Line culture and Raft culture.

Module 5

6 Hrs

Culture of ornamental fishes- Types of Aquaria, Aquarium accessories. Setting up and maintenance of Aquaria. Filtration of Aquarium water- Mechanical, Chemical and Biological filtration. Breeding techniques of Aquarium fishes;- gold fish (Egg scatterer) and Fighter fish (Bubble nest builder)

Culture of sea weeds and holothurians.

Culture of live feeds- micro algae, artemia, rotifer, daphnia.

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CMFRI Bulletin, No. 41, 1987

SEMESTER II

VOCATIONAL COURSE 3

CAPTURE FISHERY

36 hrs
Credits 2

Objectives:

1. Introduce the student to the fishery potential of Indian waters- marine and inland.
2. To study the major groups of finfishes and shellfishes contributing to the commercial fishery
3. Introduction to fishing gears and diverse fish catching methods of tropical waters.
4. To develop the concept of fishery as a renewable resource to be managed and study of population dynamics and different management techniques in commercial fisheries.

Module 1

8 Hrs

Commercially important orders, families, genera and species of elasmobranchs and teleost of the Indian region and their identification. Identification of commercially important species of prawn, crab, lobster, bivalve, gastropod and cephalopods.

Module 2

8 Hrs

Craft and gear-Types of fishing craft in India –Traditional, Motorised and Mechanized. Classification of fishing gear. Fishing gear material- Synthetic and natural. Properties of fishing gear, floats, sinkers and accessories. Major fishing gears and their operation. Static gear –Gill nets, Long line and Fish traps. Mobile gear- Drag nets-Trawl nets. Seine nets-Purse seine, Shore seines.

Module 3

6 Hrs

Inland capture fishery resources of India – Riverine fisheries,,Cold water fisheries resources, Lacustrine fisheries (Estuarine or brackish water fisheries and fisheries of fresh water lakes)- Important species and gears.

Module 4

8 Hrs

Marine Fishery Resources of India- Pelagic fishery- Fisheries of oil sardine, lesser sardine, anchovies, mackerel, ribbon fishes. Demersal fisheries. Fisheries of elasmobranchs, Bombay duck, cat fishes, silver bellies, sciaenids, pomfrets, threadfins, threadfin breams and other perches, Flatfishes, Prawns, Lobsters, Crabs, Mussels, Oysters and Clams – Fishing seasons, abundance and major gears for each group.

Module 5

6 Hrs

Fishery management- Concept of population, Yield and Recruitment. Factors affecting fish stocks. Population dynamics. Problems of over fishing- Growth overfishing and Recruitment overfishing. Fishery. Management practices- Input and output controls. Maximum Sustainable Yield.

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SEMESTER II

VOCATIONAL COURSE 4

BIOLOGY OF FISHES

**36 hrs
Credits 2**

Objectives:

1. To create an understanding about the morphological and anatomical organization of finfishes and shellfishes.
2. Introduce the student to the basic principles of Taxonomy of cultivable organisms.
3. To have an awareness of the fundamental biological aspects of food and feeding, age and growth and reproductive biology.

Module 1

4 Hrs

Need for taxonomy, binomial nomenclature, Data requirements for classification of fishes, Methods for collection of taxonomic data- Morphologic and Meristic data., Study of external morphology of a typical elasmobranch and a typical teleost, Variations in form and structures used in taxonomic studies.

Module 2

12 Hrs

Internal anatomy of fish- Alimentary canal and associated structures. Gills, Swim bladder, Accessory respiratory organs, Heart and circulatory system, skeletal system (Visceral arches, Vertebral column and skeleton of fins only) Nervous and lateral line system, sense organs (eye, ear, olfactory organs)

Module 3

6 Hrs

Excretion, osmotic and ionic regulation in marine and freshwater fishes. Swimming activity. Types of locomotion- Anguilliform, Carangiform and Ostraciform. Muscles in locomotion. Parental care, Social behaviour- Aggregation and shoaling. Migration of fishes.

Module 4

6 Hrs

Natural food of fishes. Feeding habits and types of feeding in fishes- Carnivorous, Herbivorous and Omnivorous, Predators, Grazers, Suckers, Strainers and parasites.. Feeding habits and method of feeding in prawn, bivalve and cephalopod.

Module 5

8 Hrs

Growth of fishes- Absolute and relative growth, isometric growth and allometric growth. The cube law. Methods for determination of growth checks. Length frequency analysis. Analysis of growth using hard parts like scales, otoliths and vertebrae. Estimation of growth by direct methods. Marking and tagging of fish for growth studies. Methods of studying reproduction- Maturity Stages, Gonadosomatic Index, Ova Diameter Frequency studies. Determination of size at first maturity and spawning season, Fecundity and its determination.

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SEMESTER III

VOCATIONAL COURSE 5

FISHERIES ENVIRONMENT

**36 hrs
Credits 2**

Objectives

1. To study the environment and their effect on fish populations.
2. Study the use of Remote sensing techniques for the assess fish stocks
3. Introduction to the ancillary marine resources like seaweeds, echinoderms and corals.
4. To understand the different techniques and equipments for the study of environmental parameters and different fish finding devices.

Module 1

5 Hrs

Habitat Ecology. Freshwater Habitat- Lentic (Pond, Lake), Lotic (Riffles, Pools). Marine Habitat- Zonation, Biota and adaptations. Principles of limiting factors- Shelford's law of tolerance, Liebig's law of minimum, Combined concept. Ecological succession and Ecological indicators. Photosynthetic and saprophytic food chain.

Module 2

10 Hrs

Basic marine meteorology- weather, air-sea interactions. Monsoons, seasonal changes, Circulation of water masses, Waves, Tides and sediment transportation.

Module 3

7 Hrs

Physical and chemical parameters of Aquatic environments- temperature, salinity, oxygen, nutrition, Microelements and Macroelements. Phytoplankton and primary production- Methods of Estimation (Dark and Light bottle method, C14 Method, Chlorophyll Technique). Estimation of Zooplankton and secondary production.

Module 4

4 Hrs

Ecology of estuaries and mangroves- Soil , Water and Biota. Biogeochemical cycles- Nitrogen, Phosphorus and Sulphur cycle.

Module 5

10 Hrs

Ancillary marine resources-Sea weeds, corals, Echinoderms and their commercial importance. Aquatic pollution- Causes and Remedial Measures. Instruments used for Biological sampling- Plankton International Indian Ocean Expedition Net, Hardy's continuous plankton recorder), Nekton (Isaac Kidd's Midwater trawl), Benthos (Dredges, Grabs, Agassiz trawl). Fish finding devices- Echo sounder, Sonar and net sonde . Remote sensing techniques and application.. Satellite remote sensing of fish stocks- Ocean colour maps, Sea surface Temperature Contour Maps. Potential Fishing Zone (PFZ). Deep Scattering or Sonic Scattering Layer.

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SEMESTER III

VOCATIONAL COURSE 6

FISH NUTRITION

36 hrs
Credits 2

Objectives:

1. To create an understanding on the nutritional needs of aquatic organisms in culture.
2. To make the student have a basic concept of energy budgeting, food additives and varieties of feed ingredients used in Aquafeeds.
3. To have a basic understanding of the principles of feed formulation and equipments used in feed manufacture.

Module 1

5 Hrs

Digestive system of fish, Digestive Glands and their secretions. Digestive physiology of fish- Digestion of Carbohydrates, Proteins and Fats. Proteins, carbohydrates, fats, vitamins and minerals in fish nutrition- Classification, Structure and functions.

Module 2

8 Hrs

Nutritional Bioenergetics- Gross energy, Digestible energy (Digestibility co-efficient and measurement of digestible energy), Metabolisable energy, Heat increment (Specific Dynamic action) Net energy, Retained energy, Protein utilization. (Protein Efficiency Ratio, Protein

conversion ratio, Productive protein value) .Proximate Analysis- Moisture, Crude protein, Crude Lipid, Crude Fibre, Ash and , Nitrogen free extract- Methods of analysis of each component.

Module 3

8 Hrs

Factors affecting digestibility, Nitrogen balance index, Food additives- Binders, Antioxidants, Chemo-attractants and feeding stimulants, Pigments, Antimicrobial agents and Anabolic agents. Non conventional feed stuffs. Food growth equation. Feed ingredients of plant and animal origin.

Module 4

5 Hrs

Feed preparation techniques. Factors affecting the energy requirement of fish. Non nutrient constituents of the diet. Measurement of calorific value- Component Analysis, Wet oxidation, Bomb Calorimetry. Types of feeds (Wet, Moist and Dry feeds-advantages and disadvantages) Larval feeds- Minced diets, Microparticulate diets, Spray dried diets, Microbound diets, Microcoated diets and Microencapsulated diets.

Module 5

10 Hrs

Growth promoters. Principles of feed formulation (Pearson's Square and Linear programming). Different systems of fish feeding or Fish feeding devices. Equipments used in Feed mills- Weighing Scales, Grinders, Miners, Mixers, Elevators, Extruders, Coolers/Dryers, Fat sprayer, Crumbler, Sifter and Bag seamer. Food Conversion Ratio and Food efficiency ratio. Economics of feed preparation.

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SEMESTER IV

VOCATIONAL COURSE 7

REPRODUCTIVE PHYSIOLOGY AND ENDOCRINOLOGY

36 hrs

Credits 2

Objectives:

1. To have an understanding of the variety of reproductive techniques in finfishes and shellfishes and the factors controlling reproduction.
2. To study the endocrine and neurosecretory system of finfishes and shellfishes.
3. To understand the principles and techniques of induced breeding, and cryopreservation of fish gametes.

Module 1

6 Hrs

Reproductive systems and Sexual dimorphism in fish, crab and prawn. Types of reproduction- Viviparity, ovoviviparity, oviparity in Teleosts and Elasmobranchs. Classification of maturity stages of ovary and testes in fishes and prawns. Oogenesis and spermatogenesis in fishes. Hermaphroditism- different types. Sex reversal and sex determination in fishes.

Module 2

6 Hrs

Organisation, structure and Functions of Neurosecretory and endocrine systems in fin fishes. Pituitary, Thyroid, Chromaffin tissue, Interrenal tissue, Pancreatic islets, Corpuscles of Stannius, Ultimobranchial Glands, Gonads, Gastro-intestinal Hormones, Pineal organ, Caudal neurosecretory system or Urophysis. Neuroendocrine control of reproduction. Role of Hypothalamus - Pituitary – Gonadal axis in control of maturation in fishes. Gonadotropin releasing hormones, gonadotropins and sex steroids.

Module 3

6 Hrs

Neuroendocrine systems in crustaceans and control of reproduction. Sinus gland complex and X- organs. Pericardial and Post-commisural organs. True Endocrine organs-Y- organs, androgenic gland and Mandibular organs. Hormones produced by the neuroendocrine and true endocrine glands and their role in the control of reproduction and moulting in Crustaceans. Parasitic castration.

Module 4

10 Hrs

Principles of induced maturation and spawning in fishes and crustaceans. Levels of control in induced breeding and maturation in fishes. Environmental control of reproduction in fishes and prawns. Use of hormones and hormone analogues in fishes- Gonadotropin releasing hormones, Gonadotropins and Sex steroids. Methods of hormonal administration. Hypophysation. Linpe Method. Ovaprim. Use of Anaesthetics. Eyestalk ablation- Its principle and application in crustacean hatcheries. Use of hormones for producing monosex population and sex reversal in fishes. Principles and methods of cryopreservation of gametes.

Module 5

8 Hrs

Types of eggs in fishes – Pelagic, Demersal and according to yolk content. Embryonic development- Cleavage, fate map of Blastula, gastrulation- Invagination, Involution, Delamination, Convergence, Epiboly. Hatching , Post Embryonic development and Larval development.

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SEMESTER IV

VOCATIONAL COURSE 8

MICROBIOLOGY, PATHOLOGY AND POST HARVEST TECHNOLOGY

**36 Hrs
Credits 2**

Objectives

1. To have a clear understanding of the bacterial fauna associated with fish sanitation.
2. To have a basic idea of the factors associated with fish spoilage and the variety of fish preservation techniques.
3. To clearly understand the symptoms, diagnostic and remedial measures of fish diseases and have an idea of the Critical Control Points in seafood industry.

Module 1

8 Hrs

Bacteriology- Classification of bacteria based on temperature and oxygen requirements, Bacterial growth curve, growth phases Sterilization techniques, preparation of culture media, Estimation of total plate count, Staining techniques (Gram's Staining). Important bacteria of sanitary significance- *Staphylococcus aureus*, *Vibrio cholerae*, *salmonella*. Faecal Indicator organisms- *E.coli* and Faecal streptococcus.

Module 2

8 Hrs

Biochemical composition of fish- Moisture, Protein, Fats, NPN compounds and Minerals. Spoilage of fish - Post mortem changes and Rigor mortis. Causes of spoilage - Enzymatic, microbial, Biochemical (rancidity). Indices of spoilage - organoleptic, chemical (Total Volatile

Basic Nitrogen, Hypoxanthine content, Peroxide value and microbial (direct count and Total Plate Count).

Module 3

8 Hrs

Processing and Preservation of fish – Chilling and Freezing- Slow freezing, and quick freezing-critical temperature. Freezer burn, thawing, drip loss and glazing. Types of Freezers- Plate Freezer, Tunnel (Air Blast) Freezer, Immersion Freezer, Fluidised bed Freezer (IQF), Cryogenic Freezing, Accelerated Freeze drying , Irradiation. Canning- Principle and Procedure. Common defects in canning- Struvite formation, Panelling, Flipper, Springer, Soft swell and Hard swell.

Module 4

6 Hrs

Curing- Types of Curing- Simple, Sun drying, dry and wet curing, Monacuring, Pit Curing, Colombo curing, Smoke curing. Special cured products- Masmine and Marinade. Common defects in curing- Dun, Rust, Pink, Maggots. Value added products. Fishery byproducts- Fish oil, Shark liver oil, Chitin, Chitosan, Isinglass, Fish meal , Shark fin rays.

Module 5

6 Hrs

Diseases of fin fishes and prawns.-Protozoan, Bacterial, viral, fungal, Crustacean, Leech, Helminth diseases. Symptoms and Remedial measures. Nutritional deficiency diseases - Pin head, Rickets, Soft Shell Syndrome, Lipoid hepatic degeneration, Vitaminosis A. Hazard analysis and critical control points in seafood industry.

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8. Ronald J. Roberts. (2012).*Fish Pathology*. 4th Edn.Wiley Blackwell.
9. Srivastava.C.B.L (2006). *A text book of Fishery Science and Indian Fisheries*. Kitab Mahal.
10. Sinderman.C.J.(1990) Principal diseases of marine fish and shellfish.Vol 1 &2. Academic Press.
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AQUACULTURE PRACTICALS

ZA1V02U (P) PRINCIPLES AND METHODS IN AQUACULTURE, HATCHERY AND CULTURE TECHNIQUES

36 hrs

Credit 1

1. Identification and major biological characteristics of cultivable organisms
2. Gut content analysis.
3. Study of common weed and predatory fishes in aquaculture ponds
4. Study of aquatic insects and aquatic weeds.
4. Identification of different larval stages and hatchery operations of prawn
- 6 Setting up and keeping of aquariums
- 7 Visit to carp and prawn hatcheries.

SEMESTER II

ZA2V04U (P) PRACTICAL – II CAPTURE FISHERY & BIOLOGY OF FISHES

36 Hrs

Credit 1

1. Identification of commercially important fishes, crustaceans and molluscs.
2. Fish- Study of external morphology and scales..
3. Dissection of Alimentary canal.
4. Dissecting and identification of internal organs of a fish.
5. Prawn- Study of external morphology and nervous system
6. Gill structure- Herbivorous, carnivorous and omnivorous fishes.
7. Gill structure of a prawn - Dissection
8. Molluscs- Study of morphology, and Dissection of Gills of bivalves
9. Visit to marine fish landing centre.

SEMESTER III

ZA3V05U(P) PRACTICAL – III FISHERIES ENVIRONMENT

54 Hrs

Credit 2

1. Determination of salinity, dissolved oxygen, pH, total alkalinity, hardness, nitrate, nitrite and ammonia and phosphate.
2. Determination of soil pH
3. Study of common marine phytoplankton, zooplankton.
4. Quantitative evaluation of phytoplankton and zooplankton in culture ponds
5. Identification of the common Ancillary Marine Resources – Corals, Sea cucumber and Sea weeds
6. Equipments and Instruments used for the collection of Environmental Data – Plankton samplers and Counters including haemocytometer, Digital pH meter, Salinometer, Spectrophotometer, Colorimeter etc.
7. Study of Ecological sub-divisions of the sea, Principles of Remote sensing and software used (Wikimapia.org)

SEMESTER III

ZA3V06U (P) PRACTICAL – IV FISH NUTRITION

54 Hrs

Credit 2

1. Comparative study of Digestive system of Herbivorous and Carnivorous fishes
2. Qualitative estimation of proteins, Polysaccharides and lipids
3. Formulation of artificial feed for aquarium fishes and prawns with locally available ingredients.
4. Study of identification feed ingredients of plant origin and animal origin (oil cakes and meals eg: Groundnut oil cake, coconut oil cake, Mustard oil cake, Fish meal, Crustacean meals, Molluscan meals, Blood meal etc)
5. Use of Pearson's square method in balancing feed Ingredients.
6. Study of equipments used in feed preparation (Oven, Pelletiser, Feed Press and Die Plate, Extruders etc.)
7. Study of non-conventional feed stuffs eg. Spirulina etc. and Feed Additives (Binders, Antibiotics etc).

SEMESTER IV

ZA4V07U(P) PRACTICAL – V REPRODUCTIVE PHYSIOLOGY AND ENDOCRINOLOGY

54 Hrs

Credit 2

1. Dissection of reproductive organs of Teleost fish.
2. Dissection of reproductive organs of Prawn and Crab.
3. Eyestalk ablation technique and electrocautery apparatus(Demonstration)
4. Methods of hormone injection in fish.
5. Observation of larval and embryonic stages in fish egg development.
6. Estimation of maturity stages and fecundity in fish
7. Equipments used in cryopreservation (Cryocan, French straws etc)

SEMESTER IV

ZA4V08U(P) PRACTICAL – VI MICROBIOLOGY , PATHOLOGY AND POST HARVEST TECHNOLOGY

54 Hrs

Credit 2

1. Sterilisation techniques, preparation of culture media (TGBE and Nutrient Agar Media), nutrient agar slants, staining techniques.(Gram staining)
2. Determination of total plate count
3. Types of bacterial colonies
4. Instruments used in bacteriological Studies (Inoculation chamber, Autoclave, Colony counter etc.)
5. Examination of internal and external organs of diseased fish and shell fishes.
6. Identification of parasites in fishes and shell fishes.
7. Materials used in fish processing and packaging (Cans, Retortable pouches etc.)