



Centurion
UNIVERSITY
Shaping Lives...
Empowering Communities...

B.Sc. (Zoology) Syllabus

(Four Years Programme)

School of Applied Sciences

**Centurion University of Technology &
Management**

2025-26

STRUCTURE OF UNDER GRADUATE PROGRAMME

Sl. No.	Board Category of Courses	Minimum Credit Requirement	
		3 Year UG	4 Year UG
01	Major (Core)	60	80
02	Multidisciplinary + Minor	34	42
03	Value added course	07/06	07/06
04	Ability Enhancement Courses (AEC) + Skill Enhancement Courses (SEC)	18	18
05	Summer Internship	02	02
06	Research Project/Domain Project	0	12
	Total	121/120	161/160

CHOICE BASED CREDIT SYSTEM IN B.Sc. (Honours)

Sl. No	Code	Subject Name	Type of course	T-P-Pr (Credit)	Credits	Level
SEMESTER I						
01	-	Value Added	Theory + Project	2-0-1	3	-
02	CUTM1674	Environmental Science	Theory + Practice+ Project	3-0-1	4	4.5
03	CUTM4617	Non-Chordates I	Theory + Practice	3-1-0	4	4.5
04	CUTM4618	Animal Taxonomy	Theory + Practice	3-1-0	4	4.5
05	GE-1@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	4.5
TOTAL					19	
SEMESTER II						
06	CUTM1016	Job Readiness(Generic Specific Elective)	Practice	0-0-2	2	-
07	CUTM4619	Non-Chordates II	Theory + Practice	3-1-0	4	4.5
08	CUTM4620	Cell Biology (GE)	Theory + Practice	3-1-0	4	4.5
09	GE-2@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	4.5
10		Skill		-	4	4
TOTAL					18	
SEMESTER III						
11	CUTM1016	Job Readiness (Generic Specific Elective)	Practice	0-0-2	2	-
12		Value added	Theory + Project	-	3	-
13	CUTM4621	Diversity of Chordates	Theory + Practice	3-1-0	4	5
14	CUTM4622	Physiology: Life Sustaining Systems (GE)	Theory + Practice	3-1-0	4	5
15	CUTM4623	Biochemistry and Metabolic Processes	Theory Practice+Project +	2-1-1	4	5
16	GE-3@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	5
TOTAL					21	
SEMESTER IV						
17		Skill			4	-
18		Job Readiness	Practice	0-0-2	2	-
19	CUTM4624	Comparative Anatomy of Vertebrates	Theory + Practice	3-1-0	4	5
20	CUTM4625	Water and Soil Quality Management Biochemistry and	Theory + Practice	2-1-1	4	5

		Metabolic Processes				
21	CUTM2380	Advanced Sustainable Aquaculture	Theory + Practice	3-1-0	4	5
22	GE-4@	Inter Disciplinary Subject	Theory + Practice	3-1-0	4	5
TOTAL					22	
SEMESTER V						
23	CUTM4116	Molecular Biology	Theory + Practice	3-1-0	4	5.5
24	CUTM4626	Evolutionary Biology	Theory + Practice	3-1-0	4	5.5
25	CUTM4627	Principles of Ecology/ Water and Soil Quality Management	Theory + Practice	3-1-0	4	5.5
26	Domain	Multidisciplinary	Theory	-	9	5.5
TOTAL					21	
SEMESTER VI						
27	CUTM4628	Developmental Biology	Theory + Practice	3-1-0	4	5.5
28	CUTM4629	Genetics	Theory + Practice	3-1-0	4	5.5
29	Domain	Multidisciplinary	Practice	-	9	5.5
30	Skill	-		-	4	5
TOTAL					21	
SEMESTER VII						
31	CUTM1452	Animal Biotechnology	Theory + Practice	3-1-0	4	6
32	CUTM1436	Microbiology	Theory + Practice	3-1-0	4	6
33	CUTM4630	Bioanalytical Techniques	Theory + Practice	3-1-0	4	6
34	Domain	Multidisciplinary	Project	-	6	
35	-	Internship	-	-	2	
TOTAL					20	
SEMESTER VIII						
36	CUTM4631	Immunology and Cancer Biology	Theory + Practice	3-1-0	4	6
37	CUTM1453	Animal Breeding	Theory + Practice	3-1-0	4	6
38	-	Research Project / Domain Project / 3 No.s Discipline Specific Elective	-	-	12	
TOTAL					20	
GRAND TOTAL					162	

DEPARTMENT OF ZOOLOGY

B.Sc. Zoology Four Years Programme Course Structure 2025-26

BASKET I - CORE COURSES				
Sl. No.	Code	Subject Name	T-P-P	Credits
1.	CUTM4617	Non-Chordates I	Theory + Practice	4
2.	CUTM4618	Animal Taxonomy	Theory + Practice	4
3.	CUTM4619	Non-Chordates II	Theory + Practice	4
4.	CUTM4620	Cell Biology (GE)	Theory + Practice	4
5.	CUTM4621	Diversity of Chordates	Theory + Practice	4
6.	CUTM4622	Physiology: Life Sustaining Systems (GE)	Theory + Practice	4
7.	CUTM4623	Biochemistry and Metabolic Processes	Theory + Practice + Project	4
8.	CUTM4624	Comparative Anatomy of Vertebrates	Theory + Practice	4
9.	CUTM2380	Water and Soil Quality Management	Theory + Practice	4
10.	CUTM2380	Advanced Sustainable Aquaculture	Theory + Practice	4
11.	CUTM4116	Molecular Biology	Theory + Practice	4
12.	CUTM4626	Evolutionary Biology	Theory + Practice	4
13.	CUTM4626	Principles of Ecology	Theory + Practice	4
14.	CUTM4628	Developmental Biology	Theory + Practice	4
15.	CUTM4629	Genetics	Theory + Practice	4
16.	CUTM1452	Animal Biotechnology	Theory + Practice	4
17.	CUTM1436	Microbiology	Theory + Practice	4
18.	CUTM4630	Bioanalytical Techniques	Theory + Practice	4
19.	CUTM4631	Immunology and Cancer Biology	Theory + Practice	4
20.	CUTM1453	Animal Breeding	Theory + Practice	4

NON CHORDATES-I

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4617	Non – Chordates-I	Theory+Practice	3-1-0	

Course Objectives

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- To have in depth knowledge about invertebrates of different phyla.
- To understand the taxonomic position of Protozoa to Helminthes.
- To understand the body organization and general characteristics of animals belonging to different phylum ranging from unicellular to multicellular organization.

Course Outcomes

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

COs	Course Outcomes
CO1	To understand invertebrates of different categories which affects the ecosystem in various ways
CO2	To describe the unique character of Protozoa, Porifera, Coelenterata and Helminthes.
CO3	To analyze the life functions and the ecological role of animals belonging to different phyla ranging from unicellular to multicellular organization.
CO4	To represent invertebrates of different categories which affects the ecosystem in various ways.
CO5	To analyze the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply

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		3	-		3					3	3	2	2
CO2	2	-		3	1		2					3	3	2	2
CO3	2	3		2	2		2					2	2	1	1
CO4	2			2			2					2	1	2	2
CO5	3	1		3	2		1					3	2	2	3

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

Course content

Module- I - General characteristics and classification of kingdom Protista (06H)

Protista, Parazoa and Metazoa :General characteristics and Classification up to classes, Study of Euglena, Amoeba and Paramecium,Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica.

Module- II- General characteristics of Metazoa (05H)

Locomotion and Reproduction in Protista , Evolution of symmetry and segmentation of Metazoa.

Module- III- Porifera (6 H)

Porifera: General characteristics and Classification up to classes, Canal system and spicules in sponges.

Module- IV - Coelenterates (6 H)

Cnidaria: General characteristics and Classification up to classes, Metagenesis in Obelia Polymorphism in Cnidaria, Corals and coral reefs.

Module- V- Ctenophora (5 H)

Ctenophora: General characteristics and Evolutionary significance, General characteristics and Evolutionary significance.

Module- VI- Platyhelminthes (6H)

Platyhelminthes: General characteristics and Classification up to classes, Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Module-VII - Nemathelminthes (6H)

Nemathelminthes: General characteristics and Classification up to classes,Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereriabancroftii*, Parasitic adaptations in helminthes

PRACTICE :

1. Study of whole mount of Euglena, Amoeba and Paramecium.
2. Study of Permanent slides of Binary fission and Conjugation in Paramecium
3. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora
4. Study of Corallium, Alcyonium, Gorgonia, Metridium
5. Study of Museum specimen of *Pennatula*, *Fungia*, *Meandrina*, *Madrepora* and ctenophore.
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs).
8. Study of adult *Wuchereriabancroftii* and its life stages (Slides/micro-photographs).
9. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.
10. Study of *Sycon* (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
11. Examination of pond water collected from different water bodies (University Campus) for diversity study.

Text Books:

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders

Reference Books:

- International Edition. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.

ANIMAL TAXONOMY

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4618	Animal Taxonomy	Theory-Practice	3-1-0	-

Course Objectives

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

Course Outcomes

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.
CO2	Students will understand and explores the methods of classification, nomenclature, phylogenetics.
CO3	Students will able to integrate both traditional and modern techniques of taxonomy.
CO4	Students will gain experience in researching, discussing, and answering questions about animal taxonomy.
CO5	Students will gain experience in species identification and will apply systematics to understand biodiversity 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 content

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 Trends in taxonomy
- 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

Practice 2 (2 h): Influence of climate condition on taxonomic diversity in a given habitat.

Module- III

Taxonomic Methods I – Morphology

- 3.1 Taxonomic Collection
- 3.2 Preservation
- 3.3 Curation
- 3.4 Process of identification

Practice 3 (2 h) : Dry and Wet Preservation

Module- IV

Taxonomic Methods II – Molecular Systematics

- 4.1 Dimension of Speciation
- 4.2 Species Concept
- 4.3 Typological, Nominalistic, Biological
- 4.4 Sub species, Other infra specific Categories, Cryptic Species

Practice 4 (2 h) : Ecological and Environmental Analysis

Module- V

Phylogenetic Methods

- 5.1 Morphological characteristics and animal identification
- 5.2 Diagnostic features in measure animal phyla
- 5.3 Incorporating developmental data
- 5.4 Incorporating analytical data
- 5.5 Limitation and challenges of morphological taxonomy

Practice 5 (2 h): Chromosome Staining and Preparation

Module- VI

Evolutionary Biology and Systematics

- 6.1 Taxonomic Keys
- 6.2 Different types of key
- 6.3 Merits and demerits of keys
- 6.4 Formation of scientific name of various taxa
- 6.5 Synonyms, Homonyms and taxonomy

Practice 6 (2 h): Preparation of DNA sequencing

Module- VII

Species Concepts and Speciation

- 7.1 Importance of taxonomic in conservation biology
- 7.2 Endangered species and role of taxonomic
- 7.3 Human impact on diversity and taxonomic effort
- 7.4 Ethical consideration 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.

Non Chordates-II

Course Code	Course Title	Type of Course	T-P-Pj (Credit)	Prerequisite
CUTM4619	Non – Chordates-II	Theory +Practice	3-1-0	

Course Objectives

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- To have in depth knowledge about invertebrates of different phyla.
- To understand the taxonomic position of Annelida to Echinodermata.
- To evaluate the body organization and general characteristics of animals belonging to different phylums.

Course Outcomes

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

COs	Course Outcomes
CO1	To represent invertebrates of different categories which affects the ecosystem in various ways
CO2	To describe the unique characters of Annelida, Arthropoda, Mollusca and Echinodermata.
CO3	To understand the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.
CO4	To analyze invertebrates of different categories which affect the ecosystem in various ways.
CO5	To evaluate the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply.

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					2	2	3	1
CO2	3			2	1		3					3	3	1	2
CO3	2	2		2			3					3	2	3	3
CO4	3			2	2		2					2	3	2	3
CO5	2	1		2	2		1					2	2	2	2

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

Course content

Module-I- Introduction to Coelomates- (3h)

Evolution of coelom and metamerism

Module-II- Annelida: (5h)

General characteristics and Classification up to classes, Excretion in Annelida

Module-III- Arthropoda: (4h)

General characteristics and Classification up to classes, Vision and Respiration in Arthropoda, Metamorphosis in Insects, Social life in bees and termites.

Module-IV- Onychophora:(3h)

General characteristics and Evolutionary significance of Onychophora.

Module-V Mollusca:-(8h)

General characteristics and Classification up to classes, Respiration in Mollusca, Torsion and detorsion in Gastropoda, Pearl formation in bivalves, Evolutionary significance of trochophore larva.

Module-VI- Echinodermata (4h)

General characteristics and Classification up to classes, Water-vascular system in Asteroidea

Module-VII -Developmental aspects of Echinoderms (4h)

Larval forms in Echinodermata, Affinities with Chordates.

Practices

1. Study of museum specimen belonging to phylum Annelida Earthworm, Nereis, Sabella , Leech and Aphrodite.
2. Study of digestive system of Earthworm.
3. Study of septal nephridia and pharyngeal nephridia of Earthworm
4. Study of museum specimen belonging to phylum Arthropoda Cockroach, Honeybee, Prawn Peripatus, Balanus
5. Study of mouth parts of Cockroach.
6. Study of digestive system of Cockroach (Dissection)
7. Study of nervous system of Cockroach (Dissection)
8. Study of museum specimen belonging to phylum Mollusca Snail , Octopus, Sepia , Chiton, Helix, Pila
9. Study of museum specimen belonging to phylum Echinodermata : Starfish, Antedon, Echinus, Ophiura

- **Text Books:**

Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition

Reference Books:

1. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Cell Biology

Course Code	Course Title	Type of Course	T-P-Pj (Credit)	Prerequisite
CUTM4620	Cell Biology	Theory+Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> To make the student understand all type of cells and cellular components, and how cell works in healthy and diseased states Students will understand Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells. To understand the organization of cellular components and their specific functions.
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Course Outcomes

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

COs	Course Outcomes
CO1	Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells.
CO2	To understand the organization of cellular components and their specific functions.
CO3	Basic knowledge on mitotic and meiotic cell division, cellular communication and signal transduction taking place in cells
CO4	To describe the concept of cell cycle regulation
CO5	To analyze the biological role of different ligands in regulating the gene transcription.

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			3					3	2	3	1
CO2	2	2		1	1		3					3	1	3	2
CO3	3			2			2					2	2	1	3
CO4	2	2		2			3					3	1	2	2
CO5	2	1		2			1					3	2	2	2

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

Course Content

Module- I (11 Hrs)

Overview of Cells; Cell theory; Prokaryotic and Eukaryotic cells; Virus; Viroids; Mycoplasma; Prions
Assignment 1: Prions and associated diseases

Module- II (10 Hrs)

Plasma Membrane: Various models of plasma membrane structure; Transport across membranes: Active and Passive transport, Facilitated Transport; Cell junctions: Tight junctions, Gap junctions, Desmosomes, Hemidesmosomes

Module- III (6 Hrs)

Endomembrane System: Structure and Functions of Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Module- IV (8 Hrs)

Mitochondria: Structure and function, Semi-autonomous nature, Endosymbiotic hypothesis, Chemiosmotic hypothesis, Mitochondrial electron transport chain; Peroxisomes: structure and function.

Module- V (10 Hrs)

Cytoskeleton: Structure and Functions: Microtubules, Microfilaments and Intermediate filaments; Nucleus: Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome)

Module- VI (10 Hrs)

Cell Division and Cell cycle: Mitosis, Meiosis; Regulation of cell cycle

Module- VII (10 Hrs)

Cell Signaling: Overview of cell signaling, signaling molecules and receptors, GPCR, Second messengers, Role of second messenger (cAMP) in cell signaling, Activation of gene transcription by GPCR

Practices

1. Cell Organization and Sub Cellular Structure Studies
2. Gram's staining technique for visualization of prokaryotic cells
3. Counting of cells using Hemocytometer
4. Study of cell attachment, cell proliferation and Isolation of Endoplasmic Reticulum
5. Isolation and microscopic study of mitochondria
6. Study the presence of Barr body in human female blood cells/cheek cell
7. Study various stages of mitosis & meiosis using permanent slides
8. Maintenance of mammalian cell lines.

Text Books:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins

Reference Books:

1. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San
3. 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

Diversity of Chordates

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4621	Diversity of Chordates	Theory+ Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> • To understand about aware of higher organisms and their taxonomy to correlate the evolutionary trend in organisms. • To know students about identify the diversification of species of chordate world • Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
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Course Outcomes

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

COs	Course Outcomes
CO1	To know the unique characters of urochordates, cephalochordates and fishes.
CO2	To identify the life functions of urochordates to fishes.
CO3	To acquire in depth knowledge on the diversity of chordates and their systematic position
CO4	To distinguish the general characters and systematics of Vertebrates

CO5	To recognize the different vertebrates and their distribution.
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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			1					3	2	2	3
CO2		2		2	1		3					1	1	1	3
CO3		1		1			1					3	3	2	3
CO4				2	2		2					2	3	3	2
CO5	3						2					3	3	3	2

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

Course Content

Module- I

Introduction to Chordates: General characteristics and classification of chordates, General characteristics of Protochordates and Hemichordata, General characteristics of Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata

Module- II

Origin of Chordata: Origin of chordates- Dipleurula concept & Echinoderm theory, Advanced features of vertebrates over Protochordata

Agantha: General characteristics and classification of cyclostomes, Classification of cyclostomes up to class, Characteristics of Petromyzon, Myxin

Module- III

Pisces: General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration, Osmoregulation in fishes, Parental care in fishes

Module- IV

Amphibia: Origin of Tetrapoda (Evolution of terrestrial ectotherms), General characteristics and classification of amphibia up to order, Parental care in Amphibians & Neoteny

Module- V

Reptilia: General characteristics and Classification of Reptilia, Affinities of *Sphenodon*, Poison apparatus and biting mechanism in snakes, Adaptive characteristics of crocodile

Module-VI

Aves: General characteristics and classification (up to order Archaeopteryx), Principles and aerodynamics of flight, Flight adaptations, Migration in birds

Module-VII

Mammals:Affinities of Prototheria, Adaptive radiate: Zoogeographical realm, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, Distribution of vertebrates in different realms

Diversity of Chordates Lab (Practice)

Experiments:

1. Museum specimen on Protochordata- Balanoglossus, Herdmania, Branchiostoma
2. Sections of Balanoglossus through proboscis and branchio-genital regions
3. Museum specimen on Petromyzon, Myxine
4. Museum specimen on : Fishes-Scoliodon, Pristis, Torpedo, Chimaera
5. Museum specimen on Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas
6. Museum specimen on-Amphibia: Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra
7. Museum specimen on Reptilia Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco
8. Identification of poisonous and non-poisonous snakes
9. Aves :Study of two common birds from different orders
10. Aves :Study of types beaks and claws

References

Text Books:

- Kotpal.R.L, (2007)Modern Text Book of Zoology,Rastogi Publication

Reference Books:

- Young, J. Z.(2004). The Life of Vertebrates. III Edition. Oxford University press. Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

Physiology- Life sustaining system

Code	Course Title	Type of Course	T-P-Pj (Credit)	Prerequisite
CUTM4622	Physiology : Life sustaining system	Theory +Practice	3-1-0	

Course Objectives

- To know the functioning of various organs and their inter relationship
- To facilitate students about the various metabolic processes
- Students would be able to know and compare the different anatomical aspect of various organisms

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Course Outcomes

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

COs	Course Outcomes
CO1	To know and compare the different anatomical aspect of various organisms
CO2	To acquire the knowledge of functioning of different body parts
CO3	To understand the human physiology.
CO4	To analyze the functioning of different body parts.
CO5	To apply the acquired knowledge for higher study

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			1					3	2	2	2
CO2	2	2		2	1		2					1	3	1	2
CO3	2	2		2			1					3	1	3	3
CO4		1		1	1		2					3	2	2	3
CO5				2			3					2	2	3	2

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

Course Content

Module- I

Physiology of Digestion: Structural organization of gastrointestinal tract and associated glands, Mechanical and chemical digestion of food, Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins, Hormonal control of secretion of enzymes in Gastrointestinal tract

Module- II

Physiology of Respiration: Mechanism of respiration & Pulmonary ventilation, Respiratory volumes and capacities, Transport of oxygen and carbon dioxide in blood, Respiratory pigments and Control of respiration, Dissociation curves and the factors influencing it, Carbon monoxide poisoning

Module- III

Physiology of Heart: Structure of mammalian heart, Coronary circulation, Structure and working of conducting myocardial fibers, Origin and conduction of cardiac impulses

Module- IV

Physiology of Heart: Cardiac cycle, Cardiac output and its regulation, Frank-Starling Law of the heart, Nervous and chemical regulation of heart rate, Electrocardiogram-Blood pressure and its regulation

Module- V

Renal Physiology: Structure of kidney and its function, Structure and function of Nephron, Mechanism of urine formation, Regulation of water balance, Regulation of acid-base balance, Counter-Current theory

Module-VI

Adaptive physiology: Adaptive physiology, Adaptation of reptile and aves to water, space, land, Adaptation of other species to water, space, land

Module-VII

Reproductive System: Physiology of male reproduction, Physiology of female reproduction, Puberty and Methods of contraception in male and female

Physiology: Life sustaining system Lab (Practice)

Experiments

1. Histological study of gastrointestinal tract trachea and lung
2. Estimation of haemoglobin using Sahli's haemoglobinometer
3. Enumeration of R.B.C. & W.B.C. using haemocytometer
4. Determination of ABO Blood group
5. Preparation of haemin and haemochromogen crystals
6. Recording of blood pressure using sphygmomanometer
7. Histological study of kidney(Human), Histological study of nephron, Histological study of testis(mammal), Histological study of ovary(mammal), Histological study of artery & vein

E-materials:

Online Source:

<https://www.udemy.com/course/humanphysiology/>,

<https://www.coursera.org/specializations/anatomy> ,

<https://www.edx.org/course/anatomy-cardiovascular-urinary-and-respiratory-sys>

Text Books:

1. Guyton's Physiology

Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Biochemistry and Metabolic Processes

Course Code	Course Title	Type of Course	T-P-Pj (Credit)	Prerequisite
CUTM4623	Biochemistry of Metabolic Processes	Theory+Practice	3-1-0	

Course Objectives

- To know the functioning of various organs and their inter relationship
- To understand about the various metabolic processes
- Understand the significance of Biochemistry

Course Outcomes

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

COs	Course Outcomes
CO1	To understand the significance of Biochemistry
CO2	To describe the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins
CO3	To describe the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites
CO4	To evaluate the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins
CO5	To analyze the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites

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			1					3	1		2
CO2	2			2	1		3					1	1	2	2
CO3	2	1		1			1					3	2	2	3
CO4	2			3	2		3					2	2	1	2
CO5	1			3			2					3	2	2	2

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

Course Content

Module- I

Overview of Metabolism: Stages of Metabolism (Catabolism vs Anabolism), Compartmentalization of metabolic pathways, ATP as "Energy Currency of cell" & use of reducing equivalents and cofactors, Intermediary metabolism and regulatory mechanisms.

Module- II

Carbohydrate Metabolism: Sequence of reactions and regulation of glycolysis & Gluconeogenesis, Citric acid cycle and significance, Phosphate Pentose Pathway (Role and significance), Glycogenesis, Glycogenolysis.

Module- III

Lipid Metabolism: β -oxidation of saturated fatty acids with even & odd number of carbon atoms, Omega -oxidation of even & odd number of saturated fatty acids, Biosynthesis of palmitic acid, Metabolism of unsaturated fatty acid, Ketogenesis, Metabolic Fuel Utilization & Regulation of fatty acid

Module- IV

Protein Metabolism: Catabolism of amino acids, Transamination, Deamination, Protein Metabolism

Module- V

Fate of carbon skeleton: Urea cycle, Fate of C-skeleton of Glucogenic & Ketogenic amino acids, Regulation of Urea cycle, Role of mitochondria

Module- VI

Oxidative Phosphorylation: Oxidative Phosphorylation, Redox systems & Coupled reactions, Review of mitochondrial respiratory chain, Shuttle systems & Membrane transporters

Module- VII

Inhibitors and Uncouplers: Inhibitors of Electron Transport System, Uncouplers of Electron Transport System, Activity of Enzyme

Biochemistry of Metabolic Process Lab (Practice)

Experiments:

1. To demonstrate the effect of temperature on enzyme activity
2. To estimate the carbohydrate content of supplied tissue by Spectrophotometry method
3. To estimate the glycogen content of supplied tissue by colorimeter method
4. To estimate the lipid content from the given sample
5. To estimate the protein content of supplied tissue by colorimeter method
6. Estimation of total protein content in the given sample by Lowry's /Barfoed's Method
7. To estimate amino acids from a mixture by using chromatography (paper/Thin layer)

8. To estimate amino acids from a mixture by using chromatography (paper/Thin layer)
9. Determination of SGPT in given sample by using available kit.(Chick/Goat Serum)
10. Preparation of Standard Curve of Bovine serum Albumin

1. Reference

Text Books:

1. Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.

Reference Books:

1. Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
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. Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

Comparative Anatomy of Vertebrates

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4624	Comparative Anatomy of Vertebrates	Theory+ Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> • To make a comparative study of the anatomy of an organ in different groups of vertebrates • To derive the evolutionary significance from it • To understand as to why an organ evolved the way it is present now..
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Course Outcomes

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

COs	Course Outcomes
CO1	To define vertebrate structural principles by studying all body systems of vertebrates in an evolutionary perspective.
CO2	To compare and contrast the anatomical systems of different vertebrates and identify common traits across species and groups.

CO3	To describe the anatomical systems of different vertebrates and identify common traits across species and groups.
CO4	To analyze mammalian urinogenital system.
CO5	To demonstrate the characteristics of vertebrates and what makes both chordates and vertebrates unique among animals.

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					2	3	3	2
CO2	3	1		2	1		2					2	2	1	2
CO3	2			1			1					2	2	2	1
CO4	2	2		1	2		2					2	2	2	2
CO5	3	2		1			3					3	1	2	1

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

Course Content

Module-I :Integumentary System

Introduction to integuments, General features of integuments Dermis and Epidermis, Derivatives of integuments scales nails hooves , Horn antles baleen dermal armour , Dermal derivatives

Module-II Skeletal System

Introduction to skeletolsystem, Axial Skeleton, Appendicular skeleton, Jaw suspensorium , Visceral arches

Module-III: Digestive System

Introduction to digestive system, Alimentary canal, Associate glands , Dentition

Module-IV Respiratory System

Introduction to Respiratory system, Brief account of Gills , Brief account of lungs , Brief account of air sac , Brief account of swim bladders

Module-V Circulatory System

Introduction to Circulatory system, General plan of circulation, Evolution of heart , aortic arches

Module-VI: Urinogenital System

Introduction to Urinogenital system , Succession of kidney , Evolution of urinogenital duct , Types of mammalian urinogenital system

Module-VII Nervous System

Introduction to Nervous system Comparative account of brain Autonomic nervous system, Spinal cord, Types of receptors

Practice

1. Temporary mount of external scales in fishes (cycloid, placoid, ganoid, ctenoid)
2. Study of disarticulated skeleton of Amphibia/Reptilia/Aves/Mammal
3. Demonstration of Chick to study arterial system
4. Demonstration of Specimen
5. Demonstration of heart through video
6. Mini project & Powerpoint presentation

Text Books:

- Jordan, E. L. and Verma, P. S. (2013) Chordate Zoology (14th edition).
- Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).

Reference Books:

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.

Online Source: https://www.youtube.com/playlist?list=PLdNTrjqdXm_T7DzT1AO_b5_6G8zEF2al

Water and Soil Quality Management in Aquaculture

Course Code	Course Title	Type of course	T-P-Pj	Prerequisite
CUTM2380	Water and soil quality management in aquaculture	Theory -Practice	3-1-0	-

Course Objectives

<ol style="list-style-type: none"> 1 To learn effective soil and water quality management practices which is important for any aquaculture endeavours. 2 To acquire knowledge on soil health, its assessment and maintenance for sustaining soil productivity. 3 To understand of soil health and soil quality with reference to manage and maintain aquaculture.
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Course Outcomes

COs	Course Outcomes
CO1	To insight into the important water and soil quality management and their amalgamation for successful aquaculture operation
CO2	To impart knowledge on soil health, its assessment and maintenance for sustaining soil productivity.

CO3	To clear understand of soil health and soil quality
CO4	To examine the important water and soil quality management and their amalgamation for successful aquaculture operation
CO5	To evaluate different parameters of water and soil sample to enhance the sustainability of soil product.

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	3	1	2	2			3		3	3	3	2
CO2					1	1				2	1	1	2	1	3
CO3		1		1		2	2			3		2	1	3	2
CO4	3	2	2		2					3	2	3	2	2	2
CO5	2	1		1	1	1	1			2		1	2	2	1

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

Course Content

Module-I

1. Soil and water interaction: Physical and chemical properties of soil and water, 2. Productivity vs nutrient quality and quantity of soil and water; aquatic microorganisms and their role in carbon, 3. Nitrogen, 4. Phosphorus and Sulphur cycles and impact on aquatic habitats and species; Fertilizers and manures: Different kinds of fertilizers and manures; fertilizer grade, 5. source, rate and frequency of application; Use of treated sewage for pond fertilization and biofertilizers, 6. Ecological changes taking place after fertilizing.

Practice I(2h): 1. Water analysis: measurement of temperature, 2. Turbidity, 3. Determination of pH and EC. Determination of inorganic nitrogen and phosphorus.

Module-II

1. Primary production and its estimation; 2. degradation of molecules in aquatic environment; 3. Utilization of bioactive compounds by microorganisms; 4. Cat clay/pyrite soil and its management; 5. Seepage and its control.

Practice 2(2h): Estimation of primary productivity and chlorophyll

Module-III

1. Water treatment, 2. Water filtration devices, 3. Aeration, 4. Chlorination, 5. Ozonization and UV radiation; eutrophication; Algal bloom control; Aquatic weed management.

Practice 3(2h): Determination of salinity, Chlorinity, Total solids, Redox potential, DO, Free CO₂.

Practice 4(2h): Determination of total alkalinity, hardness.

Module-IV

1. Waste water treatment practices; 2. Waste discharge standards; 3. Water quality management in carp culture; 4. Water quality management in brackish water shrimp culture; 5. Water quality management in hatcheries.

Practice 5(2h) : Calculation of dose of fertilizers and pond liming

Module-V

1. Ecology of Pond system; 2. Role of microorganisms in fish production; 3. Microbial load and algal blooms; 4. fluxes between mud and water, 5. Methane and hydrogen sulphide formation

Module-VI

1. Alkali soils and its management; 2. Saline soils and its management; 3. acid sulphate soils, iron pyrites, 4. Soil reclamation; 5. Soil and water amendments: lime, 6. Manures, fertilizers, 7. Micronutrients, 8. Zeolites, 9. Alum, gypsum.

Module-VII

1. Effluent Treatment plant; 2. Aeration, 3. Chlorination, 4. Ozonisation and UV radiation; 5. Waste and water Treatment Practices; 6. Machine Learning for water quality analysis.

Practice 6(2h) : Jar Test

Reference & Textbooks

- 1 Bottom soil, sediment and pond aquaculture --- Claude E. Body
- 2 Fundamentals of Soil --- V.N. Sahai
- 3 Water quality in ponds for aquaculture -- Claude E. Body
- 4 Fresh water fish culture --- V.R.P. Sinha and V. Ramachandran

ADVANCED SUSTAINABLE AQUACULTURE

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM2380	Advanced Sustainable aquaculture	Theory+Practice	3-1-0	-

Course 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 Outcomes

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 Content

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 (NH₃, Organic matter, CO₂)

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.
- 5 *Biotechnology of Aquatic Animals*. Science Publ.

Molecular Biology

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4116	Molecular Biology	Theory+Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> • To understand the structure function, and makeup of the molecular building blocks of prokaryotic and eukaryotic organisms. • To focus on the interrelationship of DNA, RNA and protein synthesis and their mode of interactions. • To differentiate the regulation of transcription, translation, post-transcriptional and translational modifications between prokaryotes and eukaryotes.
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Course Outcomes

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

COs	Course Outcomes
CO1	To gain detailed insights into structure of DNA, RNA, types of RNA, DNA replication and different models for replication.
CO2	To examine the different types of DNA mutation and DNA repair mechanisms existing in animals.
CO3	To demonstrate details on transcriptional machinery, post-transcriptional and translational processing.
CO4	To analyze regulation of transcription and translation in prokaryotes and eukaryotes with emphasis on role of enhancers, activators and repressors.
CO5	To evaluate the regulation of post-transcriptional, translational and co-translational modification of proteins.

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			2					3	2	2	3
CO2	2			3	1		2					1	1	1	3
CO3	2	2	1	3			1					2	3	3	3
CO4	3			2	2		3					3	2	2	1
CO5	2	1		2			1					1	2	2	2

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

Course Content

Module-I: Nucleic acids

Introduction to nucleic acids: Nucleotide and Nucleoside, Types of nucleic acids: DNA & RNA

DNA: Watson & Crick model of DNA, Different forms of DNA (A, B and Z forms). RNA: Different forms of RNA, Protein coding RNA (mRNA), Functional RNA (rRNA and tRNA), Regulatory RNA (si RNA, mi RNA, sn RNA)

Module II: DNA replication

Overview of DNA replication: Different models of DNA replication, Semi-conservative mode of DNA replication, rolling circle mode of DNA replication, Theta mode of DNA replication. Enzymes involved in DNA replication and their roles: DNA polymerases, DNA gyrase, DNA helicase, DNA ligase, Primase. Replication process: DNA replication in prokaryotes and eukaryotes

Module III: DNA mutation

Mutation: Causes of mutation and effects of mutation. Types of mutation: missense mutation, Nonsense mutation, Insertion or Deletion, Duplication, Frameshift mutation, Repeat expansion

Module IV: DNA Repair

DNA Repair: Direct repair, Excision repair, Mismatch repair, Nonhomologous end-joining, SOS response. DNA repair errors: Defects in DNA repair and its consequences.

Module V: Transcription and post transcriptional processing

Transcriptional machinery: The transcription Unit, Enzymes and transcription factors. Transcription process: Process of transcription in prokaryotes and eukaryotes. Post transcriptional processing: Processing of mRNA, Synthesis and processing of functional RNA (rRNA & tRNA). Reverse transcription: The process of synthesis of cDNA.

Module VI: Regulation of gene transcription

Transcription regulation in prokaryotes: The operon concept: The lac operon, The trp operon. Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements. Gene silencing: Transcriptional and post-transcriptional gene silencing

Module VII: Translation and post translational processing

Component of translation and their roles: mRNA: The precursor of molecule of translation, Ribosomes: The site of protein synthesis, tRNA: the carrier molecule of translation. Translation: Process of

translation in prokaryotes and eukaryotes. Post translational modifications: Co- and post-translational modifications of proteins

Molecular Biology Lab (Practice)

Experiments:

1. Isolation and spectrophotometric estimation of DNA
2. Isolation and spectrophotometric estimation of RNA
3. Visualization of DNA/RNA using agarose gel electrophoresis
4. Preparation of equilibrated phenol
5. Quantitative estimation of RNA using Orcinol reaction
6. Demonstration of DNA & RNA by MGP
7. Preparation of liquid culture medium (LB) and raise culture of *E. coli*
8. Preparation of solid agarose medium (LB) and raise colonies of *E. coli*
9. Demonstration of DNA replication, transcription and translation using Photograph, slides and/or videos.
10. Application of *in silico* tools (BIOVIA's DISCOVERY STUDIO) to study the three dimensional structure of proteins.

Text Books:

1. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular Biology of the Gene* (International Ed.).

Reference Books:

1. Brown, T. A. (2006). *Genomes 3*. Garland Science
1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.
2. Cooper G. M. and Robert E. Hausman R. E. *The Cell: A Molecular Approach*, V Edition, ASM Press and Sinauer Associates.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp, G. (2010) *Cell and Molecular Biology: Concepts and Experiments*. VI Edition. John Wiley and Sons. Inc.
5. Lewin B. (2008). *Gene XI*, Jones and Bartlett

Online Source:

- *ePathsala*
- *NPTEL*

Evolutionary Biology

Course Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4626	Evolutionary Biology	Theory +Practice	3-1-0	

Course Objectives

- To provide comprehensive overview of Concept of Evolution.
- To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
- To provide adequate information about Geological Time Scale

Course Outcomes

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

COs	Course Outcomes
CO1	To understand the main forces of evolution and the interplay among them, both over ecological and evolutionary time.
CO2	To define history of life; the evolution of humans.
CO3	To know about Origin of Life especially Prokaryotes as well as Eukaryotes in detail.
CO4	To describe main forces of evolution (natural selection, sexual selection, genetic drift). and the interplay among them, both over ecological and evolutionary time.
CO5	To analyze descriptive knowledge regarding Origin and Evolution of Man.

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					3	3	3	3
CO2	2	2		2	1		1					1	2	1	3
CO3	2	1		1			2					3	3	2	2
CO4			1	1	3		3					3	1	2	2
CO5		1		1			2					3	3	1	2

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

Course Content

Module-I :Major Events in History of Life

Major Events in History of Life ,Lamarckism , Darwinism , Neo-Darwinism

Module II : Fossils

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Module III :Organic variations

Isolating Mechanisms ,Natural selection (Example: Industrial melanism) , Types of natural selection(Directional, Stabilizing, Disruptive) , 3.5Artificial selection

Module IV

Genetic Drift , Micro evolution , Biological species concept (Advantages and Limitations) , Modes of speciation (Allopatric, Sympatric)

Module V

Macro-evolutionary Principle, Darwin's Finches , Causes and effects of extinction , Biological species concept (Advantages and Limitations) , Modes of speciation (Allopatric, Sympatric)

Module VI: Extinction

Mass extinction, K-T extinction, Role of extinction in evolution, Origin and evolution of man, Homonid characteristics

Module VII

Phylogenetic trees, multiple sequence alignment, constructions of phylogenetic trees

Practices

1. Study of homology and analogy from suitable specimens/ pictures
2. Study of fossil evidences from plaster cast models and pictures
3. Demonstration of video
4. Mini project : Study and verification of Hardy-Weinberg Law by chi square analysis
5. Demonstration of video: Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies

Reference and Text books

- B.S. Tomar& S.P. Singh, 2000. Evolutionary biology. (Rastogi Publ.).
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.Douglas,
- J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

Principles of Ecology

Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4626	Principles of Ecology	Theory +Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> • Obtain knowledge about the Ecosystem and their functioning, so that they will be crusader of environmental sustainability. • Describe the different components of ecosystem, the types of biogeochemical cycles and importance of energy as drivers of ecosystem • distinguish among allied scientific disciplines (environmental science, conservation biology, restoration ecology, and environmental engineering) and compare their purposes with that of ecology
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Course Outcome

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

COs	Course Outcomes
CO1	To define the different components of ecosystem, the types of biogeochemical cycles and importance of energy as drivers of ecosystem
CO2	To understand scientific disciplines (environmental science, conservation biology, restoration ecology, and environmental engineering) and compare their purposes with that of ecology
CO3	To describe the application of the scientific method to ecological experimentation.
CO4	To analyze ecological aspects and their contribution towards sustainable environment
CO5	To evaluate the different Wildlife Conservation and Management Policies

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						1		2	3	2	1
CO2	2		1	2	2		2			3		2	2	1	3
CO3	2		3	3			3			3		3	1	3	2
CO4	1	1	1	2	3		2			1		3	3	2	1
CO5	2		2	3	2		2			2		2	2	2	1

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

Course Content

Module- I (10Hrs)

Introduction to Ecology: History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors.

Module- II (7Hrs)

Population: Unitary and Modular populations Unique and group attributes of population: Density, nasality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Exponential and logistic growth, equation and patterns, r and K strategies .

Module-III (8Hrs)

Population regulation - density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical Responses.

Module-IV (8Hrs)

Community: Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one Example, Theories pertaining to climax community.

Module- V (5Hrs)

Ecosystem: Types of ecosystems with one example in detail, Food chain: Detritus and Grazing food chains, Linear and Y-shaped food chains, Food web. B.Sc. (Zoology) Curriculum School of Applied Sciences

Module- VI (5Hrs)

Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies.

Module- VII (5Hrs)

Nutrient and biogeochemical cycle with one example of Nitrogen cycle, Human modified ecosystem Applied Ecology: Ecology in Wildlife Conservation and Management Principles of Ecology

Practice

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
3. Study of an aquatic ecosystem: Phytoplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content.
4. Study of an aquatic ecosystem: Zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content.
5. (Winkler's method), Chemical Oxygen Demand and free CO₂.
6. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

Text books :

Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole

Reference Books:

- Colinvaux, P. A. (1993). Ecology. II Edition.
- Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Robert Leo Smith Ecology and field biology (2000) Harper and Row publisher Ricklefs, R.E.

Developmental Biology

Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4628	Developmental Biology	Theory+Practice	3-1-0	

Objectives

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- The course is so designed for acquiring knowledge to know the process of reproduction and the development of embryo.
- The Objectives of this course is to provide a comprehensive understanding of the concepts of early animal development.
- Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.

Course Outcome

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

COs	Course Outcomes
CO1	To know about the reproductive and development processes and can apply the acquired knowledge for higher study.
CO2	To have a comprehensive understanding of the concepts of early animal development
CO3	To predict the lineage outcome of transplanting mesodermal cell populations from anterior heart to posterior presomatic tail bud.
CO4	To provide a comprehensive understanding of the concepts of early animal development.
CO5	To predict the lineage outcome of transplanting mesodermal cell populations from anterior heart posterior to presomatic tail bud.

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply.

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			1					3	2	3	3
CO2	2			2	1		2					1	2	1	2
CO3	3	1		2			3					3	3	3	2
CO4	3	2		2	2		3					2	2	3	1
CO5	1			2	2		3					3	2	3	3

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

Course Outline

Module -I- Historical perspective and basic concepts (4h)

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern development, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division.

Module-II- Various Developmental aspects (4h)

Early Embryonic Development, Gametogenesis, Spermatogenesis, Oogenesis and Types of egg, Egg Membranes.

Module-III- Fertilization (5 h)

Fertilization (External and Internal), Changes in gametes, Blocks to polyspermy, Planes and patterns of cleavage.

Module - IV- Fate Maps (4h)

Fate maps (including Techniques), Early development of frog up to gastrulation, Early development of chick up to gastrulation, Embryonic induction and Organisers.

Module -V- Embryonic development (5h)

Late Embryonic Development: Fate of Germ Layers, Extra-embryonic membranes in birds, Implantation of embryo in humans, Placenta (Structure, types and functions of placenta), Post Embryonic Development. Metamorphosis: Changes, hormonal regulations in amphibians and insects.

Module-VI- Regeneration (3h)

Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each).

Module- VII- Ageing (5h)

Ageing: Concepts and Theories, Implications of Developmental Biology Teratogenesis: Teratogenic agents and their effects on embryonic, development, In vitro fertilization ,Concept of Stem cell, Amniocentesis

Practices

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula
2. Study of whole mounts and sections of developmental stages of frog through permanent slides: neurula, tail-bud stage,tadpole (external and internal gill stages).
3. Study of T.S of Testis , Semen sample , Graffian follicle(Mature follicle about to release an ovum) and corpus luteum through permanent slides.
4. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours).
5. Study of Whole mounts of chick embryo 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation.

6. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
7. Study of different sections of placenta (photomicrograph/ slides)
8. Project report on *Drosophila* culture/chick embryo development

Text Books:

Verma, Agrawal, 2007, Embryology, Rostogi Publication

Reference Books:

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press CBCS

Genetics

Code	Course Title	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4629	Genetics	Theory +Practice	3-1-0	

Course Objectives

<ul style="list-style-type: none"> • Genetics is offered as a core course that provides fundamental knowledge of inheritance and evolution of the concept of gene with study of genetic diseases. • This course provides an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like recombination, transposition, sex determination and mutations. • Describe the mechanisms governing Mendelian inheritance, gene interactions and gene expression.
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Course Outcomes

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

COs	Course Outcomes
CO1	To know the basic principles of inheritance and knowledge of the principles of genetics is essential for a deeper understanding of the varied branches of the biological.
CO2	To Know the mechanisms of mutations and the causative agents will lead to an increase in an awareness of the students about the harmful impact of various chemicals and drugs being used in day to day life.
CO3	To be able to make a strategy to manipulate genetic structure of an organism for the

	improvement in any trait or its well-being based on the techniques learned during this course.
CO4	To explain the basic principles of inheritance and knowledge of the principles of genetics is essential for a deeper understanding of the varied branches of the biological.
CO5	To develop a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well-being based on the techniques learned during this course.

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			2					3	2	3	3
CO2	2		3	2	1		2					1	2	1	3
CO3	2	2	2	3	1		3					3	3	2	1
CO4	1		2	1			2					2	1	2	2
CO5	3	1	2	3			1					3	2	1	3

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

Course Content

Module-I

Mendelian Genetics and its Extension: Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.

Module-II

Linkage, Crossing Over and Chromosomal Mapping: Linkage, Crossing Over and Chromosomal Mapping, Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination. Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

Module- III

Mutations:Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

Module-IV

Sex Determination:Genetic and environmental basis of sex determination; Chromosomal mechanisms of sex determination in *Drosophila* and Man.

Module-V

Extra-chromosomal Inheritance. Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects.

Module-VI

Polygenic Inheritance: Polygenic inheritance with suitable examples; simple numericals based on it. Recombination in Bacteria and Viruses, Conjugation, Transformation, Bacteriophage, Transduction

Module-VII

Transposons: Complementation Test in Transposable Genetic Elements: Transposons in bacteria, Ac-Ds elements in maize and P elements In *Drosophila*, Transposons in humans.

Principles of Genetics Lab Practice

Experiments:

1. Collection and Study of *Drosophilla* under compound microscope.
2. Chi-square analyses using seeds/beads/*Drosophilla*.
3. Linkage maps based on data from *Drosophila* crosses.
4. Study of karyotype (*Human or Drosophilla*).
5. Pedigree analysis of some human inherited traits.
6. Linkage maps based on data from Trihybrid cross.
7. Morphological study of chromosome by squashing method.
8. Sex Determination: Genetic and environmental basis of sex determination

Text Books and Reference Books:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. WileyIndia
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London. CBCS Undergraduate Program in Zoology 2015
- Pierce B. A. (2012). *Genetics-A conceptual approach*. IV Edition. W. H. Freeman and Company
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2007) *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.

ANIMAL BIOTECHNOLOGY

Course Name	Course Name	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM1452	Animal Biotechnology	Theory + Practice	3-1-0	-

Course 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 Outcomes

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 Content

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

MICROBIOLOGY

Course Code	Course Name	Type of course	T-P-Pj	Prerequisite
CUTM1436	Microbiology	Theory+Practice	3-1-0	

Course 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 Outcomes

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 Content

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; Prions, Virioids,

1.4 Antiviral agents and Vaccines; Bacterial Classification (phenetic, genetic and phyllogenetic);

Bergeys manual of systematic bacteriology; Classification,

1.5 Identification and

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 -II

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-III

Environmental Microbiology & Wastewater Management:

- 3.1 Microbes and quality of environment,
- 3.2 Biotransformation,
- 3.3 Microbes in waste water management; Microbial degradation of pesticides, toxic chemicals, oil; Bioremediation,
- 3.4 Bioremediation.

Module-IV

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-V

Medical Microbiology:

- 5.1 Host pathogen interactions,
- 5.2 Pathogenicity of bacteria invasiveness and toxigenicity,
- 5.3 Constitutive and inducible host defense 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-VI

Industrial Microbiology

Cyanobacterial Biotechnology:

- 6.1 Application as nutraceuticals,
- 6.2 Pharmaceuticals,
- 6.3 Cosmetic,
- 6.4 Biofertilizer; application as biofuel, CO₂ 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.
- 6.13 Industrial Application of cyanobacteria

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-VII

Microbial genetics

7.1 Lytic and Lysogenic cycle,

7.2 Conjugation,

7.3 Transduction, Transmission and Replication

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

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 Alexopoulos, C. J., Mims, C. W. and Blackwell, 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 Freifelder, 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

Bioanalytical Techniques

Course Code	Course Name	Type of course	T-P-Pj (Credit)	Prerequisite
CUTM4630	Bioanalytical Techniques	Theory-Practice	3-1-0	-

Course 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 Outcomes

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 bioanalytical techniques
CO2	Demonstrate an understanding of fundamental statistical concepts and bioanalytical methods, explaining how they are applied in biological research.
CO3	Apply bioanalytical 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 bioanalytical 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 Content

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 centrifugation)
- 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. New Jersey, USA*
 - 3 *Rodney F Boyer (2012). Biochemistry laboratory: modern theory and techniques. 2nd Edition, Pearson Prentice Hall, Boston, USA.*
- R. Katoch (2011). *Analytical techniques in biochemistry and molecular biology, Springer, New York.*

Immunology and Cancer Biology

Code	Course Title	Type of Course	(T-P-Pj) Credits	Prerequisite
CUTM4631	Immunology and Cancer biology	Theory + Practice	3-1-0	3-1-0

Course 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 Outcomes

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 Content

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,
- 1.4 Inflammation

Practice 1(2h): Demonstration of lymphoid organs in mice..

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): To perform radial immunodiffusion using a given antigen and antibody.

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 Radioimmunoassay
- 5.4 ELISA
- 5.5 Diffusion.

Practice 4(2h) : To detect the presence of an antigen using Sandwich ELISA.

Practice 5 (2h): To perform immunoprecipitation using suitable antigen and antibody.

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 tumor suppressor gene: progression of cancer,

7.2 Metastasis,

7.3 Apoptosis in cancer,

7.4 DNA repair in cancer

Recommended books:

1 **TextBooks:**

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 Therapeutics,” Oxford University.

ANIMAL BREEDING

Course Code	Course Name	Type of course	T-P-Pj	Prerequisite
CUTM1453	Animal Breeding	Theory+Practice	3-1-0	-

Course 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 Outcomes

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 Content

MODULE -I

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-II

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-III

- 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-IV

- 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-V

- 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-VI

- 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 heterosis for different types of crosses.
d) Estimation of GCA and SCA

MODULE-VII

- 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 – by Bhattacharya. B
- 5 Textbook of Animal husbandry – G.C Banerjee

ENVIRONMENTAL SCIENCE

Course Name: Environmental Science

Course Code: CUTM1674

Credit: 4

Credit Breakup: 3+0+1 (Theory + Practice + Project)

Introduction

The National Education Policy (NEP) 2020 underlines the importance of making environmental education an integral part of curricula and encouraging environmental awareness and sensitivity towards its conservation and sustainable development. Environment Education, therefore, needs to include areas such as climate change, pollution, waste management, sanitation, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development.

Course Objectives

- To understand the relationship among human being, natural resource and environment on the historical perspectives.
- To orient students towards the principles of sustainable development goals and train them for conserving Biodiversity and maintaining Ecosystem balance.
- To analyze environmental issues and problems critically, and develop strategic environmental management policies and practices.

Course Outcome

After the successful completion of the course, students should be able to:

CO1	Explain the historical perspectives of human, natural resource and environment interactions.
CO2	Identify, classify, evaluate and prospect the natural resources integrated with Sustainable Development Goals.
CO3	Analyze issues and concerns of Biodiversity conservation and Ecosystem services at local, regional and global scales.

CO4	Demonstrate their environmental management competency to combat pollution, waste generation and climate change.
CO5	Conduct independent project works and address current environmental challenges complying with Environmental agreements, treaties, acts and laws.

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						1		2	3	2	1
CO2	2		1	2	2		2			3		2	2	1	3
CO3	2		3	3			3			3		3	1	3	2
CO4	1	1	1	2	3		2			1		3	3	2	1
CO5	2		2	3	2		2			2		2	2	2	1

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

Module-1: Human and Environment

6 Hours

Introduction to Human and the Environment: Overview of human-environment interactions throughout history; Importance of mastery of fire, the origin of agriculture, and the emergence of city-states; Discussion on the impact of ancient civilisations on the environment. Emergence of Environmentalism: Anthropocentric and eco-centric perspectives; Study of significant thinkers and their contributions to environmental philosophy; Environmental movements, Analysis of critical events such as the UN Conference on Human Environment 1972.

Module-2: Natural Resources and Sustainable Development

7 Hours

Understanding Natural Resources: Definition and classification of natural resources; Renewable and Non-renewable, Biotic and abiotic resources, Forest, Grasslands, Wildlife, Water, Mineral, Food, Land, Energy; Introduction to sustainable development: Sustainable Development Goals (SDGs), targets and indicators; Discussion on challenges and strategies for achieving sustainability. World commission on Environment and Development.

Module-3: Conservation of Biodiversity and Ecosystem

12 Hours

Levels and types of Biodiversity, Biodiversity in India and the world, Biodiversity Hotspots, Land Use and Loss of Biodiversity: deforestation, urbanisation, desertification; trends in biodiversity loss; Case studies on the impact of human activities on biodiversity hotspots. Conservation of Biodiversity and Ecosystems: Understanding biodiversity and its distribution; Discussion on major ecosystem types:

forests, grasslands, agriculture, coastal and marine and their characteristics; Ecosystem services: Classification and significance; Exploration of threats to biodiversity and ecosystems; *in-situ* and *ex-situ* conservation, protected areas, traditional knowledge, sacred groves, community based conservation.

Module-4: Environmental Pollution and Management

10 Hours

Pollution and its impact; Overview of pollution: air, water, soil, noise, solid waste, hazardous waste; Discussion on transboundary pollution and its consequences; Understanding environmental issues at micro, meso, synoptic, and planetary scales; Case studies highlighting the adverse effects of pollution on human health and ecosystems. Addressing Environmental Pollution and Health: Strategies for pollution control and management; Examination of air, water, soil, and noise pollution and their health impacts; Introduction to waste management practices and their significance. Introduction to environmental management systems such as ISO 14001 and the role of organizations like UNEP and IPCC in global environmental governance; Case studies on the implementation of environmental policies and regulations in different contexts.

Module-5: Environmental Policies and Practices

10 Hours

Introduction to environmental laws and regulation: Constitutional provisions - Article 48A, Article 51A(g) and other derived environmental rights; Introduction to environmental legislations on the forest, wildlife and pollution control: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; Noise Pollution (Regulation and Control) Rules, 2000; National Green Tribunal; Climate Change policies, Greenhouse gas emissions and their impact on global climate; Climate change mitigation measures and practices: UNFCCC, Concept of NET ZERO. Environmental Treaties: Major international environmental agreements, conventions and their significance: CBD, CITES, UNCCD, Analysis of India's status and commitments under these agreements.

SUGGESTED READINGS

- Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
- Sinha, N. (2020) Wild and Wilful. Harper Collins, India.
- Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK.
- Kanchi Kohli and Manju Menon (2021). Development of Environment Laws in India, Cambridge University Press.
- Ministry of Environment, Forest and Climate Change (2019). A Handbook on International Environment Conventions & Programmes. <https://moef.gov.in/wp-content/uploads/2020/02/convention-V-16-CURVE-web.pdf>
- Headrick, Daniel R. (2020). Humans versus Nature- A Global Environmental History, Oxford University Press.
- Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future. 10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
- Harper, Charles L. (2017). Environment and Society, Human Perspectives on Environmental Issues 6th Edition. Routledge.
- Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.

- Pittock, Barrie (2009) Climate Change: The Science, Impacts and Solutions. 2nd Edition. Routledge.

THRUST AREA OF PROJECTS

Theme-1: Human and Environment

- 1.1 Environmental awareness level of students, faculties and staffs of Centurion University through a questionnaire assessment
- 1.2 Hygiene and sanitation: An important factor of Environment and Women Health
- 1.3 Environmental movements in India and their role in Environmental Protection
- 1.4 Study on major civilizations along river banks: A few case studies
- 1.5 Critical study and analysis of the first world conference on the Human Environment, Stockholm, 1972

Theme-2: Natural Resources and Sustainable development

- 2.1 Plant resource, diversity and their utility in Centurion University campus
- 2.2 Water resource use, management and conservation strategies in Centurion University campus
- 2.3 Energy audit of Centurion University campus
- 2.4 A study on the planning, execution and implementation of Sustainable Development Goals (SDGs) in Centurion University
- 2.5 Critical study and analysis of the World Commission on Environment and Development, 1983

Theme-3: Conservation of Biodiversity and Ecosystem

- 3.1 Biodiversity assessment of Centurion University campus
- 3.2 *Ex-situ* Biodiversity conservation initiatives taken in Centurion University
- 3.3 Identification and documentation of food chain and food webs in Centurion University campus including Pollinators' Paradise
- 3.4 Land use and land cover analysis across campuses of Centurion University in Odisha
- 3.5 Identification, documentation and analysis of micro ecosystems of Centurion University

Theme-4: Environmental Pollution and Management

- 4.1 Water quality assessment with isolation, characterization and application of pollutant-degrading microbes from contaminated and waste water sources
- 4.2 Soil quality assessment within and Outside Centurion University campus
- 4.3 Ambient Air Quality Assessment within and outside of Centurion University campuses using High Volume Air Sampler
- 4.4 Assessment of Noise pollution within and outside of Centurion University campuses using Sound Level Meter
- 4.5 Waste to wealth Management adopted in Centurion University Campus

Theme-5: Environmental Policies and Practices

- 5.1 Provisions for Environmental protection in the Constitution of India: Prospects and Retrospects
- 5.2 A few case studies handled and heard by National Green Tribunal (NGT), India
- 5.3 Green House gases and their impact on Global climate: Role of UNFCCC
- 5.4 A critical analysis of Convention on International trade in endangered species of Wild Fauna and Flora (CITES) to combat Wild life loss
- 5.5 Best environmental policies and practices of Centurion University across campuses in Odisha