DEPARTMENT OF ZOOLOGY

M.Sc. Zoology
Two Year Programme
Course Structure 2024-25

Basket I - Core Courses				
Sl. No.	**Code**	**Subject Name**	**T-P-P**	**Credits**
1.	CUTM2379	Advanced Sustainable Aquaculture	3-1-0	4
2.	CUTM1452	Animal Biotechnology	3-1-0	4
3.	CUTM1453	Animal Breeding	3-1-0	4
4.	CUTM4342	Aquariculture, Value addition and Quality Management	3-1-0	4
5.	CUTM4343	Fish Biology and Nutrition	3-1-0	4
6.	CUTM4344	Animal Physiology and Endocrinology	3-1-0	4
7.	CUTM1451	Immunology and Cancer Biology	3-1-0	4
8.	CUTM4345	Bioanayltical Techniques and Biostatistics	3-1-0	4
9.	CUTM1437	Cell and Molecular Biology	3-1-0	4
10.	CUTM1454	Genetics and Epigenetics	3-1-0	4
11.	CUTM1436	Microbiology	3-1-0	4
12.	CUTM4346	Animal Taxonomy and Zoo Systematics	3-1-0	4
13.	CUTM4347	Biochemistry and Enzymology	3-1-0	4
14.	CUTM4348	Wildlife Conservation	3-1-0	4
15.	CUTM4349	Developmental Biology	3-1-0	4
16.	CUTM 2378	Research Methodology and IPR	2-0-2	4
			Basket II (Domain Courses)	32
			Total	96

Course Outline for MSc courses
ADVANCED SUSTAINABLE AQUACULTURE

Subject Name	Code	Type of course	T-P-P	Prerequisite
Advanced Sustainable aquaculture	CUTM2379	Theory-Practice	3-1-0	-

Objectives

1 The goal of the Aquaculture Biology specialization is to give a theoretical basis and practical experience for understanding the biological principles in aquatic food production.
2 The specialization is intended to give a solid background for students who wish to work in aquaculture or related industries, or to pursue further research.
3 Students will understand the basis of technologies of fisheries and aquaculture.

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand the basis of technologies of fisheries and aquaculture.
CO2	Students will develop a better understanding of the history of aquaculture and different production systems employed for better production.
CO3	Students will understand the basis of technologies of fisheries and aquaculture.
CO4	Study different aquatic organism as a source of
CO5	Students will understand the basis of technologies of fisheries and aquaculture

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**		**1**	**3**		**2**				**3**		**3**	**3**	**2**	**2**
CO2	**3**	**2**		**2**	**1**	**2**	**1**			**3**	**1**	**1**	**2**	**1**	**3**
CO3	**3**		**1**	**2**						**3**		**2**	**1**	**3**	**3**
CO4		**2**	**2**		**2**		**3**			**3**		**3**	**3**	**2**	**3**
CO5		**1**	**2**	**1**		**1**	**1**			**3**			**2**	**2**	**2**

(High-3, Medium-2, Low-1)

Course outline

Module- I

1.1 Basics of aquaculture,

1.2 Definitions and scope of aquaculture,

1.3 History of aquaculture,

1.4 Present global and national scenario.

1.5 Systems of aquaculture - Pond culture,

1.6 Pen culture, Cage culture and Running water culture,

1.7 Zero water exchange system.

Practice 1 (2 h) : Aquaculture production and resource statistics- World and India

Practice 2 (2 h) : Primary productivity calculation, Estimation by Light and Dark Bottle method.

Module- II

2.1 Extensive, semi-intensive

2.2 Intensive and super intensive aquaculture in different types of water bodies - Fresh water ,

2.3 Brackish water,

2.4 Inland saline and Marine water,

2.5 Principles of organic aquaculture,

2.6 Pond Management - Pre stocking and Post stocking,

2.7 Carrying capacity of pond with shrimps and crabs (Stocking Density),

2.8 Principle of crab and shrimp culture (Pond design management of crab and shrimp farm).

2.9 Factors influencing carrying capacity.

Practice 3 (2 h) : Components of Aquaculture farms

Module- III

3.1 Criteria for selection of animal species for aquaculture,

3.2 Major animal species for aquaculture: freshwater,

3.3 Brackish water, marine water.

3.4 Culture System - Monoculture and Polyculture System,

3.5 Integrated culture systems**,**

3.6 Principles involved in seed production of lobsters crabs and mussels,

3.7 Fattening process of crab and shrimps.

Practice 4 (2 h) : Collection and identification of commercially important seed of fish and shellfishes

Module- IV

4.1 Culture of mullet,

4.2 Culture of Cobia,

4.3 Culture of Pompano,

4.4 Lobster culture,

4.5 Mussel and Pearl /Oyster culture,

4.6 Sea weed culture,

Practice 5 (2 h) : Study on waste accumulation in aquaculture system (NH_3, Organic matter, CO_2)

Module- V

5.1 Feed technology**:** Micro encapsulated feeds;

5.2 micro coated feeds;

5.3 Micro particulate feeds and bio-encapsulated feeds;

5.4 Mycotoxins and their effects on feeds, 5. Sea ranching.

Practice 6 (2 h): Analysis of manure

Module- VI

6.1 Algal biotechnology**:** Biotechnological approaches for production of important microalgae;

6.2 single cell protein from *Spirulina;* vitamins, minerals and omega3 fatty acids from microalgae;

6.3 enrichment of micro algae with micronutrients.

Module- VII

7.1 Methods of Shellfish Culture rafts,

7.2 Racks,

7.3 Cages,

7.4 Poles and Ropes,

7.5 Sea Ranching,

7.6 Resources for shore-based aquaculture and sea farming in India,

7.7 Regulation for Mariculture

Practice 7 (2 h): Estimation of seed survival
Project : Use of probiotics in aquaculture farms.

Reference & Textbooks

1 Aquaculture principles and practices ----TVR Pillay and MN Kutty
2 Encyclopedia of aquaculture
3 Hand book fisheries and aquaculture----ICAR New Delhi 2006
4 Sustainable aquaculture byNagabhushanam R, Diwan AD, Zahurnec BJ &Sarojini R. 2004. *Biotechnology of AquaticAnimals.* Science Publ.

ANIMAL BIOTECHNOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Animal Biotechnology	CUTM1452	Theory andPractice	3-1-0	-

Objectives

1 To make the student understand the tools and techniques required for the animal cell culture, assisted reproductive technology, development of transgenic animals, and development of animal models.
2 The methods of culturing animal cells
3 To utilize animal production technologies for sustainable agriculture and food security

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	The methods of culturing animal cells
CO2	Various techniques involve in making of transgenic animals
CO3	To integrate assisted reproductive biotechnology techniques in livestock improvement.
CO4	To utilize animal production technologies for sustainable agriculture and food security
CO5	To integrate assisted reproductive biotechnology techniques in livestock improvement.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1		1	3	1	2	2			1		3	3	3	2
CO2	2	2		2	1		1			2	1	1	2	1	3
CO3	3		1	1		2				1		2	1	2	2
CO4	3		2		2		1				2	3	2	2	3
CO5		1		1		1	1			2		1	2	3	1

(High-3, Medium-2, Low-1)

Course outline

Module-I (Animal Cell and tissue culture technology-I): 8 H

1.1 Overview of animal cell and tissue culture technology;
1.2 Cell culture laboratory design and basic laboratory equipments;
1.3 Media preparation,
1.4 Role of important components of culture media;
1.5 Common laboratory hazards and safety issues to consider in cell culture laboratory

Practice 1(2h): Sterilization techniques used in animal cell culture
Practice 2(2h) : Preparation of media for animal cell culture

Module-II (Animal Cell and tissue culture technology-II): 8 H

2.1 Types of animal cell culture;
2.2 Characterization and preservation of animal cells;
2.3 Advances in cell culture technology;
2.4 Opportunities and challenges in animal cell and tissue culture technology

Practice 3 (2h): Study of primary cell culture technique using chick embryo
Practice 4(2h) : Animal cell batch culture technique

Module-III (Transgenesis for livestock improvement-I): 4 H

3.1 Overview of transgenic technology;
3.2 Biopharming through animal transgenesis;
3.3 Methods of producing transgenic farm animals;
3.4 Identification and transfer of gene influencing better production and disease resistance.

Module-IV (Transgenesis for livestock improvement-II): 5 H

4.1 Gene transfer methods in animals: Microinjection,
4.2 Retrovirus mediated gene delivery,
4.3 Embryonic stem cell mediated gene transfer;
4.4 Knockout model systems & their utility;
4.5 Animal as bioreactor.

Module-V (Assisted reproduction biotechnology for livestock improvement): 4 H

5.1 Reproduction biotechnologies and their use in livestock;
5.2 Somatic cell nuclear transfer cloning;
5.3 In Vitro Fertilization,
5.4 Embryo production,
5.5 Preservation and transfer;
5.6 Sperm and embryo sexing;
5.7 Intracytoplasmic sperm injection (ICSI);
5.8 Cryopreservation and gamete banking.

Module-VI

(Animal Production technology for sustainable agriculture and food security):7H

6.1 Polyculture of fish for high yield;
6.2 Edible oyster production;
6.3 Pearl oyster production;
6.4 Vermi-culture and vermicomposting for alternative and sustainable agriculture;
6.5 Fish culture in flow through system and recirculation technology.

Practice 5 (2h) :Vermicompost preparation from plant debris, cattle dung and paper waste

Module-VII

(Animal Biotechnology & human health): 6 H

7.1 Recombinant therapeutics and production of pharmaceuticals;
7.2 Production of tissues and organs for humans and xenotransplantation;
7.3 Process of gene therapy,
7.4 .*Pros* and *cons* in gene therapy;
7.5 Retrovirus and adenovirus mediated gene therapy.

Practice 6(2h) : Preparation of competent cell (Calcium chloride treatment method)

Text Books:

1 Freshney RI (1992) Animal cell culture: a practical approach, Oxford University Press
2 Singh B, Gautam SK (2013) Text Book of Animal Biotechnology, TERI

Reference Books:

1 SinghB, Mal G, Gautam SK, Mukesh M (2019) Advances in Animal Biotechnology, Springer
2 Butler M (2003) Animal Cell Culture and Technology, Taylor & Francis

ANIMAL BREEDING

Subject Name	Code	Type of course	T-P-P	Prerequisite
Animal Breeding	CUTM1453	Theory and Practice	3-1-0	-

Objectives

1 To educate about the concept of conservation of Animal Genetic Resources and their sustainable utilization.
2 To educate about the small farm animal breeding concepts.
3 To study genetic structure of animal population and importance of genetic variation and covariation among traits.

Course Outcome

COs	Course Outcomes
CO1	To educate about molecular techniques to identify molecular markers as an aid to selection.
CO2	To study genetic structure of animal population and importance of genetic variation and covariation among traits.
CO3	To explain the methodology of selection and breeding systems for genetic improvement of livestock and poultry.
CO4	To educate about the various biometrical techniques for data analysis and their applications in animal breeding research.
CO5	To explain the methodology of selection and breeding systems for genetic improvement of livestock and poultry.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1	1	3	1	2	2			1		3	3	3	2
CO2		2		2		1	1			2	1	1	2	1	3
CO3	3					2				1	1	2	1	1	2
CO4	2		2		2					2	2		2	3	2
CO5	2	1		1		1	1			2		1	2	2	2

(High-3, Medium-2, Low-1)

Course outline

MODULE -1

1.1 Domestication,

1.2 Early Developments in Animal Breeding,Overview of Animal Breeding, Economic Traits,

1.3 Statistical Measures and Methods in Animal Breeding.

PRACTICE -1 (2h) :- Problems relating to gene and genotypic frequencies under different conditions.

MODULE-2

2.1 Selection and Response to Selection,

2.2 Improving Response to Selection,

2.3 Computation of Selection Differential,

2.4 Computation of Generation,

2.5 Interval bases of selection.

PRACTICE-2(2h) :- Estimation of inbreeding in regular and irregular systems.

Estimation of effective population size.

MODULE-3

3.1 In-breeding & line breeding,

3.2 Outbreeding & heterosis,

3.3 Estimation of heterosis & Systems of cross-breeding.

PRACTICE-3(2h) :- a) Computation of quantitative genetic effects.

b) Estimation of variance components

MODULE-4

4.1 Development of New Breeds,

4.2 Breed and Breeding Industry Structure,

4.3 Breed Comparison: Genotype-Environment Interaction,

4.4 Animal Genetic Resources & Designing of Breeding Program.

PRACTICE-4 (2h) :- Computation of heritability, repeatability, genetic, environmental and phenotypic correlations and their standard errors.

MODULE-5

5.1 Breeds–Economic traits–Prolificacy-Breeding records and standardization,

5.2 Genetic parameters – Selection of males and females – Breeding systems,

5.3 Development of new breeds& Breeding policy – Breeding research – Conservation of breeds.

PRACTICE -5 (2h) :- Estimation of breeding values from different sources of information.

Prediction of direct and correlated response to different bases of selection.

MODULE-6

6.1 Biometrical models and their analytical techniques on simulated and actual animal breeding data using computer application and use of programme in the field of animal breeding,

6.2 Advanced techniques in genetic manipulation for multiplication and improvement of livestock species.

PRACTICE-6 (2h) :- a) Computation of realized heritability and genetic correlation.

b) Selection index: Computation, Accuracy and response in component trait

c) Estimation of hetrerosis for different types of crosses.

d) Estimation of GCA and SCA

MODULE-7

7.1 History of dairy cattle and buffalo breeding,
7.2 Breeds of cattle and buffalo and their Characterization,
7.3 Inheritance of important economic traits,
7.4 Recording and handling of breeding data,

7.5 Standardization of records,
7.6 Computation of correction factors for the adjustment of the data and Estimation of the breeding values of cows and bulls.

Text books & References

1 Animal breeding – by Groenkennisnat
2 Animal breeding – by Gurvinder Singh Brar
3 Animal Genetics and Breeding – by Sukhbir Singh Tomar
4 Textbook of Veterinary Physiology – byBhattacharya. B
5 Textbook of Animal husbandry – G.C Banerjee

AQUARICULTURE, VALUE ADDITION AND QUALITY MANAGEMENT

Subject Name	Code	Type of course	T-P-P	Prerequisite
Aquariculture, Value addition and Quality management		Theory-Practice	3-1-0	-

COURSE OBJECTIVE

1 .The goal of the Aquaculture Biology specialization is to give a theoretical basis and practical experience for understanding the biological principles in aquatic food production.
2 The specialization is intended to give a solid background for students who wish to work in aquaculture or related industries, or to pursue further research.
3 Students will understand the basis of technologies of fisheries and aquaculture.

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand the basis of technologies of fisheries and aquaculture
CO2	To know the knowledge about feed based on the nutritional requirements of fish/shell fish.
CO3	To enhance the skill for preparation of feed using different feed formulations
CO4	Students will gain experience in researching, discussing, and answering questions about aquariculture and value addition
CO5	To evaluate the various techniques to enhance the skill for the fish processing and preservation. .

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2		2			2				3			3	2	3
CO2				2	1	1				2	1	1	3	1	3
CO3		1		1		1	1			3		3	3	3	3
CO4		1			1					2		1	2	3	2
CO5	2	1		1						2		3	1	1	2

(High-3, Medium-2, Low-1)

MODULE-I

PRINCIPLE OF FISH FEED IN AQUACULTURE

1.1. Scope of Food and feeding habits of fish and shell fish.

1.2. Role of different nutrients of fish and shellfish growth.

1.3. Importance of Principle of Protein energy ratio for aquaculture

1.4. General principles for feed formulation.

1.5. Different (2 h) :Identification of Common feed ingredients

Practice II..(2 h): Preparation of artificial feeds using locally available feed ingredients

MODULE- II

FISH FEED QUALITY AND NUTRITION

2.1 Evaluation of ingredient quality of fish feed

2.2 Types of feed Dry (pellets, flakes, powdered, Moist Feed),

2.3 Micro-encapsulated of fish nutrition.

2.4 Micro-bound and micro-coated diets of fish nutrition

2.5 Feed manufacturing units and processes.

Practice III.(2 h): Identification of Common feed ingredients

MODULE-III

Concept of Aquaculture and feeding Methods

3.1 Concept of Aquaculture

3.2 Criteria of selection of suitable fish species

3.3 Traditional Feeding methods in Aquaculture

3.4 Different Feeding Practices used by Indian Farmers,

3.5 Demand feeders in aquaculture.

Practice IV.(2 h): Preparation of artificial feeds using locally available feed ingredients

MODULE-IV

Aquarium setup and management

4.1Identification of common ornamental fishes

4.2Construction and setting of aquarium - Types of aquarium tanks,

4.3Construction of home aquarium and Setting up of home aquarium

4.4Maintenance of aquarium (cleaning and water quality management)

4.5 Aquarium accessories and decorative

Practice V.(2h) Setting up and maintenance of Aquarium accessories and equipment

MODULE-V

Canning and Freezing system of fish product

5.1 Principles of Canning

5.2 Packaging Materials

5.3 Canning of specific species

5.4 Freezing systems of fish

5.5 Environmental impact of freezing operations

Practice-VI. (2h) : Preparation of fish pickle and Dry Fish

MODULE-VI

ENVIRONMENTAL IMPACT AND ASSESSMENT OF AQUACULTURE

6.1 Basics of aquaculture
6.2 Definition and scope of aquaculture
6.3 Systems of aquaculture: Pond culture , Pen culture, Cage culture and Running water culture
6.4 Present global and national scenario of aquaculture
6.5 Zero water exchange system. of aquaculture
Practice VII. (2 h): Aquaculture production and resource statistic
s- World and India

MODULE-VII

PRINCIPLE OF FISH CULTURE SYSTEM

7.1 Criteria for selection of animal species for aquaculture

7.2 Culture System - Monoculture and Polyculture .

7.3 Principle of organic aquaculture

7.4 Principle of crab and shrimp culture (Pond design management of crab and shrimp farm).

7.5 Factors influencing carrying capacity

Practice VIII. (2 h) : Components of Aquaculture farms

Reference & Textbooks

1. Aquaculture principles and practices ----TVR Pillay and MN Kutty

2. Fish and Fishery s .chand Publication

3 .Fish Nutrition in Aquaculture ---- De Silva, Trevor & Anderson

4. Aquarium fish keeping and management----CLS Srivastava and Amita Saxena

Aquarium fishes ---Jena Burton

5. Handbook of Fish Biology and FisheriesEdited by Paul J.B. Hart and John D. Reynolds 2002 Volume 1 Fisheries

FISH BIOLOGY AND NUTRITION

Subject Name	Code	Type of course	T-P-P	Prerequisite
Fish Biology and Nutrition		Theory-Practice	3-1-0	-

Objective

- To understand basic biology of a fish
- To learn about nutritional requirements in fish
- To gain idea on nutritional management in fish

Course Outcome

COs	Course Outcomes
CO1	To introduce the immensely fascinating world of fish biology
CO2	To give advanced information on the unique adaptations of various biological systems of fish
CO3	To gain the knowledge about feed based on the nutritional requirements of fish/shell fish.
CO4	To explain the integrated approach to learn physiological process of nutrition related to various fish and shellfish.
CO5	To analyze the process of nutrition and its value addition.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1		1	2	2			1	2		2	3	1
CO2	2			2	1	2	1				1	3	2	1	2
CO3	2	2	1	1		2						2	1	1	2
CO4							1					1	3	3	3
CO5		1		1		1	1			2		1	3	2	2

(High-3, Medium-2, Low-1)

Course Outline

Module- I.

Scope and utility

1.1. Natural history and diversity of fishes.
1.2. General classification of fishes. Classification of selected orders.
1.3. Morphology and anatomy: Body forms, fins, scales, colouration. Meristic and morphometric studies; truss morphometry**.**
1.4. Sense organs of fishes and crustaceans.
1.5. Specialized organs in fishes – electric organ, venom and toxins

1.6 Buoyancy in fishes- swim bladder and mechanism of gas secretion.

1.7 Fish and Crustaceans of commercial importance.

Practical 1 – Demonstration of specialized organs in fish

Module II:

Digestive system in Fish.

2.1. Digestive system.

2.2. Food and feeding: Natural fish food. Types of feeding.

2.3 Structural modifications in relation to feeding habit.

2.4. Fullness of stomach and feeding intensity.

2.5. Relative gut length. Gut content analysis.

Practical 2 – Demonstration of digestive system in fish

Module- III.

General idea on respiratory, circulatory, excretory, and Nervous system in fish

3.1. Air bladders in fishes. Weberian-ossicles. Gas exchange, blood and circulatory system.

3.2. Excretory system in fish

3.3. Endocrine system in fish

3.4. Nervous system and sense organs.

3.5. Osmoregulation and ion balance.

3.6. Electric organs and luminous organs.

Practical 3 – Demonstration of respiratory, circulatory, excretory, and Nervous system in fish.

Module IV –

Reproductive Biology of fish

4.1. Breeding in fishes, breeding places, breeding habits & places,

4.2. Breeding in natural environment and in artificial ponds, courtship and reproductive cycles

4.3. Induced breeding in fishes

4.4. Breeding mechanism in fish: Old and advanced methods.

Practical 4 – Demonstration of male and female reproductive system in fish.

Module- V – Food, Feeding and Growth.

5.1. Food and feeding habits of commercially important fish,
5.2. Principal Nutrients essential for feed formulation, Role of different nutrients on fish growth.
5.3. Nutritional requirement of cultivable fish, Importance of Principle of Protein: Energy Ratio for aquaculture.
5.4. General principles for feed formulation, Different steps of feed formulation,
5.5. Methods of Feed formulation, Classification of feed ingredients, Energy and protein sources.
Practical 5 – Preparation of artificial feeds using locally available feed ingredients

Module- VI - Types of food in fish

6.1. Evaluation of ingredient quality.

6.2. Types of feed Dry (pellets, flakes, powdered, Moist Feed),

6.3 Micro-encapsulated, micro-bound and micro-coated diets,

6.4 Feed manufacturing units and processes.

Practical 6 – Proximate analysis of feed ingredients and feeds: Moisture, Crude protein

Module- VII – Feeding practices and management in fish.

7.1. Measures of feed energy and their relation.

7.2. Methods of digestibility study, Factors affecting digestibility,

7.3. Role of feed digestibility study in feed quality evaluation,

7.4. Feed Management in Aquaculture Farms. Traditional Feeding methods in Aquaculture,

7.5. Different Feeding Practices used by Indian Farmers.

7.6. Demand Feeders.

Practice 7 - Effect of Storage on Feed Quality and Determination of sinking rate feeds

References:
1. Bone, Q and R.H. Moore. 2008 (Third Ed.). Biology of fishes. Taylor & Francis Group, New York.
2. Biswas, S.P. 1993. Manual of Methods in Fish Biology. South Asian Publ. Pvt. Ltd., New Delhi,
3. Biswas, K.P. 1996. A Textbook of Fish, Fisheries and Technology. 2nd ed. Narendra Publ. Hse., India,
4. Chandrasekhar, Y.S. 2013. Fish Nutrition in Aquaculture. Swastick Publications, Delhi.
5. Cowey, C.B. et al. 1985. Nutrition and Feeding in Fish. Academic Press, New York
6. De Silva, S.S. and Anderson, T.A. 1995. Fish Nutrition in Aquaculture. Chapman and Hall Ltd., London E-sources-

ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Animal Physiology & Endocrinology		Theory-Practice	3-1-0	-

Objectives

The purpose of the course is to make the students to understand Animal Physiology & Endocrinology

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand understanding of the fundamental principles of animal physiology
CO2	Students will understand how these principles are incorporated into the adaptations of different animal groups
CO3	Students will able to provide practical experience in investigating physiological questions, and collecting, analyzing, interpreting, and reporting experimental data;
CO4	Students will gain experience in researching, discussing, and answering questions about animal physiology
CO5	Students will understand the source, significance and deficiency and dysfunctions of enzymes, vitamins, protein, carbohydrates and lipids.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1			2				2		3	3	3	3
CO2	2			2	1						1	1	2	1	3
CO3	1	1		1		2	1			1			2	3	2
CO4			1									2	1	3	3
CO5		1			1							1	3	2	3

(High-3, Medium-2, Low-1)

Course outline

Module- I

Response to Cell & Functional Physiology

1.1 Concept of Poikilothermy and Homeothermy

1.2 Survival Mechanism in Poikilotherms and Homeotherms

1.3 Cold Resistance and Cold Death, Heat Resistance and Heat Death

1.4 Respiratory Organs in Different Animals

1.5 Transport of Oxygen and Carbon dioxide 1.8 Respiratory Pigments

Practice 1 (2 h): Study of T.S/L.S/V.S of digestive organs (Stomach,Liver,Kidney,intestine etc.)

Module- II

Circulation and Cardiovascular System

2.1 Types of heart

2.2. Concepts of Neurogenic and Myogenic Hearts

2.3 Cardiac cycle, ECG patterns in Mammals

2.4 Homeostasis and Blood Clot Formation

Practice 2 (2 h) : Study of TLC/DLC from prepared blood smear/Determination of ABO Blood group

Module- III

Physiology of Digestion and Excretion

3.1 Patterns of Digestion and Absorption in Animals

3.2 Role of Digestive Enzymes

3.3 Digestion, Absorption and Assimilation of Various Food Stuffs

3.4 Functions of Kidney

3.5 Types of Nitrogenous Wastes in Different Animal Groups and their Excretion

3.6 Urea production – Hans Krebs and Kurt Henseleit cycle, Urine Formation

3.7 Osmoregulation 3.9.1 Reptiles, Aves & Mammals

Practice 3 (2 h) : Estimation of haemoglobin using Sahli'shaemoglobinometer /Enumeration

Module- IV

Physiology of Nervous system and Muscle stimulation

4.1 Structure of a Neuron

4.2 Generation of Nerve Impulsion and Propagation

4.3 Synaptic Transmission and Neurotransmitters

4.4 Concept of Sensory Receptors (Chemo and Photo)

4.5 Structure, Kinds and Characteristics of Muscles

4.6 Mechanism of Muscle Stimulation and Contraction

4.7 Neuro - Muscular Junction

Practice 4 (2 h) : Measuring B cell function and Insulin action in clinical practice

Module- V

History and Scope of Endocrinology

5.1 Brief history and Scope of Endocrinology

5.2 Classification and Chemical Nature of Hormones

Practice 5 (2 h): Immunopathoenesis of Type 1 diabetes

Module- VI

Pituitary and Thyroid Glands

6.1 Structural organization
6.2 Hormone secretion and its functions - Hypothalamic control
6.3 Thyroid Gland - Structural Organizations
6.4 Parathyroid its Structure and Functions

Practice 6 (2 h): Hypoglycemia in Diabetes

Module- VII

Pancreas and Adrenal Glands

7.1 Structure of pancreas
7.2 Pancreatic hormones and their functions
7.3 Dysfunction and disease of pancreatic hormones
7.4 Structural Organizations of Adrenals
7.5 Functions of Cortical and Medullary Hormones

Practice 7 (2 h): Clinical trials in Diabetes

Reference & Textbooks:

1. *Hoar, W.S.1991. General and Comparative Physiology. Prentice Hall of India, New Delhi.*
2. *Prosser, C.L. 1973. Comparative Animal Physiology, 3 rd edn. W.B. Saunders & Co., Philadelphia.*
3. *Barrington, E.J.W.1975. An Introduction to General and Comparative Endocrinology. Clarendon Press, Oxford*
4. *Bentley, P.J.1971. Endocrine and osmoregulation, Springer Verlag, New York.*
5. *Palmen,J.D. Brown, I.R and Hastings, J.W.1970. Biological clocks, Academic Press, London.*
6. *Welson, A. 1979. Principles of Animal Physiology.McMillan Publishing Co. Inc. New York.*
7. *Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London.*
8. *Herkat, P.C.and Mathur, P.N.1976. Text Book of Animal Physiology.S.Chand Co. Pvt, Ltd., New Delhi..*

Immunology and Cancer Biology

Code	Course Title	Course Type	Credits	L-Pr-P (hrs)
CUTM1451	**Immunology and Cancer biology**	**Theory + Practice**	**4**	**3-1-0**

Objectives

1 The primary objective of this course is to help students develop knowledge and skills related to health and disease and role of immune system.

2 students are taught immunology so as to develop understanding of the subject, such as functioning the immune system, the molecular and cellular components and pathways that protect an organism from infectious agents.

3 The common cellular and molecular mechanisms that are deregulated in cancerous cells and their contribution to the development of cancer.Role of gene mutation and environmental factors in the development of cancer.

Course Outcome

COs	Course Outcomes
CO1	To understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
CO2	To know about biological aspects of cancer, carcinogenesis and cancer therapy.
CO3	Students will know the principle and application of various immune techniques and they can Will be able to make a strategy for immunological research and execute it.
CO4	To understand the immunomodulatory strategies essential for generating or suppressing immune responses as required in hypersensitivity reactions, transplantation, autoimmune diseases and cancer.
CO5	To apply various immune techniques and they can will be able to make a strategy for immunological research and execute it.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		1			2		3				3	2	1	1
CO2	2			2	1	2		2			1	1	2	1	3
CO3	2	1		1		1	1	2					1	2	3
CO4		1			2			3				3	2	2	1
CO5		1		1			2	2				2	3	1	1

(High-3, Medium-2, Low-1)

Course Outline

Module-1

Cells and Organs of the Immune System-

1.1 Hematopoiesis,

1.2 Cells and Organs of the Immune System,

1.3 Structure and function of antibodies, 4.Inflammation

Practice 1(2h): Demonstration of lymphoid organs

Module-II

2.1 Development and Signaling of Immune system- Innate Immunity,

2.2 TLRs and their role in innate,

2.3 Immune response Adaptive Immunity,

2.4 Cytokines,

2.5. Development of B-lymphocyte and T-lymphocyte

Practice 2(2h): To isolate the lymphocyte from whole blood by density gradient centrifugation method

Module III

3.1 Structure and function of MHC complex -antigen processing cells,

3.2 Antigen processing and presentation to T lymphocytes,

3.3 MHC restriction. TCR structure and function

Practice 3(2h): Screening antisera or hybridoma supernatants for specific antibodies

Module-IV

4.1 Effector mechanisms and regulation of immune responses: Complement system,

4.2 Hypersensitivity,

4.3 Autoimmunity and tolerance,

4.4 Transplantation

Module V

5.1 Techniques related to immunology Monoclonal Antibodies,

5.2 Vaccines,

5.3 Radio

5.4 Immunoassay,

5.5 ELISA,

5.6 Diffusion.

Practice 4(2h) : To detect the presence of an antigen in a sample
Practice 5 (2h): To learn coupling of antibody to enzyme Horse Radish Peroxidase (HRP)
Practice 6(2h): Study of basic Ouchterlony's double immuno-diffusion method.

Module-VI

6.1 Biology of cancer cells,

6.2 Genetics of Cancer,

6.3 Genetic Variation and Mutation,

6.4 Two-Hit Hypothesis,

6.5 Epigenetics of cancer
Practice 7(2h): Tumor cell growth in different media

Module VII

7.1 Oncogene and tumour suppressor gene: progression of cancer,

7.2 Metastasis,

7.3 Apoptosis in cancer,

7.4 DNA repair in cancer

Recommended books:

1 **Text Books**:
Owen, J. A., Punt, J., &Stranford, S. A. (2013). Kubyimmunology.seventh Edition, New York: WH Freeman.
2 Robert A. Weinberg, "The Biology of Cancer," Garland Science; 1 Cdr Edition, 2010

Reference Books:

1. Owen, J. A., Punt, J., &Stranford, S. A. (2013). Kubyimmunology. New York: WH Freeman

2. Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology, V Edition, Saunders Publication.
3. Janeway'sImmunobiology(2016) 9th Edition, by Kenneth Murphy, Casey Weaver, Garland Science
4. David Male, Jonathan Brostoff, David Roth and Ivan Roitt(2012) Immunology,8th Edition, Elsevier Publication
5. Lauren Pecorino, "Molecular Biology of cancer: Mechanisms, Targets, and Terapeutics," Oxford University.

Bioanalytical Techniques and Biostatistics

Subject Name	Code	Type of course	T-P-P	Prerequisite
Bioanalytical Techniques and Biostatistics		Theory-Practice	3-1-0	-

Objectives

- *To understand the fundamental principles and applications of bioanalytical techniques to analyze biological samples.*
- *To develop proficiency in using statistical tools for analyzing and interpreting biological data.*
- *To combine bioanalytical methods with biostatistical analysis to draw meaningful conclusions from biological research studies.*

Course Outcome

At the end of the course, students will be able to:

COs	Course Outcomes
CO1	Recall and identify the principles, procedures, and applications of common bioanayltical techniques
CO2	Demonstrate an understanding of fundamental statistical concepts and bioanayltical methods, explaining how they are applied in biological research.
CO3	Apply bioanayltical techniques to analyze biological samples, ensuring accuracy and precision in data collection.
CO4	Analyze biological data using appropriate statistical methods to assess experimental results, identify trends, and make data-driven conclusions.
CO5	Evaluate experimental designs and bioanayltical data, assessing factors such as reliability, validity, potential biases, and the appropriateness of statistical analyses, providing recommendations for improvement.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1			2				1		2	2	3	2
CO2	2			2	1	2					1	3	2	1	1
CO3	2	1		1		1	1			1			2	3	3
CO4		2									1	1	3	1	2
CO5			2		1						2	3	1	2	3

(High-3, Medium-2, Low-1)

Course outline

Module- I

Microscopy

1.1 Visualization of cells and subcellular components by light microscopy

1.2 Resolving powers of different microscopes

1.3 Microscopy of living cells

1.4 Scanning and transmission microscopes

1.5 Different fixation and staining techniques

1.6 Freeze-etch and freeze fracture methods for EM

Practice 1 (2 h): To observe the structure of different types of human blood cells under the compound microscope.

Module- II

Spectroscopy

2.1 Absorbance spectra

2.2. Molecular analysis using UV/visible spectroscopy

2.3 Circular dichroism, Electron spin resonance spectroscopy

2.4 Molecular structure determination using X-ray diffraction and Nuclear magnetic resonance

2.5 Infrared and Raman spectroscopy

2.6 Mass spectrometry and surface plasma resonance methods

Practice 2 (2 h): To determine the concentration of proteins in chick eggs using a UV-visible spectrophotometer.

Module- III

Radiolabeling and Electrophysiological methods

3.1 Detection and measurement of different types of radioisotopes normally used in biology, safety guidelines

3.2 Molecular imaging of radioactive material

3.3 Safety guidelines in handling radioisotopes

3.4 Single neuron recording and patch-clamp recording

3.5 Electrocardiogram, Brain activity recording, lesion and stimulation of brain

3.6 Positron emission tomography and magnetic resonance imaging

Module- IV

Centrifugation

4.1 Basic principles of sedimentation

4.2 Types of centrifuges

4.3 Types of rotors

4.4 Preparative centrifugation (Differential & density gradient centrifucation)

4.5 Analytical ultracentrifugation

4.6 Separation of proteins using analytical ultracentrifugation

Practice 3 (2 h): To separate DNA from fish tissues using centrifugation.

Module- V

Chromatography and Electrophoresis

5.1 Principles of chromatography (Adsorption and Partition chromatography)

5.2 Planar and column chromatography

5.3 Ion exchange chromatography and Affinity chromatography

5.4 Gas chromatography, gel permeation chromatography and high-performance liquid chromatography

5.5 Electrophoresis of nucleic acids (Agarose gel electrophoresis, Northern and Southern blotting)

5.6 Electrophoresis of proteins (Polyacrylamide gel electrophoresis and Western blotting)

Practice 4 (2 h): To separate DNA fragments of different molecular weight using agarose gel electrophoresis.

Module- VI

Immunotechniques and Recombinant DNA methods

6.1 Antibody generation

6.2 Detection of molecules using enzyme-linked immunosorbent assay, Radioimmunoassay and flowcytometry

6.3 Fluorescence in situ hybridization and genomic in situ hybridization

6.4 DNA sequencing methods and strategies for genome sequencing

6.5 Analysis of gene expression and protein sequencing methods

6.6 Restriction Fragment Length Polymorphism, Random Amplified Polymorphic DNA and Amplified Fragment Length Polymorphism techniques

Practice 5 (2 h): To compare DNA profiles of *Labeo rohita* and *Catla catla* using DNA fingerprinting

Module- VII

Biostatistics

7.1 Measures of central tendency
7.2 Measure of Variability and standard deviation
7.3 Correlation and Regression
7.4 Student's t-test
7.5 Chi-square test
7.6 Analysis of variance

Practice 6 (2 h): To compare the effect of different fish feeds on growth of the zebrafish using measures of central tendency and one-way ANOVA.

Reference and Textbooks:

1 *Wilson K and Walker J (2009). Principles and techniques of biochemistry and molecular biology.7th Edition, Cambridge University Press, Cambridge, UK.*

2 *Voet D and Voet J (2010). Biochemistry. 4th Edition. John Wiley and Sons. NewJersey, USA*

3 *Rodney F Boyer (2012). Biochemistry laboratory: modern theory and techniques.2ndEdition, Pearson Prentice Hall, Boston, USA.*

4 *R. Katoch (2011). Analytical techniques in biochemistry and molecular biology, Springer, New York.*

CELL AND MOLECULAR BIOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Cell and Molecular Biology	CUTM1437	Theory and Practice	3-1-0	

Objectives

1 To understand cell biology of all major groups of organisms, including microorganisms, plants and animals
2 To analyze genome organisation differs in the major groups of organisms
3 To evaluate the complex interactions between nucleus and cytoplasm that determine how cells function

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	To understand major ideas and current experimental approaches in cell biology and molecular biology.
CO2	To describe the biological processes such as DNA replication, transcription and translation.
CO3	To analyze basic concepts specialization of cells into different types in complex organisms.
CO4	To apply the concepts of molecular biology in realizing the biological issues occurring in the cell.
CO5	To evaluate the role of cytoskeleton in cell trafficking.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		1	1	1	1				3	3	3	2
CO2	2	2		2			2				1	1	3	1	1
CO3	2					1	2						2	2	3
CO4			1								1	2	2	2	3
CO5		1		1	2		1					3	2	3	2

(High-3, Medium-2, Low-1)

Course outline

Module I:

Biological Membranes And Transport Of Biomolecules

1.1 Structure of biological membranes: Cell wall (Prokaryotic versus eukaryotic),
1.2 The plasma membrane,
1.3 Membrane proteins,
1.4 Mobility of membrane proteins,
1.5 Membrane biogenesis: Cell wall and cell membrane biogenesis,
1.6 Cell-Cell and cell-matrix interactions: Extracellular matrix and cell-matrix interactions (Matrix structural proteins, Matrix Polysaccharides; Matrix adhesion proteins),
1.7 Cell-Cell interactions (Adhesion Junctions,
1.8 Tight Junctions,
1.9 Gap junctions, Plasmodesmata),
1.10. Membrane Trafficking (Pumps, channels, transporters): Ions channels,
1.11 Active transport driven by ATP hydrolysis,
1.12 Active transport driven by Ion gradients,
1.13 Passive transport,
1.14 Facilitated transport,
1.15 Endocytosis (Phagocytosis, receptor-mediated endocytosis).

Module II:

Cytoskeleton, Cell motility and Cell division

2.1 Structure and Organization of Actin Filaments: assembly and disassembly of actin filaments,
2.2 Organization of actin filaments,
2.3Association of actin filaments with the plasma membrane,
2.4 Intermediate filaments: assembly of intermediate filaments,
2.5 Intracellular organization of intermediate filaments,
2.6 The microtubule: structure and dynamic organization of microtubules,
2.7 Eukaryotic cell division: Mitosis and Meiosis,
2.8 Cell death and cell renewal: Programmed cell death,
2.9 Stem cells and maintenance of adult tissues. Cell cycle and its regulation. Chek point.

Module III:

Intercellular communication and the Nucleus

3.1 Signaling molecules and their receptors,
3.2 Modes of cell signaling,
3.3 Cell surface receptors, G Protein-coupled receptors. Receptor protein tyrosine kinases,
3.4 Cytokine receptors,
3.5 Pathways of Intracellular signal transduction,
3.6 Second messengers,
3.7 The cAMP Pathway,
3.8 CGMP,

3.9 Nuclear organization,
3.10 Traffic between the nucleus and the cytoplasm,
3.11 Chromosomes,
3.12 Chromatin organization (DNA packaging),
3.13 Lampbrush chromosome,
3.14 Polytene chromosome,
3.15Telocentric chromosome,
3.16 Inter-phase chromatin,
3.17 Euchromatin and Heterochromatin,
3.18. karyotype and its significance,
3.19 The Nucleolus.

Module IV:

Replication, Protein-Nucleic Acid Interactions and Transcription

4.1 Prokaryotic and eukaryotic DNA replication: DNA polymerases,
4.2 Replisome,
4.3 Primase, telomerase,
4.4 Inhibitors of replication. DNA synthesis by reverse transcription,
4.5 Prokaryotic transcription mechanisms,
4.6 Prokaryotic transcriptional regulation (Operon concept),
4.7 Eukaryotic transcription –core promoter and general transcription factors (GTFs),
4.8 Eukaryotic transcription–activating transcription factors and enhancers,
4.9 Post-Transcriptional Control of Gene Expression.

Module V:

RNA Processing, Translation and Protein sorting.

5.1 RNA-processing,
5.2 mRNA export. Post transcriptional modification and: RNA splicing,
5.3 Spliceosome,
5.4 RNA editing,
5.5 Genetic code. Translation: Protein synthesis,
5.6 Post-translational modifications: Glycosylation,
5.7 Phosphorylation,
5.8 Ubiquitination,
5.9 Inhibitors of transcription and translation.Protein sorting and Targeting: Co translational targeting and post translational targeting. Protein targeting to Mitochondria,
5.10 Chloroplast,
5.11 Endoplasmic reticulum,
5.12 Peroxisome and Plasmamembrane. Regulation of gene expression in prokaryotes and eukaryotes: role of chromatin in regulating gene expression and gene silencing.

Module VI:

Protein Structure, Function and Evolution

6.1 Unique principles of protein structure and molecular machines (primary, secondary,
6.2 Tertiary,
6.3 quaternary structures),

6.4 Study of protein structures (circulsardichorism, X-ray crystallography and cryo electron microscopy),
6.5 How proteins have evolved and how analysis of protein structure can help us to understand the evolutionary relationships between different proteins and their function

Module VII:

Enzyme Catalysis and Protein Engineering

7.1 How the peptide and protein structures discussed in the preceding module can assume functions,
7.2 Enzyme catalysis,
7.3 Mechanism and kinetics,
7.4 Co-operative (allosteric) molecular basis of metabolic regulation, Principles of protein folding and stability,
7.5 Protein engineering and mechanistic enzymology–how to create novel,
7.6 functional proteins by rational design,
7.7 Semi-rational approaches and by directed evolution.

Practical's (Duration of each practice is of 2hours)

1. Visualization of DNA by performing agarose gel electrophoresis and extraction of DNA from the agarose gel.
2. Extraction of DNA from the fish fins.
3. Plasmid isolation (miniprep).
4. Polymerase Chain Reaction (PCR)
5. Glucose uptake assay
6. *In silico*membrane-receptor and ligand interaction studies using DISCOVERY STUDIO (BIOVIA).

Reference

E-content:

Youtube animations and videos, virtual lab, Slide share.

Text Books:

1. Geoffrey M. Cooper, Robert E. Hausman (Boston University). The Cell: A Molecular Approach. ASM Press, Washington D.C. Fourth edition.
2. Cell and molecular biology Robertis, De and Robertis Lea and Febiger. Eighth Edition.

Reference Books:

1. Molecular Biology of the Cell Alberts, B., et al. 6th Rev ed. Taylor & Francis; 2014 ISBN 978-0-8153-4432-2 (hard), 978-0-8153-4524-4
2. Essential Cell Biology Alberts, B., et al. 4th Rev ed. Garland; 2013 ISBN 9780815344544
3. Lewin's Genes XII Krebs, J.E. et al. Jones & Bartlett; 2018 ISBN 9781284104493
4. Molecular Cell Biology Lodish H. et al. 8th ed. W.H. Freeman and Company; 2016 ISBN 9781464183393

GENETICS AND EPIGENETICS

Subject Name	Code	Type of course	T-P-P	Prerequisite
Genetics and Epigenetics	CUTM1454	Theory and Practice	3-1-0	

Objectives

1. To explain and provide examples of how continuous traits are "quantitative traits" and that phenotypic variation may be due to genetic variation within a population and/or environmental variation experienced by individuals within a population.
2. To explain the polygenic theory of genetic variance and the nature of additive alleles, and the assumptions that accompany these ideas and also able to provide competing hypotheses that explain a distribution data set of phenotypes.
3. To discuss epigenetics and its role in cancer, imprinting and X chromosome inactivation.

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will have an understanding of the role of genetic mechanism in evolution.
CO2	Be able to predict the phenotypic classes and their ratios from a monohybrid cross involving dominant and recessive alleles.
CO3	Be able to predict the phenotypic classes and their ratios from a cross involving co-dominant or incompletely dominant alleles .
CO4	Be able to predict the ratio of a specific genotype and/or phenotype from a cross involving multiple independently assorting genes (with each gene exhibiting only dominant and recessive alleles) .
CO5	To analyze the modifications/mechanisms of DNA marks that result in epigenetic changes and also to discuss the role of epigenetics in environmental exposures.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1			2		1		1		1	3	3	2
CO2	2			2	1	2	2				1	1	2	1	3
CO3	3	3	2		2							2	2	3	2
CO4			2			1					2	2	2	3	3
CO5		1		2	2	1	1			1		3	1	2	3

(High-3, Medium-2, Low-1)

Course outline

Module - 1: Principles of Inheritance (5 h)

1.1 Laws of heredity, Co-and incomplete dominance, Gene Linkage and crossing over,
1.2 Varieties of Gene interractions - lethal genes,
1.3 Multiple alleles,
1.4 Pleiotropic genes,
1.5 Gene epistasis,
1.6 Structural and numerical alterations of chromosomes and meiotic consequence, Cytoplasmic Inheritance ,
1.7 Sex-chromosome systems; Different mechanisms of sex determination in animals(Drosophila, Man, Bees and Bonellia)

Module - 2: Linkage and Crossing over in diploid organisms (5 h)

2.1 Sex linkage: Sex linked genes in man,
2.2 Sex chromosome disorders in man,
2.3 Detection of linkage & Linkage maps: Test cross,
2.4 Test for linkage on the basis of F2 generation,
2.5 LOD score,
2.6 Gene mapping,
2.7 Three point test cross in Drosophila,
2.8 Construction of linkage maps, Identification of particular linkage groups with specific chromosome,
2.9 Physical distance and map distance, 10. Interference and coincidence

Module - 3: Mitotic recombination and Chromosomal abnormalities (4 h)

3.1 Mitotic Recombination,

3.2 Recombination within gene,

3.3 Spontaneous and induced mutations,

3.4 Physical and chemical mutagens,

3.5 Chromosomal aberrations,

3.6 meiotic behaviour of deletion,

3.7 Duplication,

3.8 Inversion and translocation,

3.9 Euploids and aneuploids-classification,

3.10 Origin, 11.Induction, 11.Role of polyploidy in evolution.

Practice 1 (2h) : Preparation of Mitotic chromosomes from the given sample

Module - 4: Human genetics and Genomics (5 h)

4.1 Human genetics - Chromosomal disorder,
4.2 Some common human syndromes,
4.3 Twin study,
4.4 Superfoetation,
4.5 Polyembryony,
4.6 Free Martin,
4.7 Multiple birth,
4.8 Amniocentesis and Genetic Counselling,
4.9 Nature and function of genetic material,
4.10 Chemical compounds causing genetic damage,
4.11 Gene mapping and genome analysis.

Practice 2 (2h): To study the karyotyping of chromosomes from the given animal samples.

Module - 5: Epigenetics and Chromatin structures (4 h)

5.1 Epigenetics vs Genetics,

5.2 Epigenetics from phenomena to field : overview and concepts,

5.3 Basic organization of eukaryotic genome,

5.4 Histone proteins.

Practice 3 (2h): To study the chromatin modelling and Chromatin-immunoprecipitation (ChIP)
Practice 4(2h):Isolation of total histones, and resolution on SDS-PAGE.

Module - 6: Epigenetic marks and chromatin modifications (5 h)

6.1 Histone modifications and the histone code,
6.2 Chromatin remodelling complex and histone variants,
6.3 DNA Methylation,
6.4 Acetylation and Deacetylation,
6.5 Phosphorylation, Ubiquitylation,
6.6 Deubiquitylation and Phosphorylation.

Practice 5 (2h): Isolation of DNA from animal cell (Isolation of nuclei (as a source for studies on structure of chromatin) from rat/mouse liver by discontinuous sucrose-density gradient centrifugation.

Module - 7: Dosage compensation and Genomic imprinting (4 h)

7.1 Dosage compensation in mammals,
7.2 Genomic imprinting in mammals,
7.3 Germline and pleuripotent stem cells,
7.4 Epigenetics and human disease.

Practice 6(2h): Identification of inactivated X chromosomes as barr body from the given sample

Practice 7 (2h) : Preparation and study of metaphase chromosomes from mouse bone marrow

Reference & Textbooks

1 Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India.
2 Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3 Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics X Edition. Benjamin Cummings.
4 Russell, P. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
5 Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.
6 Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
7 Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
8 Barton, N. H., Briggs, D. E. G., Eisen, J. A.Goldstein, D. B. and Patel, N. H. (2007). Cold Spring, Harbour Laboratory Press.
9 Hall, B. andHallgrimsson, B. (2008). Evolution. IV Edition. Jones and BartlettPublishers
10 Campbell, N. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin,Cummings.
11 Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
12 Epigenetics, C. David Allis and Thomas Jenuwein, (2007)Cold Spring Harbor Laboratory Press, New York, USA .
13 Molecular Biology of Gene, Watson et al., (5th Ed. 2004), Pearson Education, Delhi, INDIA, Genetics by P.K Gupta.

MICROBIOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Microbiology	CUTM1436	Theory and Practice	3-1-0	

Objectives

1 To know various culture media and their applications and also understand various physical and chemical means of sterilization.
2 To master aseptic techniques and be able to perform routine culture handling tasks safely and effectively.
3 To know the various physical and chemical growth requirements of microbes and get equipped with various methods of microbes culture techniques and their role in various industry.

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	To develop extensive knowledge in various areas of Microbiology.
CO2	To explain vaccine strategies and mechanisms of antiviral drugs and interferons.
CO3	To apply tools to study biological processes, as cloning vectors and for gene transfer.
CO4	To develop extensive knowledge in various areas of Microbiology.
CO5	To analyze the interactions between viruses, bacteria and the host immune system.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1			2		2	2	3	2
CO2	2	2	3	2	2	3	3				1	1	1	1	2
CO3	2	2	3	2	1	1	2			1			3	3	3
CO4		3	2	2	3	2	3					2	3	1	2
CO5		1	2	1	2	1	1			1		1	2	2	2

(High-3, Medium-2, Low-1)

Course Outline

Module-I

Bacteria and virus

1.1 Classification,

1.2 Taxonomy,

1.3 Cataloguing virus to ICTV and ICNV Structural and genetic diversity of viruses; Transmission and Replication; Prions, Viriods,

1.4 Antiviral agents and Vaccines; Bacterial Classification (phenetic, genetic and phyllogenetic); Bergeys manual of systematic bacteriology; Classification,

1.5 Identification and Culturing Technique of cyanobacteria; Industrial Application,

1.6 Cyanotoxins.

Practice 1(2h): Preparation of bacterial smear and staining – Gram's, Acid-fast, Staining of bacterial spores flagella, capsule, spirochaetes

Practice 2(2h):Isolation, purification, identification and biomass production of cyanobacteria

Module 2

Microbial Physiology and Metabolism

2.1 Growth Kinetics,

2.2 Growth cycle,

2.3 Logistic growth equation,

2.4 Measurement and growth monitoring in culture,

2.5 Factor affecting growth.

2.6 Photosynthetic pigments,

2.7 Paths of carbon and electron in bacterial photosynthesis.

2.8 Fermentation,

2.9 Respiratory metabolism,

2.10 Embden-Meyerhoff pathway,

2.11 Entner-Doudroff pathway,

2.12 Pasteur Effect.

Practice 3(2h): Methods for measurement of bacterial growth by haemocytometer and spectrophotometer

Module 3

Environmental Microbiology & Wastewater Management:

3.1 Microbes and quality of environment,

3.2 Biotransformation,

3.3Microbes in waste water management; Microbial degradation of pesticides, toxic chemicals, oil; Bioleaching,

3.4 Bioremediation.

Module 4

Agricultural and food Microbiology

4.1 Agriculturally important microorganisms,

4.2 Mycorrhizae,

4.3 Microbial mineralization,

4.4 Microbial toxins,

4.5 Biological control.

4.6 Microbial toxins produced in food items,

4.7 Probiotics and preBiotics,

4.8 Methods of food preservation,

4.9 Microbiological legal standards of selected food and milk products.

Practice 4(2h): Estimation of phosphate solubilizing capacity of microorganisms

Practice 5(2h): Qualitative analysis of Milk and milk products; Microbiological analysis of food products; Detection of bacteria in milk by Standard plate count

Module 5

Medical Microbiology:

5.1 Host pathogen interactions,

5.2 Pathogenicity of bacteria invasiveness and toxigenicity,

5.3Constitutive and inducible host defence mechanism,

5.4 Important diseases caused by bacteria,

5.5 Protozoa,

5.6 Virus. Antibiotics: Definition, phenomenon of antibiotics,

5.7 Chemical and biochemical modification of antibiotic structures, assay and Mode of action,

5.8 Biochemical mechanisms of resistance development,

5.9 Multiple-drug resistance.

Practice 6(2h): Antibiotic sensitivity test disc preparation; Antibiotic sensitivity test – Kirby – Bauer, Stoke's; MIC determination by filter paper disc assay

Module 6

Industrial Microbiology

Cyanobacterial Biotechnology:

6.1 Application as nutraceuticals,

6.2 Pharmaceuticals,

6.3 Cosmetic,

6.4 Biofertilizer; application as biofuel, CO_2 sequestration and pollution control,

6.5 Mass cultivation,

6.6 Single cell protein Microbial enzymes: Sources,

6.7 Large scale production,

6.8 Recovery,

6.9 Microbial enzymes of industrial interest,

6.10 Novel medicines from microbes,

6.11 Biotechnological application of Microbial enzyme,

6.12.Use of Microbes in Biotechnology.

Bioprocess technology and Engineering:

Culture media (types, Different culturing Technique, Media formulation, Preservation of Microbes, Fermenter design and growth processes, Bioreactors, and Membrane Bio reactors, Analysis of different bioreactors, stability of microbial reactors, specialized bioreactors. Isolation, preservation, and Maintenance of Industrial Microorganisms.

Practice 7(2h): Preparation of different microbial culture media

Module 7 :**Microbial genetics**

7.1 Lytic and Lysogenic cycle,

7.2 Conjugation,

7.3 Transduction,

7.4 Recombination; Genetic regulation: Operon concept (lac,trpara),

7.5 Genetic mapping: Genome mapping of E. *coli*, QTL Mapping.Molecular markers in genome analysis,

7.6 RAPD, RFLP,AFLP, FISH and GISH.

Text Books:

1 Prescott, L. M., Harley, J. P. and Klen, D. A. (1999). Microbiology, 7th Ed., McGraw-Hill, New York.
2 Pelczar, Jr., M. J., Chan E.C.S. and Krieg, N. R. (2005). Microbiology, 5th Ed, Tata McGraw-Hill, New Delhi.
3 Alexopoulus, C. J., Mims, C. W. and Blackwel, M. (1996). Introductory Mycology, John Wiley, New York.
4 Kumar, H. D. (1988). Introductory Phycology. East-West Press, New Delhi.
5 Maloy, S. R., Cronan, J. E. Jr. and Freifielder, D. (2008). Microbial Genetics, 2nd Ed. Norosa, New Delhi.

Reference Books

1 Mehrotra, R. S. and Aneja, R. S. (1998). An Introduction to Mycology, New Age International, New Delhi
2 Agrios, G. N. (2005). Plant Pathology,5th Ed, Elsevier Academic press, USA

ANIMAL TAXONOMY AND ZOO SYSTEMATICS

Subject Name	Code	Type of course	T-P-P	Prerequisite
Animal Taxonomy and Zoo systematics		Theory-Practice	3-1-0	-

Objectives

The purpose of the course is to make the students to understand Animal Taxonomy and Zoo Systematics

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand introduction to the principles and practices of animal taxonomy and zoo systematics.

CO2	Students will understand and explores the methods of classification, nomenclature, phylogenetics, and evolutionary relationships among animals,
CO3	Students will able to integrating both traditional and modern techniques such as morphological and molecular approaches.
CO4	Students will gain experience in researching, discussing, and answering questions about animal taxonomy and zoo systematics.
CO5	Students will gain experience in species identification and will apply systematics to understand biodiversity, evolution, and conservation.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		1	1	3	1	2	2			1		3	3	3	2
CO2		2		2		1	1			2	1	1	2	1	3
CO3	3					2				1	1	2	1	1	2
CO4	2		2		2					2	2		2	3	2
CO5	2	1		1		1	1			2		1	2	2	2

(High-3, Medium-2, Low-1)

Course outline

Module- I

Introduction to Taxonomy and Biosystematics

1.1 Overview of Animal Diversity and Classification

1.2 History of Taxonomy

1.3 Taxonomic Hierarchy (Kingdom, Phylum, Class, etc.)

1.4 Taxonomy vs. Systematics vs. Phylogenetics

1.5 Key Terminology: Species, Genus, Family, Clade, Taxon

Practice 1 (2 h): Morphological identification of different classes of fauna

Module- II

The Principles of Nomenclature

2.1 The International Code of Zoological Nomenclature (ICZN)

2.2. Binomial Nomenclature

2.3 Rules of Naming Species

2.4 Types of Specimens (Holotype, Paratype, Lectotype)

Practice 2 (2 h) : Phylogenetic Studies-Protein Electrophoresis.

Module- III

Taxonomic Methods I – Morphology

3.1 Morphological Characteristics in Animal Identification

3.2 Diagnostic Features in Major Animal Phyla

3.3 Incorporating Developmental and Anatomical Data

3.4 Limitations and Challenges of Morphological Taxonomy

Practice 3 (2 h) : Thin Layer Chromatography

Module- IV

Taxonomic Methods II – Molecular Systematics

4.1 Introduction to Molecular Markers (DNA, RNA, Proteins)

4.2 Polymerase Chain Reaction (PCR) and Sequencing Techniques

4.3 Phylogenetic Trees from Molecular Data

4.4 Challenges in Molecular Systematics

Practice 4 (2 h) : Ecological and Environmental Analysis

Module- V

Phylogenetic Methods

5.1 Cladistics vs. Phenetics

5.2 Character State Analysis

5.3 Constructing Cladograms and Phylogenetic Trees

5.4 *Tools: PAUP, RAxML, BEAST**

Practice 5 (2 h): Chromosome Staining and Preparation

Module- VI

Evolutionary Biology and Systematics

6.1 Evolutionary Forces Shaping Biodiversity (Natural Selection, Genetic Drift, Speciation)
6.2 The Role of Systematics in Understanding Evolution
6.3 The Modern Synthesis and Evolutionary Theory

Practice 6 (2 h): Preparation of DNA sequencing

Module- VII

Species Concepts and Speciation

7.1 Biological, Morphological, and Phylogenetic Species Concepts
7.2 Speciation Mechanisms (Allopatric, Sympatric, Parapatric)
7.3 Cryptic Species and Hybridization
7.4 Importance of Taxonomy in Conservation Biology
7.5 Endangered Species and the Role of Systematics
7.6 Human Impact on Biodiversity and Taxonomic Efforts
7.7 Ethical Considerations in Taxonomic Research

Practice 7 (2 h): Preparation of Biodiversity register.

Reference & Textbooks:

1. *Textbook: Systematic Biology: An Introduction by Humphries et al.*
2. *Research Papers: Selected articles from journals like Systematic Biology, Molecular Phylogenetics and Evolution, and Journal of Zoological Systematics and Evolutionary Research.*
3. *Online Resources: Databases like GenBank, Tree of Life, Barcode of Life Data Systems (BOLD), and others.*

BIOCHEMISTRY & ENZYMOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Biochemistry & Enzymology		Theory-Practice	3-1-0	-

Objectives

The purpose of the course is to make the students to understand Biochemistry & Enzymology

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand the fundamental concepts and principles of biochemistry and the action of enzyme
CO2	Students will understand the application of these principles in biological system
CO3	Students will able to provide practical experience in investigating biochemical and enzymatic activity questions, and collecting, analyzing, interpreting, and reporting experimental data
CO4	Students will gain experience in researching, discussing, and answering questions about cell biochemistry and enzymatic action.

CO5	Students will understand the source, significance and deficiency and dysfunctions of enzymes, vitamins, protein, carbohydrates and lipids.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1			2				2		3	3	3	3
CO2	2			2	1						1	1	2	1	3
CO3	1	1		1		2	1			1			2	3	2
CO4			1									2	1	3	3
CO5		1			1							1	3	2	3

(High-3, Medium-2, Low-1)

Course outline

Module- I

Carbohydrate Metabolism

1.1 Classification of carbohydrates and properties

1.2 Glycolysis, & Gluconeogenesis, Citric acid cycle and significance,

1.3 Role and regulation of Glycogenesis, Glycogenolysis.

1.4 Regulatory mechanism of Phosphate Pentose Pathway

1.5 Mechanism of phosphorylation and regulation

Practice 1 (2 h): Estimation of the carbohydrate content of supplied tissue by Spectrophotometry method

Module- II

Lipid Metabolism

2.1 Classification of lipid and properties

2.2. β-oxidation of saturated fatty acids with even & odd number carbon atoms

2.3 Omega -oxidation of even & odd number of saturated fatty acids

2.4 Metabolism of unsaturated fatty acid

2.5 Ketogenesis and regulation of fatty acid metabolism

Practice 2 (2 h) : Estimation of the presence of lipid content from the given sample

Module- III

Protein Metabolism

3.1 Classification of Protein and Properties

3.2 Role and regulation of deamination

3.3 Role and regulation of transamination

3.4 Regulation of Urea cycle

43.5 Fate of C-skeleton of Glycogenic & Ketogenic amino acids

Practice 3 (2 h) : Estimation of total protein content in the given sample by Lowry's /Barcode's Method

Module- VI

Nucleic Acids and immunoglobulin:

4.1 Structure of Nucleosides, Nucleotides, Purines and pyrimidines

4.2 Types of DNA and RNA

4.3 Complementarity of DNA, Hpyo-Hyperchromaticity of DNA

4.4 Cot Curves: Base pairing, Denaturation and Renaturation of DNA

4.5 Immunoglobulin: Structure, Classes and Function

4.6 Antigenic Determinants.

Practice 4 (2h) : Isolation and spectrophotometric estimation of DNA

Module- V

Enzymes:

5.1 Chemistry of enzymes, co-factors and types

5.2 Chemistry of enzymes, co-factors and types

5.3 enzyme catalysis and theories (Lock and key theory, induced fit theory, transition state model, quantum tunneling model)

5.4 Concept of Allosteric enzymes and Isoezymes,

5.5 Multi enzyme complex

5.6 single molecule enzymology

Practice 5 (2 h) : Demonstrate the enzymatic action of saliva on starch \

Module- VI

Mechanism of enzyme action

6.1 Enzyme kinetics: Michaelis – Menten equation

6.2 Michaelis constant (K_M), Factors affecting rate of enzyme catalyzed reactions

6.3 Description of vo versus [So]

6.4 Determination of Vmax & Km from (Lineweaver – Burk (L-B) plot

6.5 Direct Linear Plot and Nonlinear Curve.

Practice 6 (2 h): Determination of specific activity of salivary amylase by DNS

Module- VII

Application of Enzymes

7.1 Industrial application
7.2 Marker enzymes, enzyme role in antibiotic production
7.3 Enzymes in agriculture and medicine
7.4 Biotechnological applications

Practice 7 (2 h): Determination of Enzyme-Substrate Dissociation Constants

Reference & Textbooks:

1. *Cox, M.M and NelsoEXT n, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition,*
2. *W.H. Freeman and Co., New York.*
3. *Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.rs*
4. Biochemistry Donald Voet, Judith G. Voet Publisher: John Wiley &Sons Inc
5. *Fundamentals of Enzymology: The cell and molecular Biology of Catalytic Proteins by Nicholas C. Price, Lewis Stevens, and Lewis stevens, Oxford University Press, USA*
6. *Enzyme Kinetics: A modern Approach, Alejandro G. Marangoni, Wiley-Interscience*
7. *Enzyme Mechanism by P.K Sivaraj Kumar, RBSA Publishers*
8. *Enzymes in Industry: Production And Applications by Aehle W (2007) John Wiley & Sons Inc*
9. *Enzymes: Biotechnology, Clinical Chemistry (second Edition)by Trevor Palmer, Philip Bonner Horwood Publishing* Limited

WILDLIFE AND CONSERVATION

Subject Name	Code	Type of course	T-P-P	Prerequisite
Wildlife and conservation		Theory-Practice	3-1-0	-

Objectives

The purpose of the course is to make the students to understand wildlife and conservation.

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand introduction to the principles and practices of wildlife conservation
CO2	Students will understand and explores the face the challenges by wildlife populations
CO3	Students will able to integrating role of human activity in both the destruction and protection of biodiversity
CO4	Students will gain an understanding of key conservation concepts, ecological principles, and strategies
CO5	Students will gain experience in preserve and restore ecosystems and wildlife.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**2**		**1**	**3**		**2**				**2**		**3**	**3**	**2**	**2**
CO2	**2**	**2**		**2**	**1**	**2**	**1**			**2**	**1**	**1**	**2**	**1**	**3**
CO3	**1**		**1**	**2**						**1**		**2**	**1**	**3**	**3**
CO4		**2**	**2**		**2**		**3**			**1**		**3**	**3**	**2**	**3**
CO5		**1**	**2**	**1**		**1**	**1**			**2**			**2**	**2**	**2**

(High-3, Medium-2, Low-1)

Course outline

Module- I

Introduction to Wildlife and Conservation

1.1 Definition of wildlife and conservation.

1.2 Historical perspectives on wildlife management and conservation.

1.3 Types of biodiversity: genetic, species, and ecosystem diversity.

1.4 The value of biodiversity: economic, cultural, and ecological benefits.

1.5 Ecosystem services: provisioning, regulating, cultural, and supporting services.

1.6 Loss of biodiversity and its consequences.

Practice 1 (2 h): Field identification & characterization of wildlife of India.

Module- II

Threats to Wildlife and Ecosystems

2.1 Habitat loss and fragmentation.

2.2. Pollution (chemical, plastic, noise, light).

2.3 Climate change and its effects on wildlife.

2.4 Overexploitation and illegal trade.

2.5 Invasive species.

Practice 2 (2 h) : Estimation of wildlife populations (Bird, crocodile, dolphin, tiger, elephant, turtle etc.)

Module- III

Conservation Planning and Management

3.1 Steps in conservation planning (site selection, priority species).

3.2 Wildlife corridors and protected areas.

3.3 Restoration ecology and habitat rehabilitation.

3.4 Community-based conservation models.

Practice 3 (2 h) : Analyses of the data collected in the field by using software.

Module- IV

Protected Areas and Wildlife Reserves

4.1 Types of protected areas (national parks, nature reserves, marine protected areas).

4.2 Management challenges and success stories.

4.3 Buffer zones, zoning, and multiple use areas.

4.4 The role of Indigenous knowledge in managing protected areas.

Practice 4 (2 h) : Indirect sample collection procedure

Module- V

Conservation Policies and Laws

5.1 International conventions and agreements (CITES, CBD, Ramsar).

5.2 National and regional conservation policies.

5.3 The role of NGOs and international organizations.

5.4 Wildlife legislation and enforcement issues. (WPA, 1972, Biological Diversity Act,2002)

Practice 5 (2 h): Case study of wildlife.

Module- VI

Emerging Technologies in Conservation

6.1 Remote sensing and GIS for wildlife monitoring.
6.2 Drones and camera traps in ecological studies.
6.3 Environmental DNA (eDNA) in biodiversity assessment.
6.4 Artificial intelligence and data analysis in conservation decision-making.

Practice 6 (2 h): Camera Trap installation procedure

Module- VII

Future of Wildlife Conservation

7.1 Trends in wildlife conservation: shifting paradigms and new approaches.
7.2 The role of education, public awareness, and advocacy in conservation.
7.3 Global biodiversity targets and post-2020 frameworks.
7.4 Career opportunities in wildlife conservation.

Practice 7 (2 h): Basic techniques on Wildlife Photography

Reference & Textbooks:

4. **Primack, R. B.** *Essentials of Conservation Biology* (6th ed.). Sinauer Associates.
5. **Soulé, M. E., & Estes, J. A.** *Conservation Biology: The Science of Scarcity and Diversity* (2nd ed.). Sinauer Associates.
6. **Groom, M. J., Meffe, G. K., & Carroll, C. R.** *Principles of Conservation Biology* (4th ed.). Sinauer Associates.

7. **Sutherland, W. J., et al.** *Conservation Science and Action*. Wiley-Blackwell.
8. **Heywood, V. H., & Watson, R. T.** *Global Biodiversity Assessment*. Cambridge University Press.

Supplementary Materials:

1. *Scientific journals (e.g., Conservation Biology, Journal of Wildlife Management).*
2. *Reports from organizations like the IUCN, WWF, and UNEP.*
3. *Online platforms (e.g., Earthwatch, Conservation International).*

DEVELOPMENTAL BIOLOGY

Subject Name	Code	Type of course	T-P-P	Prerequisite
Developmental Biology		Theory-Practice	3-1-0	-

Objectives

The purpose of the course is to make the students to understand developmental biology

Course Outcome

At the end of the course, students will be able:

COs	Course Outcomes
CO1	Students will understand the principals of developmental biology including cell differentiation, morphogenesis and pattern formation
CO2	Students will able to explain the stages and processes of embryonic development of various models organisms.
CO3	Students will understand the molecular mechanism of gene expression.
CO4	Students will able to compare and contrast developmental processes among different animal models.
CO5	By the end of course students will be prepared to apply developmental biology concepts in different biological fields.

Course Outcome to Program Outcome Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1			2		1		1		1	3	3	2
CO2	2			2	1	2	2				1	1	2	1	3
CO3	3	3	2		2							2	2	3	2
CO4			2			1					2	2	2	3	3
CO5		1		2	2	1	1			1		3	1	2	3

(High-3, Medium-2, Low-1)

Course outline

Module- I

History and basic concepts

1.1The origin of developmental biology-

1.2 Cell theory, mosaic and regulative development, genetics and development;

1.3 Basic concepts of developmental biology- cell division, cell differentiation, signaling, patterning

1.4 **Model systems**: vertebrates model organism Xenopus laevis, chicken, mammals, zebra fish

1.5 Invertebrate model organism Drosophila melanogaster,

Practice 1 (2 h): Study of life cycle of Drosophila melanogaster.

Practice 2 (2 h): Study of the developmental stages and life cycle of Drosophila from stock culture.

Module- II

Early embryonic development of vertebrates and invertebrates

2.1Structure of the gametes– the sperm, the egg

2.2.**Morphogenesis** - Cleavage and gastrulation, neural tube formation, cell migration

2.3**Axis specification** in Drosophila; origin of anterior- posterior and dorsal- ventral patterning.

2.4 **Patterning -** patterning of early embryo by zygotic genes;

2.5 **Segmentation genes-** the gap genes, the pair– rule genes, the segment polarity genes.

Practice 2 (2 h) : Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula

Module- III

General concepts of organogenesis

3.1Development of chick limb (

3.2Proximal- distal and dorso- ventral axis formation

3.3Insect imaginal disc– determination of wing and leg imaginal discs

3.4Organizing center in patterning of butterfly wing

3.5 Development of insect compound eye (morphogenetic furrow, ommatidia, signaling, eyeless gene;)

Practice 3 (2 h) : Dissection and Study of Whole mounts of chick embryo 24, 36, 48, 72, hours of incubation.

Module- IV

Postembryonic Development

4.1Growth- cell proliferation, growth hormones;

4.2Aginggenes involved in alteration in timing of senescence

4.3Regeneration– epimorphic regeneration of reptile (salamander) limb

4.4Requirement of nerves for the proliferation of blastema cells

Practice 4 (2 h) : Study of regeneration in planaria and house lizard.

Module- V

Embryonic stem cells and their applications

5.1Medical implications of developmental biology

5.2Genetic errors of human development

5.3The nature of human syndromes– pleiotropy

5.4Genetic heterogeneity

5.5Phenotypic variability.

Practice 5 (2 h): Study of Homeotic gene mutations.

Module- VI

6.1Gene expression and human disease
6.2 Inborn errors of nuclear RNA processing
6.3 Inborn errors of translation

6.4 Teratogenesis- environmental assaults on human development
6.5 Teratogenic agents like alcohol, retinoic acid etc.

Practice 6 (2 h): Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula

Module- VII

7.1Ageing: Concepts and Theories
7.2 Implications of Developmental Biology Teratogenesis
7.3 Teratogenic agents and their effects on embryonic, development
7.4 In vitro fertilization
7.5 Concept of Stem cell
7.6 Amniocentesis
Practice 7 (2 h): Influence of temperature and teratogenes on animal development.
Project: Study of regeneration in Hydra.

Reference & Textbooks:

1. *Developmental Biology, Gilbert, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA.*
2. *Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.*
3. *Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGrawHill Science, New Delhi, INDIA*
4. *Welson, A. 1979. Principles of Animal Physiology.McMillan Publishing Co. Inc. New York.*
5. *Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London.*
6. *Herkat, P.C.and Mathur, P.N.1976. Text Book of Animal Physiology.S.Chand Co. Pvt, Ltd., New Delhi..*

RESEARCH METHODOLOGY AND IPR

Code	Subject Name	Type of course	T-P-Pr (Credit)
CUTM 2378	Research Methodology and IPR	Theory + Project	(2-0-2)

Course objectives

- To develop an appropriate framework for various research designs and techniques
- To identify various sources of information for literature review and data collection
- To make expertise in academic writing and patenting

Course outcome

At the end of the course the student will be able to:

COs	Course outcomes
CO1	**Know** about the elementary research methodology and significance of research
CO2	**Understand** the scientific writing skills, plagiarism, impact factor, citation index of standard journals and importance of publications
CO3	**Acquire** knowledge on web browsing for gathering scientific data, PowerPoint making, scientific poster preparation and presentation skills including computing skills required for scientific research
CO4	**Utilize** the knowledge on intellectual property, trademarks, copyright, plant variety protection and farmers' rights
CO5	**Decide** about the types of patents and able to **compile** the patent application forms

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		3		3	3	1					2	2	3	1
CO2	3	2		2	3						1	1	1	1	2
CO3	3		1		1	1	2					3	2	3	2
CO4	2		1	1		3						2	3	1	3
CO5	2	1		1	2	1	1					1	3	3	2

Module 1

Elementary Research Methodology: Research Concept, Objectives, characteristics, Steps and Significance of Research, Arbitrary and Scientific Research, Research approaches. Types of research: Historical, Descriptive, Analytical, Case Study, Quantitative vs. qualitative, Conceptual, Empirical Action Research, Research Methods Vs Methodology. Research Problems: Selection and definition of the research problems, formulating a research problem, identifying variables and Constructing hypothesis; Choosing a mentor, lab and research question; maintaining a lab notebook; Selection of problems - stages in the execution of research

Module II

Academic Writing and Presentation: Technical writing skills - types of reports; layout of a formal report; standard of Journal (Impact Factor, Citation Index), Scientific writing skills - importance of communicating science; problems while writing a scientific document; plagiarism, software for plagiarism; scientific publication writing: elements of a scientific paper including abstract, introduction, materials & methods, results, discussion, references; drafting titles and

framing abstracts; publishing scientific papers - peer review process and problems, recent developments such as open access and non-blind review; characteristics of effective technical communication; scientific presentations; ethical issues; scientific misconduct.

Module III

Scientific communication skills: Concept of effective communication- setting clear goals for communication; determining outcomes and results; barriers to effective communication; non-verbal communication- importance of body language, power of effective listening; Presentation skills - formal presentation skills; preparing and presenting using over-head projector, PowerPoint; defending interrogation; scientific poster preparation & presentation; participating in group discussions; Computing skills for scientific research - web browsing for information search.

Module IV

Introduction to IPR: Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; plant variety protection and farmer's rights.

Module V

Types of Patents: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; filing of a patent application; role of a Country Patent Office; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications.

Projects

1. Write a review article and submit to a journal
2. Write a book chapter/ book for publishing
3. Write an original article for a journal

Text Books:

1. Kothari CR (2016) Research Methodology: Methods and Techniques, New Age Pvt Ltd
2. Ganbawale RM, (2017) Bioststistics and Research Methodology, New Central Book Agency
3. Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Ess Publications. 2 volumes

Reference Books:

1. Geoffrey Marczyk, David DeMatteo, David Festinger (2005). Essentials of Research Design and Methodology, John Wiley & Sons, Inc.
2. Carol Ellison (2010) McGraw-Hill's ConcisevGuide to WritingvResearch Papers, McGraw-Hill
3. Trochim, W.M.K., (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
4. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
5. Neuman, W.L. (2008). Social research methods: Qualitative and quantitative approaches, Pearson Education