Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL
(AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC

'College with Potential for Excellence' Status Awarded by UGC

'Best College Award' by University of Mumbai

Program: Bachelor's in Science (B. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on 13th June 2024)

F. Y. B. Sc. Zoology

NEW ACADEMIC POLICY 2020

w. e. f. Academic Year 2024-25

To be implemented from the Academic year 2024-2025

Zoology Major

SEMESTER I

COURSE I: Diversity in Non- Chordates

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USC1ZO1	I	Diversity in non-chordates	3	1
	II	Animal Diversity- Non chordates		1
	III	Type study- Earthworm		1
USC1ZOP	Practical based on major course		1	2

SEMESTER II

Course II: Diversity in Chordates

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USC1ZO1	I	Animal Diversity in chordates	3	1
	II	Group Eurochordata		1
	III	Type study- Shark		1
USC1ZOP	Practical based on both courses		1	2

Syllabus for F.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester I
Paper I and Practical I

F.Y.B.Sc. ZOOLOGY (THEORY) Course Code: USC1ZO1			
SEMESTER I			
Diversity in Non-chordates			
Course Objectives: • *To nurture interest in the students for the subject of Zoology.* • *To understand animal diversity.* • *To study detailed morphology of invertebrates.*			
Course Outcomes • *Learners will be able to comprehend the diversity of animals.* • *Learners will be able to understand the importance of classification.* • *Learners develop insight of group and type study.*			
Unit	**Title**	**Lectures**	**Credits**
Unit I: Diversity of animal Kingdom I	**1.1: Levels of organization** **1.1.1:** Unicellularity Vs multicellularity, Colonization and organization of germ layers (diploblastic and triploblastic condition) **1.1.2:** Division of labour and organization of tissues (Brief fate of ectoderm, mesoderm and endoderm) **1.1.3:** Development of coelom: Acoelomate, pseudocoelomate and coelomate organization **1.1.4:** Radial and bilateral symmetry **1.1.5:** Metamerism **1.2: Unicellular and multicellular organization** **1.2.1:** Unicellular organization: Phylum Protozoa	**12 lectures**	**01**

	1.2.2: Multicellular organization: Colonization level- Phylum Porifera **1.2.3:** Multicellular organization: Division of labour (Cell differentiation)- Phylum Coelenterata		
	1.3 Triploblastic acoelomate and pseudocoelomate organization		
	1.3.1: Acoelomate organization - Phylum Platyhelminthes **1.3.2:** Pseudocoelomate organization – Phylum Nemathelminths		
	1.4: Triploblastic coelomate organization		
	1.4.1: Animals with metameric segmentation- Phylum Annelida **1.4.2:** Animals with jointed appendages- Phylum Arthropoda		
Unit II: Animal Diversity- Non chordates	**2.1 Non–Chordates:** General characters and classification of the following up to classes with examples showing distinctive / adaptive features of the following phyla:	**12 lectures**	**01**
	2.1.1: Kingdom Protista: Protozoa (Amoeba, Paramecium, Euglena, Plasmodium)		
	2.2: Kingdom Animalia		
	2.2.1: Porifera (Leucosolenia, Euplactella, Hyalonema, Euspongia) **2.2.2:** Coelenterata (Cnidaria) (Physalia, Obelia, Aurelia, sea Anemone) **2.2.3:** Ctenophora (Comb jelly) **2.2.4:** Platyhelminthes (Fasciola, Planaria, Liverfluke, Tapeworm) **2.2.5**: Nematohelminthes (*Ascaris, Ancyclostoma, Enterobius*) **2.2.6**: Annelida (Nereis, Earthworm, Leech) **2.2.7:** Arthropoda (Crab,Lobster, Beetle, Dragonfly, Butterfly, Moth, Spider, Centipede, Millipede) **2.2.8:** Mollusca (Chiton, Dentalium, Pila, Unio, Sepia and Nautilus) **2.2.9:** Echinodermata (Starfish, Brittle star, Sea urchin, Sea cucumber, Feather star)		
	2.2. General topics: Economic importance of Protozoa		

Unit III: Type study- Earthworm:	Systematic position, Habits and habitat, External characters, Body wall, Digestive system, Blood Vascular System, Excretory system, Nervous system and sense organs. Reproductive system, Economic importance.	**12 lectures**	**01**
	SEMESTER I **Practical Code: USC1ZOP** **PRACTICAL – I**	**30 lectures**	**01**
	1. Study of levels of organization in Animal kingdom A) Symmetry: i) Asymmetric organization: Amoeba ii) Radial symmetry: Sea anemone, Aurelia iii) Bilateral symmetry: Planaria / liver fluke B) Acoelomate: T.S. of Planaria / liver fluke C) Pseudocoelomate: T.S. of Ascaris D) Coelomate: T.S. of Earthworm E) Segmentation i) Pseudosegmentation: Tapeworm ii) Metamerism: Earthworm F) Specialization of body parts for division of labour: Head, thorax and abdomen - Insect G) Cephalization i) Cockroach – Head ii) Prawn/ crab – Cephalothorax **2.** Study of animal diversity with reference to- i) Protozoa: Amoeba, Paramecium, Euglena, Plasmodium ii) Porifera: Leucosolenia, bath sponge iii) Coelenterate: Hydra, obelia colony, Aurelia, sea anemone and any one coral iv) Platyhelminthes: Planaria, liver fluke and tapeworm v) Nemathelminths: Ascaris- male and female vi) Annelida: Nereis, earthworm and leech vii) Arthropoda: Crab, lobster, Lepisma, beetle,		

	dragonfly, butterfly, moth, spider, centipede, millipede **3.** Preparation and observation of Paramecium. **4.** Determination of the rate of heart beat in Daphnia **5.** Study of animal interaction: ➢ Commensalism: Echinus and shark ➢ Mutualism: Termite and Trichonympha ➢ Antibiosis: Effect of antibiotic on bacterial growth on a petri plate ➢ Parasitism: Ectoparasite – head louse and bed bug ➢ Endoparasite: *Trichinella spiralis* ➢ Predation: Praying mantis and spider **6.** Mounting of foraminiferan shells from sand **7.** Demonstration of systems/ organs in Earthworm: Digestive system, Excretory system, Reproductive system and Nervous system (Use of permanent slide, model or photographs) **8.** Study of life cycle and pathogenicity of *Entamoeba, Leishmania*, liver fluke and Tapeworm **9.** Study of any 5 invertebrates available in nearby area (Submit the project)		

References:

1. Invertebrate Zoology Volume II- Jordan andVerma , S. Chand and Co.
2. Invertebrate Zoology- T. C. Majupuria , S. Nagin and Co.
3. Invertebrate Zoology- P. S. Dhami and J. K. Dhami , R. Chand and Co.
4. Zoology- S. A. Miller and J. B. Harley, Tata McGraw Hill
5. Modern Textbook of Zoology, Invertebrates, R. L. Kotpal
6. Biodiversity- S.V.S Rana- Prentice Hall Publications
7. Modern Biology- V. B. Rastogi
8. Biology of Mollusca- D. R. Khanna
9. A Textbook of Zoology, Vol. II- T. Jeffery Parker and William. A. Haswell- Low Price Publications.
10. Manuals of Laboratory Specimens Invertebrates Gurudarshan Singh

Syllabus for F.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester I
SKILL ENHANCEMENT COURSE 1

Theory and Practical

CREDITS -2 (1 Theory + 1 Practical)

Skill Enhancement Course 1 (THEORY)

ORNAMENTAL FISH BREEDING USC1ZOSEC1

Course Objectives:

- *Understand the basic concepts and significance of ornamental fishery.*
- *Learn the techniques and best practices for breeding ornamental fish and managing fish farms.*
- *Acquire practical skills in constructing and maintaining aquariums for ornamental fish.*

Course outcomes

- *Students will be able to define ornamental fishery, explain its economic and ecological importance, and identify various types of ornamental fish.*
- *Students will demonstrate knowledge of breeding techniques, including spawning methods and larval rearing, and apply management practices for maintaining healthy fish populations and optimizing farm productivity.*
- *Students will gain hands-on experience in designing, building, and maintaining aquariums, including knowledge of water quality management, filtration systems, and the selection of suitable aquatic plants and decorations.*

Unit	Title	Lectures	Credit
Introduction ornamental fishery	1.1: Introduction to Ornamental fishes 1.2. Introduction to aquarium and aquarium accessories. 1.2. Basic knowledge on profile of ornamental fishes in world.	**04 lectures**	**01**
Construction of Aquarium	2.1 Engineering Aspect and construction of aquarium. Design and construction: Construction, settings, and maintenance of aquarium 2.2: Construction of ornamental fish unit 2.3: Engineering aspect in Ornamental Fish Farming 2.3.1: Aerators, filters, and lighting. 2.3.2: Biofilters in aquarium.	**04 lectures**	

	2.4: Introduction to Aquarium plants and its propagation techniques 2.4.1: Introduction to Aquarium plants and their export potential. 2.4.2: Profiles of some selected aquarium plants. Morphology, multiplication of aquarium plants – different methods. Indigenous ornamental plants of Western Ghats.		
Ornamental fish breeding and Ornamental fish farming-Management Aspects	3.1. Fish Breeding and rearing in Live Bearers 3.1.1: Breeding of ornamental fish with reference to live bearer species. 3.1.2: Breeding of Guppies, Mollies, Sword tail fish and Platy fish 3.1.3: Introduction hatchery management system for live bearers 3.1.4: Nursery management of live bearers 3.2. Fish Breeding and rearing in Egg layers 3.2.1: Breeding of ornamental fish with reference to selected egg layer species. 3.2.2: Introduction to Breeding of Angel fish, Zebra fish and Neon tetra 3.2.3: Introduction hatchery management system for egg layers 3.2.4: Nursery management of egg layers Special emphasis on Breeding of Gold fish 3.3: Ornamental Fish-diseases and their management 3.4: Live Food culture for tropical ornamental fish 3.5: Feeding for breeding and maintenance of ornamental fish. 3.6: Health management in Ornamental Fish Farming	**04 lectures**	

SKILL ENHANCEMENT COURSE (PRACTICAL) **Course Code: USCZ2P02**
SEMESTER I
ORNAMENTAL FISH BREEDING
CREDIT :1 **30 Lecture**
1. Identify classify and describe an aquarium fish (any five).
2. Study of breeding in live bearer
3. Identify and describe the aquarium accessories with their use and maintains.
4. Identify and describe hybrid aquarium fishes

5. Identify and describe food and its Types
6. Identify and describe an aquarium plant (any five).
7. Preparation of an aquarium tank of suitable size
8. Setting of aquarium
9. Maintenance of an aquarium.
10. Cultivation of some common live food
11. Aquarium fish diseases
12. Report on Field visit

ANNEXURE -I Suggested Field Visits

Field visits are to be organized to facilitate students to have first-hand experience and exposure to technology / production / functioning of an organization / unit or witness a relevant activity. Each student must make at least 02 (Two) such visits to the units/markets/public aquarium out of 2 to 3 such visits organized by the college.

i) Visit to one of the units with one or multiple activities such as • Ornamental fish farm / Nursery/ Hatchery.

ii) Visit any production units such as Ornamental fish Food industry Ornamental articles

iii) Govt. Offices such as • Fishery Department. • MPEDA, Mumbai • NFDB, Hyderabad • CIFI, Mumbai iv) Visit to National Laboratories, National Research Labs & Training Institutes such as NIO, Goa; CIFE, Mumbai; Fishery College, Ratnagiri; (Field visit is desirable to know the organization; however guest lecturers could also be helpful in understanding functioning).

ANNEXURE –II Suggested

Topics for Entrepreneurial Skill Development

1. Setting and Maintenance of fresh water aquarium.
2. Setting and Maintenance of marine aquarium.
3. Breeding of various aquarium fishes.
4. Preparation of aquarium fish feed.
5. Breeding of aquarium fishes.
6. Rearing of aquarium fishes.
7. Propagation of aquatic plants.

ANNEXURE -III Suggested Topics for Individual Project

1. Feasibility report of the maintenance of aquarium fishes in high profile residences.
2. Probability report of maintenance of a culture of Chaetoceros & Artemia by the fish farmers.
4. Project report for the establishment of small / medium / large ornamental fish farming unit

5. Feasibility report of various packaging materials in freezing / canning industry.
6. Feasibility report for establishing an aquarium shop.
7. Feasibility report for establishing a fish feed industry.
8. Setting up of marine aquarium with various accessories and its costing.
9. Finding herbal medicines for ornamental fish diseases
10 Propagation of aquarium plants and tissue culturing methods

References:

1. Hawlins, A.D. (Ed). Aquarium Systems. Academic Press.
2. Hunnam, P. Ward Lock, Living Aquarium.
3. Ratjak, K. and Zukal, R., Aquarium Fishes and Plants.
4. Spotte and John Wiley, S., Seawater Aquariums.
5. Straughan, R.P.L. and Thomas Yoseloff. Salt water Aquarium in the Home.
6. Dick Mills, 1987. Illustrated Guide to Aquarium Fishes. Published by Galley and Price, an imprint of W.H. Smith and Sons Limited, England.
7. Stephen Spotte. Marine Aquarium Keeping. A Wiley-Interscience Publication.
8. Dick Mills and Gwynne Vevere. Tropical Aquarium Fishes. Published by Salamander Books Limited. London.
9. Carcacson, R.H. A field guide to the Coral Reef Fishes of the Indian and West Pacific Oceans.
10. Vincent B. Hargreaves. The Tropical Marine Aquarium. Mc-Graw-Hill Book Company. New York.
11. Guy N. Smith. Profitable Fish Keeping.
12. Maurice Melzak. Marine Aquarium Manual. B.T. Balsford Ltd., London.
13. Ornamental aquarium fishes of India- 1999- K.L.Tekrival and A.A. Rao.- TFH United Kingdom.
14. Marine Ornamental species (collection, culture and conservation) – J.C.Cato and C.L.Brown. – Blackwell Science

Syllabus for F.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester II
Paper I and Practical I

F.Y.B.Sc. ZOOLOGY (THEORY)
Course Code: USC2ZO1
SEMESTER II Paper I
Course III: Diversity in Chordates

COURSE CODE	UNIT	TOPICS	CREDITS	LECTURES/WEEK
USC1ZO1	I	Animal Diversity in chordates	3	1
	II	Group Eurochordata		1
	III	Type study- Shark		1
USC1ZOP	Practical based on both courses		2	6

F.Y.B.Sc. ZOOLOGY (THEORY) Course Code: USCZ1P01			
SEMESTER II			
Title: Diversity in Chordates			
Course Objectives: • *To nurture interest in the students for the subject of Zoology.* • *To understand animal diversity.* • *To study detailed morphology of chordates*			
Course Outcomes: • *Learners will be able to comprehend the diversity of animals.* • *Learners will be able to understand the importance of classification.* • *Learners develop insight of group and type study*			
Unit	**Title**	**Lectures**	**Credits**

Unit I: Animal Diversity in chordates	**1.1:** Phylum Chordata: **1.1.1.** General characters and classification of Chordata. **1.1.2.** Difference between Chordates and non-chordates. **1.1.3.** Affinities of Balanoglossus **1.2:** Group Protochordata: **1.2.1.** Subphylum Hemichordata e.g., Balanoglossus **1.2.2:** Subphylum Urochordata e.g., Herdmania **1.2.3:** General characters of Ascidian **1.2.4:** Retrogressive Metamorphosis in Ascidian **1.2.5:**Subphylum Cephalochordata e.g., Amphioxus	**12 lectures**	**01**
Unit II: Group Eurochordata	**2.1:** Division: Agnatha **2.1.1:** Class Ostracodermi **2.1.2**: Class Cyclostomata **2.1.3:** Division: Gnathostomata **2.1.3.1:** Superclass Pisces (Cartilaginous and bony fish) • Class Chondrichthyes • Class Osteichthyes **2.1.3.2:** Superclass Tetrapoda ➢ Class Amphibia ➢ Class Reptilia ➢ Class Aves ➢ Class Mammalia	**12 lectures**	**01**
Unit III: Type study- Shark:	**3.1**. Systematic position, Habits and habitat **3.2.** External characters **3.3.** Digestive system **3.4.** Circulatory system **3.5.** Excretory system **3.6.** Reproductive system	**12 lectures**	**01**

	3.7. Nervous system and sense organs		
	SEMESTER II **Practical code: USC2ZOP** **Practical II**	**30 lectures**	**01**
	1. Study of museum specimen of Herdmania, *Petromyzon* (Sea lamprey) and *Myxine* (Hagfish) **2.** Study of permanent slide of Amphioxus and Balanoglossus. **3.** Study of classification and morphological characteristics of vertebrates i. Superclass Pisces: Shark (Scoliodon), Skate (Rhinobatys), Sting ray (Dasiatias), Electric ray, Sciena, Flying fish, Tilapia ii. Class Amphibia: Frog, toad iii. Class Reptilia: Chameleon, Calotes, Turtle, Cobra iv. Class Aves: Duck, Kingfisher, Parakeet v. Class Mammalia: Bat, Shrew **4.** Study of External morphology of Scoliodon (Demonstration). **5.** Study of Digestive system of Scoliodon (Demonstration). **6.** Study of Circulatory system of Scoliodon (Demonstration). **7.** Study of Reproductive system of Scoliodon (Demonstration). **8.** Study of Nervous system (Brain and Cranial Nerves) of Scoliodon (Demonstration). **9.** Mounting of scales of fish (Placoid, Cycloid, Ctenoid) **10.** Visit to forest/ wildlife sanctuary/ biodiversity park/ museum and preparation of field visit report.		

Syllabus for F.Y.B.Sc.
Program B.Sc.
Course: ZOOLOGY
Semester II
SKILL ENHANCEMENT COURSE II
Theory and Practical

Skill Enhancement Course (THEORY)			
SERICULTURE (USC2ZOSEC2)			
CREDITS -2 (1 Theory + 1 Practical)			
Course objectives: • *Define sericulture, trace its historical development, and explain its status globally and within India.* • *Understand and analyze the entire process of silkworm rearing, focusing on selecting appropriate mulberry varieties and establishing productive mulberry gardens.* • *Perform hands-on practical examinations of non-mulberry plants, silkworm anatomy, and various rearing appliances, supplemented by field visits to sericulture centers.*			
Course outcomes • *Students will be able to articulate the definition and history of sericulture, describe significant milestones in its development, and evaluate its current global and national status, including economic and cultural impacts.* • *Students will demonstrate the ability to select suitable mulberry varieties, plan and establish efficient mulberry gardens, and manage the rearing process to optimize silk production.* • *Students will gain practical skills by examining non-mulberry plants, understanding the anatomy of silkworms, using rearing appliances, and applying their knowledge in real-world settings through field visits to sericulture centers.*			
	Title	**Lectures**	**Credits**
Introduction to Sericulture	1: Introduction Sericulture: Definition, history, and present status; Silk route, Types of silkworms, Distribution and Races of Exotic and indigenous races Mulberry and non-mulberry	03 lectures	1
Silkworm Biology	2: Biology of Silkworm Life cycle of Bombyx mori Structure of silk gland and secretion of silk	03 lectures	
Sericulture Technique	3: Rearing of Silkworms Selection of mulberry variety and establishment of mulberry garden	03 lectures	

	Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing Types of mountages Spinning, harvesting and storage of cocoons		
Pest management	4: Pests and Diseases Pests of silkworm: Uzi fly, dermestid beetles and vertebrates Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial Control and prevention of pests and diseases	03 lectures	
Scope of Sericulture	5: Entrepreneurship in Sericulture Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture.	03 lectures	
Practicals based on Theory of Sericulture			
	1. Taxonomic features of non-mulberry (Terminalia arjuna, Ricinus communis) **2.** Life Cycle of Bombyx mori: **3.** Morphology of egg, larva, pupa and adult of silkworm Bombyx mori: **4.** Anatomy of Silkworm **5.** Study of Digestive system silkworm **6.** Study of respiratory system **7.** Mounting of larval mouth parts and spiracle **8.** Silk gland **9.** Nervous system of silkworm larva **10.** Reproductive system of male and female silkworm moth **11.** Rearing appliances used in rearing and seed preparation of non-mulberry silkworms (Drawings/sketches) **12.** Identification of Tasar, Eri and Muga raw silk **13.** Visit to sericulture center	30	1 credit

References:

1. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
2. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
3. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
4. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
5. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
6. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
7. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

Faculty of Science

Second Year Bachelor of Science (B.Sc.)

Level	Semester	Major				Minor		Open Elective		VSEC				AEC/IKS/VEC						Cocurricular Courses, On Job Training, Field Projects, Community Engagement Project, Research Project				Cr/ Sem	Cumulative Credits
		Mandatory	Credits	Elective	Credits	Course	Credits	Course	Credits	VSC Maj/Min	Credits	SEC	Credits	AEC	Credits	VEC	Credits	IKS Maj/ Min	Credits	Cocurricular Courses	Credits	OJT/FP/ CEP/RP	Credits		
5	III	Course 5	3+1			Minor Course 3	3+1	OE 5	2	VSC3	2			CS in English	2					FC in NSS/ NCC/ PE/ Culture	2	Field Project (Major)	2	22	88
		Course 6	3+1																						
	IV	Course 7	3+1			Minor Course 3	3+1	OE 6	2			SEC 3	2	CS in English	2					FC in NSS/ NCC/ PE/ Culture	2	Community Engagement Project	2	22	
		Course 8	3+1																						

Exit option; Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship

OR

Continue with Major and Minor

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

ARTS, COMMERCE & SCIENCE COLLEGE, NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC

'College with Potential for Excellence' Status Awarded by UGC

'Best College Award' by University of Mumbai

Program: Bachelor's in Science (B. Sc.)

SYLLABUS

(Approved in the Academic council meeting held on 13th June 2024)

S. Y. B. Sc. Zoology

NEW ACADEMIC POLICY 2020

w. e. f. Academic Year 2024-25

SECOND YEAR B.Sc. Zoology
Academic Year 2024-25
Proposed structure of NEP 2020

YEAR	SEMESTER	PAPER CODE	PAPER TITLE	TOPIC	CREDITS
II	**III**	USC3ZO1	MAJOR	MOLECULAR BIOLOGY	3+1
		USC3ZO2	MAJOR	ANIMAL PHYSIOLOGY	3+1
		USC3ZOVSC	VOCATIONAL SKILL COURSE	BIODIVERSITY CONSERVATION AND SUSTAINABLE DEVELOPMENT	1+1
		USC3ZOM1	MINOR	WONDERS OF ANIMAL WORLD	3+1
		USC3ZOOE	OPEN ELECTIVES	BIOMIMICRY-1	2
		FIELD PROJECTS OR COMMUNITY ENGAGEMENT PROJECT		FIELD PROJECT (BASED ON MAJOR)	2
II	**IV**	USC4ZO1	MAJOR	FOUNDATION OF EVOLUTIONARY BIOLOGY AND RESEARCH ETHICS	3+1
		USC4ZO2	MAJOR	DEVELOPMENTAL BIOLOGY	3+1
		SEC	SKILL ENHANCEMENT COURSE	FOOD TOXICOLOGY	
		USC4ZOM2	MINOR	ECONOMIC ZOOLOGY	3+1
		OPEN ELECTIVES	OPEN ELECTIVES	BIOMIMICRY-2	2
		FIELD PROJECTS ORCOMMUNITY ENGAGEMENT PROJECT		COMMUNITY ENGAGEMENT PROJECT	2

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III
Paper I and Practical I

MAJOR COURSE: ZOOLOGY SEMEMSTER -III COURSE CODE: USC3ZO1 CREDIT= 3 Theory +1 Practical		
PAPER-I	**MOLECULAR BIOLOGY**	**Credit -03+01**
Course Objectives: • *To provide students with a comprehensive understanding of nucleic acids.* • *To familiarize students with the processes of transcription and translation in prokaryotes and eukaryotes.* • *To explore post-transcriptional modifications and gene regulation.*		
Course Outcomes: • *Demonstrate an ability to describe the structure and functions of DNA and RNA.* • *Exhibit proficiency in demonstrated by their ability to explain the mechanisms of transcription and translation.* • *Illustrated by their ability to describe splicing mechanisms and the roles of regulatory RNAs*		
Theory	**Unit 1: Nucleic Acids and DNA Replication**	**12 lectures**
	• Introduction to Nucleic acids • DNA Structure • RNA Structure and function • DNA Replication: Overview • Mechanism of DNA replication • Enzymes involved in DNA replication • Initiation of DNA Replication • Elongation Phase of DNA Replication • Termination of DNA Replication • DNA replication in prokaryotes and eukaryotes	
	Unit 2: Transcription and Translation	**12 lectures**
	• Introduction to Gene Expression • DNA to RNA: Transcription Basics (RNA polymerase and its role in transcription) • Overview of transcription process • Transcription: Elongation and Termination • Transcriptional Regulation • Transcription in prokaryotes and eukaryotes • RNA Structure and Function • Introduction to Translation • Initiation of Translation • Elongation Phase of Translation • Termination of Translation • Difference between prokaryotic and eukaryotic translation	
	Unit 3: Post-Transcriptional Modifications and Gene Regulation	**12 lectures**
	A. Post-Transcriptional Modifications and Processing of Eukaryotic RNA • Split genes: concept of introns and exons	

	• Splicing mechanism, alternative splicing, exon shuffling, and RNA editing • Processing of tRNA **B. Gene Regulation and Regulatory RNAs** • Transcription regulation in prokaryotes • Transcription regulation in eukaryotes	
PRACTICALS	**PRACTICALS BASED ON MAJOR COURSE** **COURSE CODE: USC4ZOP**	**CREDIT -1**
	1. Study of Polytene chromosomes from Chironomus / Drosophila larvae **2.** Extraction of DNA **3.** Extraction of RNA **4.** Quantitative estimation of DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260nm measurement) **5.** Quantitative estimation of RNA using Orcinol reagent **6.** Separation of DNA using Gel electrophoresis (D) **7.** Study and interpretation of electron micrographs/ photograph showing (a) DNA replication, (b) Transcription and (c) Split genes. **8.** Submission of survey project using NCBI.	

Recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. Lewin B. (2013). Gene XI, Jones and Bartlett. De Robertis E.D.P. (2017) Cell and Molecular Biology 8Ed.
3. ArnoldBerk , ChrisA. Kaiser, HarveyLodish , Angelika Amon, Hidde Ploegh, Anthony Bretscher, Monty Krieger Kelsey C. Martin(2016) Molecular Cell Biology. 8th edition.
4. 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 Francisco.
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter
6. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
7. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IVEdition. GS, Taylor and Francis Group, New York and London.

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III
Paper II and Practical II

MAJOR COURSE: ZOOLOGY SEMEMSTER -III COURSE CODE: USC3ZO2 CREDIT= 3 Theory +1 Practical		
PAPER-I	**ANIMAL PHYSIOLOGY**	**Credit -03+1**
Course Objectives: • *To introduce the concepts of physiology of nutrition, excretion and osmoregulation.* • *To introduce the concepts of physiology of respiration and circulation.* • *To introduce the concepts of physiology of control and coordination, locomotion and reproduction.*		
Course Outcome: • *Learner would be able to correlate the habit and habitat with nutritional, excretory and osmoregulatory structures.* • *Learner will be able to correlate the habit and habitat of animals with respiratory and circulatory organs.* • *Learner would understand the process of control and coordination by nervous and endocrine regulation, locomotory structures found in the animal kingdom and acquainted with various reproductive strategies present in animals.*		
Theory	**Unit 1: Physiology of Digestion and Excretion**	**12 LECTURES**
	• Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants. • Physiology of digestion in man. • Comparative study of excretory and osmoregulatory structures and functions. ➢ Amoeba -Contractile vacuole ➢ Planaria -Flame cells ➢ Cockroach- Malpighian tubules • Categorization of animals based on principle nitrogenous excretory products • Structure of kidney, uriniferous tubule and physiology of urine formation in man	
	Unit 2: Physiology of Respiration and Circulation	**12 LECTURES**
	• Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish, Frog and Pigeon. • Structure of lungs and physiology of respiration in man • Comparative study of circulation: • Open and Closed type, Single and Double type. • Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood • Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon • Structure and mechanism of working of heart in man	
	Unit 3: Physiology of Nervous System, Locomotion and Reproduction.	**12 LECTURES**

	• Nervous system in Invertebrate: Irritability in Paramecium, nerve net in Hydra, nerve ring and nerve cord in earthworm. • Control and Co-ordination- Types of neurons based on the structure and function • Conduction of nerve impulse: Resting potential, Action potential and Refractory period, Synaptic transmission • Movement and Locomotion • Locomotory organs- structure and functions; ➢ Pseudopodia in Amoeba (Sol- Gel theory), Cilia in Paramecium ➢ Wings and legs in cockroach ➢ Tube feet in starfish ➢ Fins of fish • Structure of striated muscle fiber in human and sliding filament theory • Reproduction ➢ Asexual Reproduction- Fission, Fragmentation, Gemmule formation and Budding ➢ Sexual reproduction ✓ Gametogenesis ✓ Structure of male and female gametes in human ✓ Types of fertilization ✓ Oviparity, Viviparity, Ovo-viviparity	
PRACTICALS	**PRACTICALS BASED ON MAJOR COURSE COURSE CODE: USC3ZOP**	**CREDIT -1**
	1. Urine analysis—Normal and abnormal constituents 2. Detection of ammonia in water excreted by fish 3. Detection of uric acid from excreta of Birds 4. Study of striated and nonstriated muscle fibre 5. Study of nutritional Apparatus (Amoeba, Hydra, Earthworm, Pigeon, Ruminant stomach) 6. Study of respiratory structures: i. Gills of Bony fish and Cartilaginous fish. ii. Lungs of Frog iii. Lungs of Mammal. iv. Accessory respiratory structure in Anabas (Labyrinthine organ) v. Air sacs of Pigeon 7. Study of locomotory organs (Amoeba, Unio, Cockroach, Starfish, Fish, and Birds) 8. Study of hearts (Cockroach, Shark, Frog, Calotes, Crocodile, Mammal) 9. Study of permanent slides of - a. Sponge gemmules b. Hydra budding c. T.S. of mammalian testis d. T.S. of mammalian ovary	

Recommended readings

1. Barrington, E J W. (1967) Invertebrate structure and function, Nelson, London.
2. Barnes, R. D. (1968) Invertebrate Zoology, 2nd Ed. Saunders, Philadelphia.

3. Hyman, L H. (1940-67). The Invertebrates, Vol. I-VI. McGraw-Hill, New York.

4. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002)

5. The Invertebrates: A New Synthesis. III Edition. Blackwell Science.

6. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.

7. Marshall, A.J and Williams, W.D. (1995) Text book of Zoology-Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.

8. http://abacus.bates.edu/acad/depts/biobook/AnimPhyl.pdf

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III
Vocational Skilled Course

VSC COURSE: ZOOLOGY
SEMESTER -III
COURSE CODE: USC4ZOVSC

PAPER VSC	**Biodiversity Conservation**	**Credit -02**

Course Objectives:

- *To educate students about nature conservation, forestry and forest.*
    - *Creating awareness for protection and conservation of flora, fauna, forests and wildlife, biodiversity conservation.*
- *To promote the efficient use of forest resources.*
- *Wildlife Habitat Management for In-situ and Ex-situ Conservation of wildlife.*

Course Outcomes:

- *To educate students about nature conservation, forestry and forest.*
- *Creating awareness for protection and conservation of flora, fauna, forests and wildlife, biodiversity conservation.*
- *To promote the efficient use of forest resources.*
- *Wildlife Habitat Management for In-situ and Ex-situ Conservation of wildlife.*

PRACTICALS	**PRACTICALS BASED ON VSC COURSE CODE US3ZOMP**	**CREDIT - 2**
	1. Identification of **a.** Flora, **b.** Mammalian fauna, **c.** Avian fauna, **d.** Herpeto-fauna. **2.** Demonstration of basic equipment needed in wildlife studies use, care and maintenance **a.** Compass, Binoculars, **b.** Spotting scope, **c.** Range Finders, **d.** Global Positioning System, **e.** Various types of Cameras and lenses). **3.** Familiarization and study of animal evidences in the field **4.** Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc. **5.** Demonstration of different field techniques for flora and fauna. **6.** Estimation of phosphates from sample water. **7.** Estimation of BOD from given water sample. **8.** Estimation of COD from given water sample. **9.** Estimation of Nitrates from sample water. **10.** Estimation of acidity of sample water by methyl orange and phenolphthalein indicator. **11.** Estimation of alkalinity of sample water by methyl orange and phenolphthalein indicator. **12.** Analyze the physical and chemical properties of the soil, including pH, nutrient content, and organic matter. **13.** Study of threatened animal species inhabiting Indian continent with reasons for decline- Great Indian bustard, One-horned rhinoceros, Royal Bengal tiger, Blackbuck, lion tailed macaque, Nilgiri Thar, Asiatic lion, Snow leopard, Gharial, and Gangetic dolphin.	

	14. Study tour/Visit to Zoo/Sanctuary/National Park/Research institute. **15.** Visit to local biodiversity area and submission of field report.	

Recommended readings

1. Joseph, B. (2008) Environmental studies, Tata McGraw Hill.
2. Miller, G.T. (2002). Sustaining the earth, an integrated approach. (5th edition) Books/Cole, Thompson Learning, Inc.
3. Chapman, J.L. and Reiss, M.J. (1999). Ecology: Principles and applications (2nd edition) Cambridge University Press.
4. Ghosh, S.K. and Singh, R. (2003). Social forestry and Forest Management. Global Vision Pub.
5. Wilson, E.O. (1986) Biodiversity, Academic press Washington
6. Wagher, R.H. (1974) Environment and Man. (Second Edition), Norton, New York.

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III
MINOR COURSE
Theory and Practical

MINOR COURSE: ZOOLOGY SEMESTER -III COURSE CODE: USC3ZOM		
PAPER-I	**Wonders of the Animal World**	**Credit -03+1**
Course Objectives: • *To Explore the Astonishing Diversity of Animal Adaptations* • *To Investigate the Mechanisms of Mimicry and Camouflage* • *To Foster Ethical Awareness in Studying and Appreciating Animal Wonders*		
Course Outcomes: • *Able to identify and explain various extraordinary adaptations found in animals, such as extreme morphologies, behavioral strategies, and mimicry techniques.* • *Develop the ability to critically analyze the mechanisms of mimicry and camouflage in animals.* • *Gain a heightened awareness of the ethical implications of studying and appreciating animal wonders, fostering a sense of responsibility towards conservation and ethical treatment of animal.*		
Theory	**Unit 1: Wonderous Wildlife: Insights and Behaviours**	**12 LECTURES**
	A. **Introduction to Animal Wonders** Definition of extraordinary animal traits and behaviours Historical perspectives on human fascination with animals Ethical considerations in studying and appreciating animal wonders **B. Wonderous Wildlife** • Bioluminescence in Animals: Noctiluca, Glow worm, Fire fly, Angler fish (Mechanism and use for animal) • Mimicry in Butterflies and its significance • Mechanism of Coral formation and types of Corel reefs • Adaptive features of desert animals: Reptiles (Phrynosoma) and mammals (Camel). • Breeding and Parental care in: ➢ Pisces: Ovoviviparous (Block Molly/ Guppy), Mouth brooders (Tilapia), Brood Pouches (Sea horse) ➢ Amphibia: Mouth brooders (Darwin's frog), Egg Carriers (Mid wife toad) ➢ Mammals: Egg laying (Duck billed Platypus) Marsupial (Kangaroo) ➢ Aves Brood Parasitism (Cuckoo)	**12 LECTURES**
	Unit 3: Conservation Challenges and Solutions	**12 LECTURES**
	A. Human Impact on Extraordinary Animal Species ➢ Habitat destruction, pollution, climate change ➢ Overexploitation and illegal wildlife trade **B. Conservation Efforts and Success Stories** ➢ Protected areas and wildlife reserves ➢ Species recovery and reintroduction programs **C. Ethical Considerations in Conservation Practices** ➢ Balancing conservation priorities with human needs	

	➢ Wildlife tourism and responsible ecotourism.	
PRACTICALS	**PRACTICALS BASED ON MINOR COURSE COURSE CODE US3ZOMP**	**CREDIT -1**
	1. Mounting of foraminiferan shells from sand (any 3) **2.** Study of types of Corals - Brain, Organ pipe, Stag Horn, Mushroom coral Study of **3.** Study of Symbiosis (Termite and Trychonympha, hermit crab and sea anemone) **4.** Study of Camouflage (leaf insect, chameleon) **5.** Study of Cannibalistic mate-eating animals (Spider and Praying Mantis) **6.** Study of Animal architects: Termites, Harvester ant and Baya weaver bird **7.** Study of bioluminescent organisms – Noctiluca, glow worm, fire fly, angler fish. **8.** Breeding and parental care in Amphibia- Rhacophorus, Midwife toad, Darwin's frog, Caecilian. **9.** Nesting and Parental care in fishes **10.** Study of Adaptive radiation in Reptiles - Turtle, Tortoise, Phrynosoma, Draco) **11.** Identification and differentiation of venomous and non-venomous snakes (Scales, Fangs, Bite marks, etc.) **12.** Study of Types of feathers in birds: (contour, filoplume, down), beaks (Nectar feeding, Insect catching, Fruit eating, Scavenging, Filter feeding), **13.** Study of Types of claws in birds: (perching, wading, swimming, hopping) in birds **14.** Study of Types of beaks in birds: (Nector feeding, Insect catching, Fruit eating, Scavenging beak) in birds **15. Field Report–** Visit a local habitat such as a forest, wetland, or beach to observe and document examples of extreme adaptations, mimicry, and camouflage among local fauna. (To be done in a group of students and submission of written / typed report preferably along with photographs/ tables/ graphs)	

Note –

The practical's may be conducted by using specimens authorised by the wildlife and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/ simulations / models, etc. as recommended by the UGC and as envisaged in the regulations of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in-above.

Recommended readings

1. "Animal Wise: The Thoughts and Emotions of Our Fellow Creatures" by Virginia Morell
2. "Social Behavior in Animals: Insights from Proximate and Ultimate Perspectives" by John Alcock
3. "The Greatest Show on Earth: The Evidence for Evolution" by Richard Dawkins
4. "Ethical Considerations in Animal Research" by Franklin M. Loew
5. "The Sixth Extinction: An Unnatural History" by Elizabeth Kolbert
6. "Conservation Biology: The Science of Scarcity and Diversity" by Michael E. Soulé and Bruce A. Wilcox

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester III
OPEN ELECTIVES COURSE

OPEN ELECTIVES COURSE: ZOOLOGY
SEMESTER -III
COURSE CODE: USC4ZOOE1

PAPER VSC	**"Biomimicry: Innovation Inspiring Industries"**	**Credit -02**

Course Objectives:

- *Understand the fundamental concepts and principles of biomimicry.*
- *Explore examples of biomimetic designs and innovations in various industries, including architecture, engineering, materials science, and robotics.*
- *Evaluate the potential benefits and challenges of applying biomimicry in different industrial sectors.*

Course Outcomes:

- *Demonstrate a comprehensive understanding of the principles and applications of biomimicry.*
- *Identify biomimetic solutions in existing technologies and industries.*
- *Evaluate the environmental, economic, and social impacts of biomimetic innovations.*

Theory	**Unit 1: Introduction to Biomimicry**	**12 LECTURES**
	Introduction • Definition and historical background • Principles of biomimicry • Importance of Biomimicry in Sustainable Design and Innovation **Biological Inspiration** • Understanding biological systems • Adaptations and strategies in nature • Biomimicry in organismal structures and functions **Biomimicry Examples in Daily Life-** 1. Modern Turbine Blades, 2. Bullet Trains 3. Needles 4. Swim Suits 5. Velcro 6. Camouflage 7. Air Crafts 8. Self-Filling Water Bottles 9. Air Conditioning 10. Shock Absorbers	
	Unit 2: Case Studies	**12 LECTURES**
	A. **Iconic Case Studies** B. **Emerging Case Studies**	

Recommended readings

1. "Biomimicry: Innovation Inspired by Nature" by Janine M. Benyus
2. "Biomimicry for Designers: Applying Nature's Processes & Materials in the Real World" by Veronika Kapsali

3. "Biomimicry Resource Handbook: A Seed Bank of Knowledge and Best Practices" by Dayna Baumeister, Bryony Schwan, and Janine Benyus
4. "Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life" by Stephen R. Kellert, Judith Heerwagen, and Martin Mador
5. "Biomimetics: Nature-Based Innovation" by Yoseph Bar-Cohen
6. "Biomimicry in Architecture" by Michael Pawlyn
7. "Biomimetics: Nature-Inspired Design and Innovation" by Paolo S. Coelho
8. "The Shark's Paintbrush: Biomimicry and How Nature is Inspiring Innovation" by Jay Harman
9. "Biomimicry in Organizations: Business Management Inspired by Nature" by Isabel Rimanoczy
10. "Biomimicry: Nature as Model, Measure, and Mentor" edited by Joanna Aizenberg, Peter H. Raven, Donald E. Ingber, and Janine M. Benyu

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester IV
Paper I and Practical I

MAJOR COURSE: ZOOLOGY SEMEMSTER -IV COURSE CODE: USC4ZO1		
PAPER-I	**Foundation of Evolutionary Biology and Research Ethics**	**Credit -03+1**
Theory	**Unit 1: Origin and Evolution of Life**	**12 LECTURES**
	• Introduction ▪ Origin of Universe ▪ Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory ▪ Origin of Life ▪ Origin of Eukaryotic cell • Evidences in favors of Organic evolution • Evidences from: Geographical distribution, Palaeontology, Anatomy, Embryology, Physiology and Genetics • Theories of organic evolution ▪ Theory of Lamarck ▪ Theory of Darwin and Neo Darwinism ▪ Mutation Theory ▪ Modern Synthetic theory ▪ Weismann's Germplasm theory ▪ Neutral theory of Molecular evolution	
	Unit 2: Population Genetics and Evolution	**12 LECTURES**
	• Introduction to Population genetics ➢ Definition ➢ Brief explanation of the following terms: ➢ Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution • Population genetics ➢ Hardy- Weinberg Law ➢ Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (Gene flow), Non-random mating (Inbreeding, inbreeding depression, Assortative mating-Positive and Negative, Dis- assortativemating), Genetic drift (Sampling error, Fixation, Bottleneck effect and Founder effect) ➢ Natural Selection, ➢ Patterns of Natural Selection: • Stabilizing selection • Directional selection (Examples: Peppered moth, Antibiotic resistance in bacteria, Pesticide resistance) • Disruptive selection • Evolutionary genetics • Genetic variation: Genetic basis of Variation-Mutations and Recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization) • Neutral variations	

	• Geographic variation (Cline) • Species Concept: Biological species concept and evolutionary species concept • Speciation and Isolating mechanisms: Definition and Modes of speciation (Allopatric, Sympatric, Parapatric and Peripatric) • Geographical isolation • Reproductive isolation and its isolating mechanisms (Prezygotic and Postzygotic) • Macroevolution and Megaevolution: Concept and Patterns of macroevolution (Stasis, Preadaptation /Exaptation, Mass extinctions, Adaptive radiation and Coevolution), Megaevolution	
	Unit 3: Scientific Aptitude, Methodology, Writing and Ethics	
	• Process of science: • A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery (serendipity) • Scientific research: Definition, difference between method and methodology, characteristics, types • Dissemination of data: Reporting results to scientific community (publication in peer- reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation) • Application of knowledge: Basic research, Applied research and Translational research • Scientific writing: • Structure and components of a research paper: preparation of manuscript for publication of research paper • Writing a review paper: Structure and components of review • Report writing and types of report • Ethics: o Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC) o Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent • Plagiarism	
PRACTICALS	**PRACTICALS BASED ON MAJOR COURSE COURSE CODE US4ZOP**	**CREDIT -1**
	. Study of population density by Line transect method & Quadrant method and calculate different diversity indices. ➢ Index of Dominance ➢ Index of frequency ➢ Rarity Index	

	➢ Shannon Index 2. Study of prokaryotic cells (bacteria) by Crystal violet staining technique 3. Study of eukaryotic cells (WBCs) from blood smear by Leishman stain 4. Identification and study of fossils: ➢ Arthropods: Trilobite ➢ Mollusca: Ammonite ➢ Aves: Archaeopteryx 5. Identification of: ➢ Allopatric speciation (Cyprinodont species) ➢ Sympatric speciation (Hawthorn fly and Apple maggot fly) ➢ Parapatric speciation (Snail) 6. Preparation of Bibliography and Abstract writing 7. Preparation of Power Point Presentation based on research paper. 8. Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources	

Recommended readings

1. Ridley, M (2004) Evolution (3rd edition) Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008) Evolution (4th edition) Jones and Barlett Publishers
3. Campbell, N.A. and Reece J.B (2011) Biology (9th edition) Pearson, Benjamin, Cummings
4. Douglas, J.F. (1997) Evolutionary Biology. Sinauer Associates.
5. Pevsner, J. (2009) Bioinformatics and Functional Genomics (2nd edition) WileyBlackwell.

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester IV
Paper II and Practical II

MAJOR COURSE: ZOOLOGY SEMESTER -IV COURSE CODE: USC4ZO2		
PAPER-I	**DEVELOPMENTAL BIOLOGY**	**Credit - 03+1**
Course Objectives:	• To provide students with a comprehensive understanding of the fundamental principles and processes underlying developmental biology. • To equip students with the necessary theoretical knowledge and practical skills to conduct experimental research in developmental biology. • To foster critical thinking and analytical skills in students, enabling them to evaluate and contribute to advancements in developmental biology research.	
Course Outcomes:	• Demonstrate a deep understanding of key developmental biology concepts, including embryonic development, cell signaling pathways, and genetic regulation. • Proficient in employing a wide range of experimental techniques and methodologies in developmental biology research. • Exhibit advanced critical thinking skills in developmental biology, contributing to the advancement of scientific knowledge in the field.	
Theory	**Unit 1: Introduction to Developmental Biology, Gametogenesis & Fertilization**	**12 LECTURES**
	Historical perspective and basic concepts: • Phases of development • Cell-cell interaction • Pattern formation • Differentiation and growth • Differential gene expression • Cytoplasmic determinants and asymmetric cell division • Gametogenesis • Spermatogenesis • Oogenesis • Types of eggs • Egg membranes • Fertilization (External and Internal) • Changes in gametes • Blocks to polyspermy	
	Unit 2: Early Embryonic Development Cleavage	**12 LECTURES**
	• Planes and patterns of cleavage • Types of Blastula • Fate maps (including Techniques) • Early development of frog and chick up to gastrulation • Embryonic induction and organizers	

	Unit 3: A. Embryonic Development	
	A. Late Embryonic Development • Fate of Germ Layers • Extra-embryonic membranes in birds • Implantation of embryo in humans • Placenta (Structure, types, and functions of placenta)	**12 LECTURES**
	B. Post Embryonic Development & Implications of Developmental Biology	
	• Metamorphosis: Changes, hormonal regulations in amphibians and insects • Regeneration: Modes of regeneration • In vitro fertilization • Amniocentesis	
PRACTICALS	**PRACTICALS BASED ON MAJOR COURSE COURSE CODE US4ZOP**	**CREDIT - 1**
	1. Observation of Asexual and Sexual Reproduction in organisms **2.** Types of eggs based on quantity and distribution of yolk: sea urchin, insect, frog, Chick. **3.** Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages). **4.** Comparative study of cleavage patterns in Frog and Amphioxus models. **5.** Morphogenetic movement of Blastulation, Gastrulation in Chick **6.** Study of development of chick embryo through incubated chick eggs up to 96 h. **7.** Extra embryonic membranes of chick through permanent slides. **8.** Some videos to develop understanding on the process of development. **9.** Understanding embryological evidence of evolution (through charts and videos). **10.** Visit to IVF center and submission of report.	

Recommended readings

1. Gerhart, J. et al. (1997) Cells, Embryos and Evolution. Blackwell Science
2. Gilbert, S.F. (2010) Developmental Biology (9th edition). Sinauer
3. Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press
4. Campbell, N. and Reece, J. (2014) Biology (10th edition). Benjamin Cummings
5. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing.
6. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
7. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester IV
MINOR COURSE
Theory and Practical

MINOR COURSE: ZOOLOGY SEMESTER -IV COURSE CODE: USC4ZOM		
PAPER-I	**ECONOMIC ZOOLOGY**	**Credit - 03+1**
Theory	**Unit 1: Aquaculture**	**12 LECTURES**
	1. Prawn culture: Culture of fresh water prawn; culture of marine prawn; preparation of farm. preservation and processing of prawn. Export of prawn. 2. Pearl Culture. 3. Fish Culture, Breeding Pond, Fish Seed, Hatching Pond. Transport of fish fry to rearing ponds. Harvesting, preservation of fish. Composite fish farming. 4. Introduction of byproducts of fishing industry and common fish diseases.	
	Unit 2: Apiculture	**12 LECTURES**
	Species of honey bees in India. Life history of Apis. Methods of Bee keeping and its equipments. Bee products and their uses. Natural enemies and their control. Morphology and Biology of honey bees; social behavior of honey bees. Bee keeping and and ancillary industries. Medicinal value of honey; bee products. Importance of bee colonies in crop pollination.	
	Unit 3: Vermiculture	**12 lectures**
	Biology of *Eisenia foetida*. Rearing of earthworms, Equipments , devices used in vermiculture, Vermicompost Technology. Methods and products, Vermiwash Collection, Composition and use. importance of vermiculture.	
PRACTICALS	**PRACTICALS BASED ON MINOR COURSE COURSE CODE US3ZOMP**	**CREDIT -1**
	1. Prawn culture-types of prawns **2.** Morphological characterization of common fish species. **3.** Identification of two major carps – *Labeo rohita* and *Catla catla* and their life cycles. **4.** Mounting of the sting apparatus. **5.** Castes (through charts/specimens) study of bees **6.** Worker honey bee with emphasis on leg modifications (through specimens/charts) and whole mount preparation of the 3 pairs of legs. **7.** Group discussion or seminar presentation on one or two related topics	

	8. Visit to vermicomposting unit or visit to aquarium (report may be submitted in a group not exceeding five students).	

Recommended readings

1 1. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
2. Mani, M.S. (2006). Insects, NBT, India.
3. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.

Syllabus for S.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester IV
OPEN ELECTIVES COURSE

OPEN ELECTIVES COURSE: ZOOLOGY SEMESTER -III COURSE CODE: USC4ZOOE1		
PAPER VSC	**"Biomimicry: Innovation Inspiring Industries"**	**Credit -02**
Course Objectives:	• Understand the fundamental concepts and principles of biomimicry. • Explore examples of biomimetic designs and innovations in various industries, including architecture, engineering, materials science, and robotics. • Evaluate the potential benefits and challenges of applying biomimicry in different industrial sectors.	
Course Outcomes:	• Demonstrate a comprehensive understanding of the principles and applications of biomimicry. • Identify biomimetic solutions in existing technologies and industries. • Evaluate the environmental, economic, and social impacts of biomimetic innovations	
Theory	**Unit 1: Application of Biomimicry**	**12 LECTURES**
	a. Biomimicry in Fashion • Lotus Effect • Spider Silk • Butterfly Wing Patterns. • Sharkskin-Inspired Swimwear. • Production Methods **b. Biomimicry in Design** • Biologically inspired design methodologies • Sustainable architecture and building design **c. Biomimicry in Medicine and Healthcare** • Nature-inspired medical technologies • Drug discovery and bio-mimetic drug delivery systems • Biomimetic prosthetics and implants **d. Biomimicry for Sustainability** • Ecological design and systems thinking • Biomimetic solutions for environmental challenges • Biomimicry and circular economy	
	Unit 2: A. Biomimicry Design Process	**12 LECTURES**
	• Understanding Nature's Strategies: Observation and Analysis • Biomimicry in Action: Ideation and Conceptualization	

	• Biomimetic Design Principles: Adaptation, Integration, and Optimization • Prototyping and Testing: Translating Nature's Solutions to Human Needs	
	Unit 2: B. Biomimicry and Entrepreneurship	
	• From Idea to Prototype: Applying Biomimicry in Product Development • Business Models for Biomimetic Start-ups: Sustainability and Scalability • Pitching Biomimetic Solutions: Effective Communication and Investor Relations.	

Recommended readings

1. "Biomimicry: Innovation Inspired by Nature" by Janine M. Benyus
2. "Biomimicry for Designers: Applying Nature's Processes & Materials in the Real World" by Veronika Kapsali
3. "Biomimicry Resource Handbook: A Seed Bank of Knowledge and Best Practices" by Dayna Baumeister, Bryony Schwan, and Janine Benyus
4. "Biophilic Design: The Theory, Science and Practice of Bringing Buildings to Life" by Stephen R. Kellert, Judith Heerwagen, and Martin Mador
5. "Biomimetics: Nature-Based Innovation" by Yoseph Bar-Cohen
6. "Biomimicry in Architecture" by Michael Pawlyn
7. "Biomimetics: Nature-Inspired Design and Innovation" by Paolo S. Coelho
8. "The Shark's Paintbrush: Biomimicry and How Nature is Inspiring Innovation" by Jay Harman
9. "Biomimicry in Organizations: Business Management Inspired by Nature" by Isabel Rimanoczy
10. "Biomimicry: Nature as Model, Measure, and Mentor" edited by Joanna Aizenberg, Peter H. Raven, Donald E. Ingber, and Janine M. Benyu

Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

ARTS, COMMERCE & SCIENCE COLLEGE,NEW PANVEL

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Program: B.Sc Zoology Revised Syllabus of T.Y.B.Sc. Zoology

Choice Based Credit & Grading System (60:40)

w.e.f. Academic Year 2023-2024

Sr. No.	**Heading**	**Particulars**
1	Title of Course	Zoology
2	Eligibility for Admission	S.Y.B.Sc. with subject Zoology
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (60:40)
8	Status	Revised
9	To be implemented from Academic year	2023-2024

PREAMBLE OF THE SYLLABUS

The ongoing B.Sc. Zoology course was introduced by the Faculty of Sciences fromthe academic year 2019-2020. The Revised Syllabus of T.Y.B.Sc. Zoology (CBCGS) that will be effective from the academic year 2021- 2022, will follow the Semester mode. It has been prepared keeping in view the unique requirements of B.Sc. Zoology students. The syllabus has been drawn up to introduction of the classical zoology with accommodation of widening horizons of the discipline of Biological Sciences.

The Board of Studies examined the existing syllabus and after analyzing with respective subjects in term of content relevance, quality and pattern of teaching along with examination in present scenario.

With the holistic approach the syllabus including basic as well as advanced concepts in Zoology from first year to third year shall inspire the students for pursuing higher studies in Zoology and for becoming an entrepreneur and also enable students toget employed in the biological research Institutes, Industries, Educational Institutes andin the various concerning departments of State and Central Government based on subjectZoology.

Program Specific Outcomes

PSO1 Gain the comprehensive knowledge and understanding of major concepts,theoretical principles and experimental findings in Zoology and its different subfields.

PSO2 Learn a wide range of approaches, from genetics to molecular and cellular biology, well as physiological processes and anatomy, and diseases

PSO3 Spread awareness about wildlife and ecology as well as the environment and its conservation in the society

PSO4 Gain knowledge of Agro based Small Scale industries like sericulture, aquaculture and vermicomposting.

PSO5 Develop the interest and employability, program includes learning experiences which offer opportunities for higher studies and research at reputed laboratories

PSO6 Understand the concept of research and its type along with basic knowledge of qualitative research techniques, data collection and process of scientific documentation.

PSO7 Analyze the ethical aspects of research and evaluate the different methods of scientific writing and reporting by appropriate documentations and presentations.

OBJECTIVES OF THE COURSE

Zoology deals with the study of animal kingdom along with the different realm. The main focus of curriculum is to enable the learner to be professionally competent and successful incareer.

- The learners to be proficient in identification of animals by studying modern system of classification.
- Learners will learn the skill required to study or perceive laboratory and experimental work such as Molecular Biology, Genetic Engineering, Human Genetics and Bioinformatics.
- Learners will achieve proficiency in the skills necessary for the study of haematology and immunology.
- Introduce the learners to principles of toxicology with particular emphasis on toxic responses and toxicity testing and obtain knowledge and practical skills in the toxicology.
- To make the learners to understand the principal concepts of biostatistics, collect data relating to variable/variables, which can be examined and descriptive statistics can be calculated from these data.
- Aim to introduce various tools and their applications in bioinformatics and statistical studies.
- To make learner understand various concepts of endocrinology, developmental biology, integumentary system and human osteology.
- To introduce the learners to understand the importance of different factors of environment and its management, importance of wildlife conservation, zoopharmacognosy and zoogeography.

EXPECTED OUTCOME OF SYLLABUS

The present course of T.Y.B.Sc. Zoology introduced by the Board of studies and Faculty of Sciences from the academic year 2023-24 has some expected outcomes of entire syllabi as follows:

- The present syllabus helps to understand the basic concepts of animal taxonomy and zoological nomenclature and evaluate the significance of museum specimens.
- Students can learn about the historical development of systematic biology from 18th century to the present.
- The syllabus helps learners to understand the concepts, mechanisms, evolutionary significance and relevance of molecular biology in the current scenario.
- Learners will be familiar with the concepts of molecular biology and genetic engineeringwhich holds application in biomedical & genomic science, agriculture, environment management, etc.
- Syllabus will help learners to identify the major cellular and tissue components which comprise the innate and adaptive immune system.
- The students learn about various aspects of enzymological assays and their applications in industries and study of basics histological techniques
- The students will gain a broad understanding of different areas of toxicology.
- Learners will know the theory behind fundamental bioinformatics analysis methods and acquire knowledge of various databases of proteins, nucleic acids, primary, secondary and composite databases like BLAST, FASTA etc. This will make them familiar with widely used bioinformatics databases.
- Learners will know basic concepts of probability and statistics which help them todescribe statistical methods and probability distributions relevant for biological data analysis.
- Learners can understand the basic concepts of endocrinology and learn about the hypothalamus and hypophysial axis, endocrine glands and mechanism of hormone action.
- Learners will understand about environment and wildlife management, and learn the basic concepts of bioprospecting, zoopharmacognosy and zoogeography.

Revised Scheme of Examination

Faculty of Science

(Undergraduate Programmes)

Choice Based Credit System (CBCS)

- Revised Scheme of Examination

The performance of the learners shall be evaluated into two components. The learner's Performance shall be assessed by Internal Assessment with 40% marks in the first component by conducting the Semester End Examinations with 60% marks in the second component. The allocation of marks for the Internal Assessment and Semester End Examinations are as shown below: -

A) Internal Assessment: 40 % 40 Marks

Sr. No.	Particular	Marks
01	One periodical class test / online examination to be conducted in the given semester	20 Marks
02	Test on Practical Skills/ Case studies /Group/ Individual Survey Project/Presentation and write up on the selected topics of the subjects/ Test based on tutorials /Book Review / Open Book Test	15 Marks
03	Active participation in routine class instructional deliveries and overall conduct as a responsible learner, mannerism and articulation and exhibit of leadership qualities in organizing related academic activities	05 Marks

Question Paper Pattern

(Periodical Class Test)

Maximum Marks: 20 Duration: 40 Minutes

Questions to be set: 02

All Questions are Compulsory

Question No.	Particular	Marks
Q-1	Match the Column / Fill in the Blanks / Multiple Choice Questions/ Answer in One or Two Lines (Concept based Questions) (1Marks / 2 Marks each)	10 Marks
Q-2	Answer in Brief (Attempt any Two of the Three) (5 Marks each)	10 Marks

B) Semester End Examination: 60 % 60 Marks

- Undergraduate Programmes of S. Y. B.Sc. (Sem. III & IV)
  - Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be four questions of 15 marks each (30 marks with internal options). 2. On each unit there will be one question and fourth question will be based on entire syllabus. 3. All questions shall be compulsory with internal options. 4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- Undergraduate Programmes of T. Y. B.Sc. (Sem. V & VI)
  - Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 12 marks (24 marks with internal options). 2. On each unit there will be one question and fifth question will be based on entire syllabus. 3. All questions shall be compulsory with internal options. 4. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- Undergraduate Programmes for B.Sc. in Information Technology

  - Duration: The examination shall be of 2 hours duration.

Question Paper Pattern

Theory question paper pattern
1. There shall be five questions each of 12 marks. 2. All questions shall be compulsory with internal options. 3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depends on the weightage of the unit.

- Passing Standard

The learners to pass a course shall have to obtain a minimum of 40% marks in aggregate for each course where the course consists of Internal Assessment and Semester End Examination. The learners shall obtain minimum of 40% marks (i.e. 16 out of 40) in the Internal Assessment and 40% marks in Semester End Examination (i.e. 24 Out of 60) separately, to pass the course and minimum of Grade D, wherever applicable, to pass a particular semester. A learner will be said to have passed the course if the learner passes the Internal Assessment and Semester End Examination together.

- Evaluation pattern of the project work (50 Marks)

  Student would undertake a project for 1-2 months during the semester.

Sr. No.	Particular		Marks
01	Project		50 Marks
	Documentation	25 Marks	
	Presentation	15 Marks	
	Viva	10 Marks	

- *The plagiarism should be maintained as per the UGC guidelines.*

Note: As per previous ordinance there will not be any internal examination for practical.

Note: 1) It is noted that the concerned regulation of the College is amended and implemented to Semester III to Semester VI of undergraduate programmes, under faculty of Arts, Commerce and Science with effect from the academic year 2023 - 2024.

2) This revised scheme of evaluation is discussed in detail, finalised and accepted.

Syllabus for T.Y.B.Sc. (REVISED)

Course - ZOOLOGY

(Credit Based Semester and Grading System)

(To be implemented from the Academic Year 2023- 2024)

SEMESTER- V					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES / WEEK**
DSC 11	USC5ZO1	I	Basics of Taxonomy, Trends in biosystematics and Dimensions of speciation	2.5	1
		II	Protista and Metazoa		1
		III	Non- Chordates		1
		IV	Type Study – Earthworm		1
DSC 12	USC5ZO2	I	Basic Haematology	2.5	1
		II	Applied Haematology		1
		III	Basic Immunology		1
		IV	Applied Immunology		1
DSC 13	USC5ZO3	I	Histology	2.5	1
		II	Toxicology		1
		III	Enzymology		1
		IV	Biostatistics		1
DSE 14	USC5ZO4	I	Microscopy and Microtomy	2.5	1
		II	Tools and techniques in Biochemistry and Physiology		1
		III	Cell culture, maintenance of Laboratory animals		1
		IV	Introduction to Endocrinology		1
				10	**16**
PRACTICAL					
USC5ZOP	Practicals based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**

Syllabus for T.Y.B.Sc.

Course-ZOOLOGY

(Credit Based Semester and Grading System)

(To be implemented from the Academic Year 2023-2024)

SEMESTER-VI					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES/ WEEK**
DSC 15	USC6ZO1	I	Chordata	2.5	1
		II	Euchordata I		1
		III	Euchordata II		1
		IV	Type study - Shark		1
DSC 16	USC6ZO2	I	Molecular Biology	2.5	1
		II	Genetic Engineering		1
		III	Human Genetics		1
		IV	Bioinformatics		1
DSC 17	USC6ZO3	I	Basic concept Developmental biology	2.5	1
		II	Gametogenesis, fertilization and early		1
		III	Morphogenesis and organogenesis in animals		1
		IV	Chick Embryology		1
DSE18	USC6ZO4	I	Value of wildlife and need for its conservation	2.5	1
		II	Population and prey-predator dynamics		1
		III	Wildlife Conservation		1
		IV	Rehabilitation and management		1
				10	**16**
PRACTICAL					
USC6ZOP	Practical's based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**

SYLLABUS T.Y.B.Sc.

ZOOLOGY

UNIT WISE DISTRIBUTION

Semester V			
Core Course 11	**Core Course 12**	**Core Course 13**	**Discipline Specific Elective 14**
Unit 1 Basics of Taxonomy, Trends in biosystematics and Dimensions of speciation	Unit 1 Basic Hematology	Unit 1 Histology	Unit 1 Microscopy and Microtomy
Unit 2 Protista and Metazoa	Unit 2 Applied Hematology	Unit 2 Toxicology	Unit 2 Tools and techniques in Biochemistry and Physiology
Unit 3- Non- Chordates	Unit 3 Basic Immunology	Unit 3 Enzymology	Unit 3 Cell culture, maintenance of Laboratory animals
Unit 4 Type Study – Earthworm	Unit 4 Applied Immunology	Unit 4 Biostatistics	Unit 4 Introducti on to Endocrinology
Practical (USC5ZOP1)	Practical (USC5ZOP2)	Practical (USC5ZOP3)	Practical (USC5ZOP4)

SYLLABUS T.Y.B.Sc.

ZOOLOGY

UNIT WISE DISTRIBUTION

Semester VI			
Core Course 15	**Core Course 16**	**Core Course 17**	**Discipline Specific Elective 18**
Unit 1 Chordata	Unit 1 Molecular Biology	Unit 1 Basic concept Developmental biology	Unit 1 Value of wildlife and need for its conservation
Unit 2 Euchordata- I	Unit 2 Genetic Engineering	Unit 2 Gametogenesis, fertilization and early development	Unit 2 Population and prey-predator dynamics
Unit 3 Euchordata- II	Unit 3 Human Genetics	Unit 3 Morphogenesis and organogenesis in animals	Unit 3 Wildlife Conservation
Unit 4 Type Study- Shark	Unit 4 Bioinformatics	Unit 4 Chick Embryology	Unit 4 Rehabilitation and management
Practical (USC6ZOP1)	Practical (USC6ZOP2)	Practical (USC6ZOP3)	Practical (USC6ZOP4)

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester V Paper I and Practical I

T.Y.B.Sc. Zoology Semester V (Theory)Course

Code: USC5ZO1

Core Course 11

Principles of Taxonomy, Modern Trends in Taxonomy and study of invertebrates

Course objectives:

To introduce the basics of taxonomy along with the study of invertebrates.

Course outcome*:*

- *Learners will understand the basics concept of taxonomy and learn to classify animals on the basis of their relation to other animals by body structure, external characters and development*
- *Apply the International rules of Nomenclature to give a scientific name to animals which are found during research.*
- *Understand the gradual development and evolutionary history of different kinds of living organisms from earlier forms over several generations*
- *Understand and demonstrate the internal anatomy of various animals, biodiversity and related indices.*

Unit 1: Basics of Taxonomy, Trends in biosystematics and Dimensions of speciation

(15 lectures)

Learning objectives:

To introducing the students for the basic concepts of Taxonomy and trends in biosystematics.

Desired outcome:

Learners will understand the rules of nomenclature and other theories, concepts and principlesof taxonomy.

1.1 *: Definition and basic concept of biosystematics taxonomy and classification.*

a. Introduction,

b. Definition of taxonomy,

c. Definition of Systematics

d. Basic concepts of taxonomy

e. History of Classification

1.2 *: Trends in biosystematics*

a. Chemotaxonomy

b. Cytotoaxonomy

c. Molecular taxonomy

1.3 *: Dimensions of speciation.*

Species concepts: Typological, Nominalist and Biological Species concepts.

Unit 2- : Protista and Metazoa *(15 lectures)*

Learning objectives:

To comprehend the general characters and classification of Kingdom Animalia from Protista and Metazoa and specific characters of organisms.

Desired outcome:

The learners will be familiarized with classification up to Nematoda and their distinctive features.

2.1 *: Protozoa*

- General characteristics and Classification up to phylum (according to Levine et. al., 1980)
- Locomotion in Euglena, Paramoecium and Amoeba; Conjugation in Paramoecium.
- Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica

2.2 *: Metazoa*

- Evolution of symmetry and segmentation of Metazoa

2.3 *: Porifera*

- General characteristics and Classification up to orders (after Hyman, 1951); Canal system and spicules in sponges

2.4 *: Cnidaria*

- General characteristics and Classification up to orders.
- Metagenesis in Obelia, Polymorphism in Cnidaria
- Corals and coral reef diversity, function & conservation

2.5 *: Ctenophora*

- General characteristics and classification upto classes

2.6 *: Platyhelminthes*

- General characteristics and Classification up to classes

2.7 *: Nematoda*

- General characteristics and Classification up to classes

Unit3: Non- Chordates *(15 lectures)*

Learning objectives:

To introduce basic concepts of classification up to class in animal kingdom from phylum Annelida to Hemichordata and to familiarize with their characters.

Desired outcome:

Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.

***3.1** : Introduction*

- Evolution of coelom and metamerism

***3.2** : Annelida*

- General characteristics and Classification up to order
- Excretion in Annelida through nephridia.

***3.3** : Arthropoda*

- General characteristics and Classification up to subclass
- Vision in Insecta
- Respiration in Arthropoda (Gills in prawn and trachea in cockroach)
- Metamorphosis in Lepidopteran Insects.
- Social life in termite

***3.4** : Onychophora*

- General characteristics and Evolutionary significance

***3.5** : Mollusca*

- General characteristics and Classification up to classes
- Nervous system and torsion in Gastropoda
- Feeding and respiration in Pila sp.

***3.6** : Echinodermata*

- General characteristics and Classification up to orders
- Larval forms in Echinodermata
- Affinities with Chordates

3.7 *: Hemichordata*

- General characteristics of phylum Hemichordata.
- Relationship with non-chordates and chordates

Unit 4: Type study- Earthworm *(15 lectures)*

Learning objective-

To acquaint learners with the details of earthworm as a representative of invertebrate animals.

Desired outcome-

Learners will get an idea of general characteristics and details of invertebrate animal systems. **4.1:** General characters and classification, Habit and habitat, External characters, metamerism, locomotion, economic importance.

4.2: Digestive system, Respiratory system, Circulatory system, excretory system, nervous system, and Reproductive system.

T.Y.B.Sc. Semester V (Practical)Course

Code: USC5ZOP1

Core Course 11

1. Identification of *Amoeba, Euglena, Entamoeba, Opalina, Paramecium, Plasmodium vivax and Plasmodium falciparum* (from the prepared slides)
2. Identification of *Sycon, Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
3. Identification and significance of adult *Fasciola hepatica, Taenia solium and Ascaris lumbricoides.*
4. Staining/mounting of any protozoa/helminth from gut of cockroach.
5. Identification of following specimens (based on specimen characters):
   a. Annelids- *Nereis, Heteronereis, Sabella, Chaetopterus, Pheretima, Hirudinaria*
   b. Arthropods- *Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, Odontotermes and Apis*
   c. Onychophora- *Peripatus*
   d. Molluscs –*Chiton, Dentalium, Pila, Doris, Helix, Lamellidens, Ostrea, Pinctada, Sepia, Octopus, Nautilus*
   e. Echinoderms- *Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon*
   f. Hemichordates – *Balanoglossus*
7. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm using model and chart.
8. Study of T.S. through pharynx, gizzard, and intestine at typhlosolar region of earthworm
9. Study of mouth parts and study of digestive system and nervous system of *Periplaneta.*
10. To submit a Project Report on any related topic on larval forms (arthropods, mollusca and Echinodermata).

Reference and Additional Reading

1. Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
2. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
3. Barrington, E. J. W. (1981). Invertebrate Structure and function. 2nd Ed. ELBS & Nelson.
4. Blackwelder, R. E., (1967). Taxonomy- A text and reference book. John Wiley & Sons.
5. Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates...
6. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
7. Hickman, C.P. Jr., F.M. Hickuman and L.S. Roberts, 1984. Integrated Principles of Zoology,7th Edition, Times Merror/Mosby College Publication. St. Louis. 1065pp.
8. Hyman, L. H. (1951). The Invertebrates (Vol-I). Mc.GrawHill Book Company.
9. Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology. S. Chand & Company Ltd. New Delhi.
10. Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
11. Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
12. Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
13. Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
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15. Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume I. Macmillan Press, London.
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17. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.
18. Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata. Classification to be followed from Barnes and Rupert 1994, 6th Edition.

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester V Paper II and Practical II

T.Y.B.Sc. Zoology Semester V (Theory)Course Code:

USC5ZO2

Core Course 12

Haematology and Immunology

Course objective:

Demonstrate an understanding of the components of human blood with their characteristics, functions, abnormalities and related diseases and also to identify the major cellular and tissue components which comprise the innate and adaptive immune system.

Course Outcome:

Learners can achieve proficiency in the skills necessary for the study of haematology and can identify the major cellular and tissue components which comprise the innate and adaptive immune system.

Unit I: Basic Haematology *(15 Lectures)*

Learning objectives:

To introduce to the learner the composition of blood, haemorrhage and haematopoiesis and to acquaint the learner with the physiology of blood clotting and clinical aspects of haematology,

Desired outcome:

- *Learner shall be familiar with the fundamental concepts in haematology.*
- *Learner shall comprehend basic haematology.*
- *Learner will be able to identify various components of haemostatic systems.*

1.1 *: Composition of blood plasma*

Water, plasma proteins, inorganic constituents, respiratory gases, organic constituents other than protein (include internal secretions, antibodies and enzymes)

1.2 *: Erythrocytes*

Structure and functions, abnormalities in structure, total count, variation in number; ESR;types of anaemia

1.3 *: Hemoglobin*

Structure, formation and degradation; variants of hemoglobin (fetal, adult), abnormalitiesin Hemoglobin (Sickle cell and Thalassemia)

***1.4** : Leucocytes*

Types of leucocytes and function, total count and variation in number; leukemia and its types

***1.5** : Thrombocytes*

Structure of thrombocytes, factors and mechanism of clotting, failure of clotting mechanism

***1.6** : Haematopoiesis*

Erythropoiesis, leucopoiesis and thrombopoiesis

***1.7** : Blood volume*

Total quantity and regulation; hemorrhage

Unit II: Applied Haematology *(15 Lectures)*

Learning Objective

- *To introduce to the learner the basics of applied hematology and to impart knowledge of basic diagnostic techniques used in pathology.*

Desired outcome:

- *Learners shall get familiar with different terminologies and diagnostic tests performed in a pathological laboratory.*
- *Learners will be acquainted with diagnostic approaches in haematological disorders*
- *Learners will be better equipped for taking any further pathological course or working in a diagnostic laboratory.*

***2.1** : Introduction to Applied Haematology*

Scope and brief introduction of basic branches: clinical, microbiological, oncological and forensic hematology

***2.2** : Diagnostic techniques used in haematology*

2.2.1 : Microscopic examination of blood: For detection of blood cancers (lymphoma, myeloma), infectious diseases (malaria, leishmaniasis), hemoglobinopathies (sickle cell, thalassemia)

2.2.2 : Coagulopathies: Diagnostic methods (hemophilia and purpura)

2.2.3 : Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB)

2.2.4 : Biochemical examination of blood:

- Liver function tests: AST, ALT, Total bilirubin, Direct bilirubin, LDH and Alkaline phosphatase
- Kidney function tests: Serum creatinine, blood urea nitrogen (BUN) Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test
- Other biochemical tests: Blood hormones - TSH, FSH, LH.

2.2.5 : Blood Bank: Collection, storage & preservation of blood components, anticoagulants

Unit III: Basic Immunology *(15 Lectures)*

Learning Objective:

- *To introduce the topic of immunology by emphasizing the basic concepts to build a strong foundation and to give an overview of the immune system that plays an important role in disease resistance.*

Desired outcome:

- *Learners would comprehend the types of immunity and the components of immune system.*
- *Learners would realize the significant role of immune system in giving resistance against diseases.*

3.1 : Overview of Immunology

Haematopoiesis, Cells and organs of the Immune system

3.2 : Innate and Adaptive Immunity

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions.

3.3 : Antigens

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes Definition, properties of antigens; haptens

3.4 : Immunoglobulins

Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Polyclonal sera, Monoclonal antibodies, Hybridoma technology

3.5 *: Major Histocompatibility Complex (MHC)*
Types and Pathways

Unit IV: Applied Immunology *(15 Lectures)*

Learning Objective:

- *To introduce to the learner immune related pathologies*
- *To introduce the concept of vaccines and vaccination.*
- *To familiarise the learner to immunological perspectives of organ transplant and tumour treatment.*

Desired outcome:

- *Learners shall understand immune related pathologies and the principles and applications of vaccines.*
- *Learners will develop basic understanding of immunology of organ transplantation.*

4.1 *: Antigen-Antibody interaction*

4.1.1 : General features of antigen-antibody interaction

4.1.2 : Precipitation reaction- Definition, characteristics and mechanism, Precipitation ingels (slide test), Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method)

4.1.3 : Immunoelectrophoresis - Counter current, Laurel's Rocket and crossed immunoelectrophoresis

4.1.4 : Agglutination reaction- definition, characteristics and mechanism Haemagglutination (slide and micro-tray agglutination), passive agglutination, Coomb'stest

4.1.5 : Immunoassay- ELISA

4.2 *: Vaccines and Vaccination*

4.2.1 : Brief history of vaccination, principles of vaccines-active and passive immunization, Routes of vaccine administration

4.2.2 : Classification of vaccines: Live attenuated; Whole-Killed or inactivated; Sub- unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines

4.2.3 : Adjuvants used for human vaccines – Virosomes and Liposomes, Saponins, Water-in-oil emulsions.

4.2.4 : Vaccines against human pathogens: Polio; Hepatitis A and B; Tuberculosis (BCG)

4.3 *: Transplantation Immunology*

Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection;

Precautions against graft rejection

4.4 *: Auto immune and immunodeficiency disorder4.4.1:*

Anaphylaxis,

4.4.2: Auto immune disorders

System specific (Systemic lupus erythematosus, Rheumatoid arthritis) and Organ specific (Grave's Disorder),

4.4.3: Immunodeficiency disorder -Primary (SCID) Secondary (AIDS).

T.Y.B.Sc. Practical (Semester V)Course codes:

USC5ZOP1

Core Course 12

1. ABO blood group determination
2. Preparation of a Peripheral Blood Smear
3. Enumeration of Erythrocytes – Total Count.
4. Enumeration of Leucocytes – Total Count.
5. Differential count of Leucocytes
6. Erythrocyte Sedimentation Rate by suitable method– Westergren or Wintrobe method.
7. Estimation of haemoglobin by Sahli's acid haematin method.
8. Determination of serum LDH.
9. Estimation of total serum/ plasma proteins by Folin's method.
10. Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
11. Latex agglutination test – Rheumatoid Arthritis.

Reference and Additional Reading

Basic Haematology

1. Human Physiology - Volume 1; C.C. Chatterjee
2. Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers
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2. Immunology - Essential and Fundamental; Pathak S., &Palan U.; Science Publishers; 2005

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Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester V

Paper III and Practical III

T.Y.B.Sc. Zoology Semester V (Theory) Course
Code: USC5ZO3
Core Course 13
Histology, Toxicology, Enzymology and Biostatistics

Course objectives:

- *To introduce the learners with the basic concepts of enzymology and enzyme kinetics, principles of toxicology and obtain knowledge and practical skills in the toxicology.*
- *To make the learners to understand the principal concepts of biostatistics, collect data relating to variable/variables, which can be examined and descriptive statistics can be calculated from these data.*

Course outcome:

- *The students can learn about various aspects of enzymological assays and their applicationsin industries and study of basics histological techniques, a broad understanding of differentareas of toxicology.*

Unit I: Histology **(15 Lectures)**

Learning Objectives:

- *To familiarize the learners with the cellular architecture of the various organs in the body.*
- *To make the learners understand the need and importance of different types of tissuesin the vital organs and their functions.*

Desired outcome:

- *Learners would appreciate the well-planned organization of tissues and cells in the organ systems.*

1.1 *: Vertical section (V.S.) of skin*

Layers and cells of epidermis; papillary and reticular; layers of dermis;sweat glands,sebaceous glands and skin receptors.

1.2 *: Digestive System*

1.2.1 : Vertical section (V.S.) of tooth – hard tissue – dentine and enamel, soft tissue – dentinal pulp and periodontal ligaments.

1.2.2 : Transverse section (T.S.) of tongue – mucosal papillae and taste buds

1.2.3 : Alimentary canal – Transverse section (T.S.) of stomach, small intestine, large intestine of mammal.

1.2.4 : Glands associated with digestive system - Transverse section (T.S.) of salivary glands, liver.

Unit II: Toxicology *(15 Lectures)*

***Learning Objective**:*

- *To introduce the learners to the principles of toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing.*
- *It also intends to develop amongst students an introductory understanding of regulatory affairs in toxicology.*

***Desired outcome**:*

- *The course will prepare learners to develop broad understanding of the different areas of toxicology.*
- *It will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.*

***2.1** : Basic toxicology*

2.1.1 : Introduction to toxicology – brief history, different areas of toxicology, principles and scope of toxicology

2.1.2 : Toxins and Toxicants – Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins), Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom).

2.1.3 : Characteristics of Exposure – Duration of exposure, Frequency of exposure, Site of exposure and Routes of exposure.

2.1.4 : Types of toxicity – Acute toxicity, subacute toxicity, sub chronic toxicity and chronictoxicity.

2.1.5 : Concept of LD_{50}, LC_{50}, ED_{50}

2.1.6 : Dose Response relationship – Individual/ Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety.

2.1.7 : Dose translation from animals to human – Concept of extrapolation of dose, NOAEL(No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake).

2.2 *: Regulatory toxicology*

2.2.1 : OECD guidelines for testing of chemicals (an overview)

2.2.2 : CPCSEA guidelines for animal testing center, ethical issues in animal studies

2.2.3 : Animal models used in regulatory toxicology studies

2.2.4 : Alternative methods in toxicology (*in vitro* tests)

Unit III: Enzymology *(15 Lectures)*

Learning Objective:

- *To introduce to the learner the basic concepts of enzyme biochemistry and to make the learner realize the power and application of enzymes in basic and applied science.*

Desired outcome:

- *Learners shall be able to understand basics of enzyme structure and function.*
- *Learners will be able to comprehend variations in enzyme activity and kinetics.*
- *Learners shall appreciate the enzyme assay procedures and the therapeutic applicationof enzymes.*

3.1 *: Introduction and Nomenclature*

Definition; Concept of activation energy; Nomenclature and classification (based on enzyme Commission) of enzymes; Co-factors and Co-enzymes.

3.2 *: Enzyme Action*

Mechanism of enzyme action; Factors affecting enzyme activity - pH and temperature; Enzyme structure (lysozyme and serine protease) .

3.3 *: Enzyme kinetics*

Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of Km, Vmax and Kcat; Modulation of enzyme activity with reference to GDH.

3.4 *: Enzyme inhibition*

Enzyme inhibitors, competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors.

3.5 *: Regulation of enzyme activity*

Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)

3.6 *: Applications*

Clinical significance and industrial applications of enzymes.

Learning Objective:

- *To make learners familiar with biostatistics as an important tool of analysis and its applications.*

Desired outcome:

- *The learners will be able to collect, organize and analyze data using parametric and non- parametric tests.*
- *They will also be able to set up a hypothesis and verify the same using limits of significance.*

4.1 *: Probability Distributions*

Normal, Binomial, Poisson distribution, Z-transformation, p-value, Probability - Additionand multiplication rules and their applications.

4.2 *: Measures of Central Tendency and Dispersion*

Variance, standard deviation, standard error.

4.3 *: Testing of Hypothesis*

Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis. Levels of significance and testing of hypothesis.

4.4 *: Parametric and non-parametric tests*

Parametric tests: two-tailed Z-test and t-test.
Non-parametric test: Chi-square test and its applications.

4.5 *: Correlation*

Correlation coefficient and its significance

T.Y.B.Sc. Semester V (Practical3)

Course Code: USC5ZOP2

Core Course 13

1. Study of mammalian tissues:
   - **i.** V.S. of Tooth
   - **ii.** T.S. of Stomach
   - **iii.** T.S. of small intestine
   - **iv.** T.S. of Liver
2. Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.
3. To study the effect of different pH on activity of salivary content (salivary amylase) on starch.
4. To study the effect of different temperature on activity of salivary content (salivary amylase) on starch.
5. Effect of varying pH on activity of enzyme Acid Phosphatase.
6. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase
7. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase
8. Effect of inhibitor on the activity of enzyme Acid Phosphatase
9. Separation of LDH isozymes by agarose gel electrophoresis
10. Biostatistics- Any 10-example based on theory
11. **Project** (preparation of slides of any suitable tissue). Slides and Report of the same to be submitted at the time of practical examination.

Reference and Additional Reading

Histology

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2. Colour Textbook of Histology; Gartner, Leslie P.; Saunders.
3. A Textbook of Histology; Mathur Ramesh; Anmol Pub.
4. A Textbook of Histology and A Practical Guide; Gunasegaran J.P.; Elsevier
5. A Textbook of Histology; Khanna D.R.; Sonali Pub.
6. Practical Zoology; Second Edition; Dr. K.C. Ghose&Dr. B. Manna; New Central Book Agency Pvt. Ltd. , Kolkata; 1999.

Toxicology

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2. Biochemistry; 5th ed.; J M Berg, J L Tymoczko and LubertStryer ;W.H. Freeman, New York; 2002
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5. Biochemistry; Third Edition: Pamela C. Champe, Richard A. Harvey, Denise R. Ferrier; Indian Edition by JP Publication.
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Biostatics

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2. Fundamentals of Biostatistics; Second Edition; Veer BalaRastogi; Ane Books Pvt. Ltd.,New Delhi; 2009 (Reprint 2010)
3. Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and AtiyaKhanum; Ukaaz Publications, Hyderabad; 2004
4. Instant Medical Biostatistics; Dr. Ranjan Das and Dr.Papri N. Das; Ane Books Pvt. Ltd.,New Delhi; 2009
5. Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.; 2002
6. Basic Biostatistics – Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington; 2015
7. Biostatistics – A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Forthofer, EunSul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007
8. Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester V

Paper IV and Practical IV

T.Y.B.Sc. Semester V (Theory)Course

Code: USC5ZO4

Discipline Specific Elective 14

Biotechniques and Introduction to Endocrinology

About the course

It has full hands-on approach to expose the students to modern techniques and methodologies. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography ELISA, tissue culture to cloning etc. are included to make the student well versed with these protocols and methods.

Learning outcomes –

After successfully completing this course, the students will be able to:

- Learn the theoretical basis of technique, its principle of working and its correct application.
- Learn the construction repair and adjustment of any equipment required for a technique.
- Learn the maintenance laboratory equipment's/ tools, safety hazards and precautions.
- Understand the technique of cell and tissue culture.
- Understand the process of preparation of buffer and learn the techniques of separation of amino acids, proteins and nucleic acids.

Theory

UNIT I : Microscopy and Microtomy **15 Lectures**

1.1. Microscopy: Introduction to Microscopy.
1.2. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical aperture.
1.3. Types of microscopes. bright field, dark-field, phase contrast.
1.4. Basic principles of Light, Electron, Fluorescence and Confocal Microscopy.
1.5. Measurements, Drawings and photomicrography.
1.6. Microtomy: Tissue preparation, fixation, block preparation, sectioning, staining, dehydration and mounting.

UNIT II : Tools and techniques in Biochemistry and Physiology 15 Lectures

2.1 Biochemistry and Physiology: Physiological Salines, Buffers and the use of pH meter.

2.2. Extraction of Tissue Glycogen, Proteins, Lipids and Nucleic Acids by Graaf's Method.

2.3. Subcellular Fractionation by Differential Centrifugation.

2.4. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law.

2.5. Principle and applications of Electrophoresis: Separation of Biomolecules by Native PAGE, 2D PAGE. Agarose gel electrophoresis.

2.6. Principle and Applications of Paper chromatography, Thin layer chromatography, Gel-filtration chromatography. .

UNIT III: Cell culture, maintenance of Laboratory animals 15 Lectures

3.1. Cell Culture and Laboratory Animals: Cell culture and its basic requirements, media Nutrient and Non-nutrient, commonly used media for human cell lines.

3.2. Sterilization of culture wares and Media, laminar flow.

3.3. Types of animal cell culture, cell viability testing, cryopreservation.

3.4. Lymphocyte culture.

3.5. Cell harvesting and Storage Methods.

3.6. In Vitro culture of Entamoeba histolytica, Coenorhabditis elegans.

3.7. Maintenance and Handling of laboratory rats and rabbits and Bioethics.

Unit 4 : Introduction to Endocrinology (15 Lectures)

Learning Objective:

- *To introduce to the learner the basics of endocrinology.*

Desired outcome:

- *Learners can understand the basic concepts of endocrinology and learn about the hypothalamus and hypophysial axis.*

4.1: General idea of Endocrine systems

4.2: Definition and classification of hormones.

4.3: Mechanism of Hormone action

4.4: Epiphysis, Hypothalamo-hypophysial Axis

4.5: Structure and functions of hypothalamus, Regulation of neuroendocrine glands and Feedback mechanisms

4.6: Structure of pituitary gland, Hormones and their functions**.**

T.Y.B.Sc. Semester V (Practical)Course

code: USC5ZOP2 Discipline Specific

Elective 14

1. Preparation of buffer and determination of pH.
2. Identification of amino acids in the mixture using paper chromatography.
3. Verification of laws of spectrophotometry.
4. Separation of proteins using SDS-PAGE.
5. Tissue fixation, paraffin block preparation, sectioning.
6. Preparation of permanent slides of microscopic organisms/ small insects Histological and cytological study of the following endocrine glands with the help ofPermanent slides:
   - **A.** T.S. of pituitary
   - **B.** Pineal gland
   - **C.** Thyroid
   - **D.** Parathyroid
   - **E.** Pancreas
   - **F.** Adrenal
   - **G.** Ovary
   - **H.** Testis
7. Histological study of testes and ovaries from various vertebrate groups.
8. Demonstration of endocrine glands in rat by using charts and model.
9. Estimation of plasma level in any hormone using ELISA.

References and Additional Reading Material

1. Boyer, R. (2000) Modern Experimental Biochemistry (3rd edition)
2. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
3. Plummer, D. (2017) An Introduction to Practical Biochemistry (3 rd edition) McGraw Hill.
4. Barington (1979) Hormones and evolution Vol I&II Academic press, New York.
5. John F- Laycock and Peter H. Wise, Essential of Endocrinology
6. Williams R.H. (1974). Textbook of Endocrinology V.Ed. Saunders Press, London.
7. Endocrinology- Hadley
8. General endocrinology Bagrara and Tumer, W.B. Saunders.
9. The Physiology of Reproduction, Vol I& II E. K .Nobil and JU. D.Neil, Raven Press, New York, 1988.
10. Benjamin Levin-Gene VII, Oxford University Press.
11. Lodish et al Molecular Cell Biology

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester VI Paper I and Practical I

T.Y.B.Sc. Semester VI (Theory)Course Code: USC6ZO1

Core Course 15

Phylum Chordata, Group Euchordata- I, Group Euchordata II and

Type study - Shark

Unit 1: Phylum Chordata *(15 lectures)*

Learning objectives:

To introduce basic concepts of modern Chordate classification with evolution point of view and to understand the concept of taxonomy in higher animal kingdom.

Desired outcome:

Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features.

1.1: General characteristics and outline classification of Phylum Chordata

1. 2: Protochordata

1.2.1 : General characteristics and classification of sub-phylum Urochordata and Cephalochordate up to Classes.

1.2.2 : Retrogressive metamorphosis in Ascidia.

1.2.3 : Chordate Features and Feeding in Branchiostoma

Unit 2: Group Euchordata- I *(15 lectures)*

2.1 : Division – Gnathostomata

Superclass – Pisces and Tetrapoda

Superclass – Pisces- Distinguishing characters.
Class- Placodermi, Chondrichthyes and Osteichthyes-

Distinguishing characters with examples:

a. Hammer headed shark

b. Skates and rays, e.g. Saw fish

c. Chimeras e.g Spotted rat fish

d. Flying fish, e.g. Exocoetus

***2.2** : Dipnoi (Lung fish) -*

Distribution, habit and habitat, External and internal characters, affinities with superclass

Pisces, affinities and differences with class Amphibia

***2.3** : Migration in fish:*

Reasons for migration, types of migration; Examples- Eel and Salmon

***2.4** : Superclass Tetrapoda-*

Class Amphibia -General characters with Examples:

a. Limb-less amphibian, e.g. Ichthyophis

b. Tailed amphibian, e.g. Amphiuma

c. Tail-less amphibian, e.g. Hyla

2.5.: Neoteny and Paedogenesis in Amphibia

Unit 3: Group Euchordata II - Reptilia, Aves and Mammals (15 Lectures)

Learning objectives:

To introduce the learners to the distinguishing characters of classes Reptilia, Aves and Mammaliaand their adaptive features with reference to their habitat.

Learning outcome:

Learners will understand the characteristic features and examples of class of Reptilia, Aves and Mammalia.

***3.1** : Class Reptilia:*

General characters with examples:

a. Extinct reptile, e.g. Ichthyosaurus

b. Living fossil, e.g. Sphenodon

c. Aquatic reptile, e.g. Chelone

d. Arboreal reptile, e.g. Chamaeleon

***3.2** : Class Aves-*

3.2.1. General Characters and Examples

a. Arboreal bird e.g Wood pecker

b. Terrestrial bird e.g. Jungle fowl

c. Swimming bird e.g. Cormorant

d. Wading bird, e.gs. Pond heron

e. Birds of prey, e.g. Owl

f. Flightless birds e.g. Emu

3.2.2: Flight adaptations in birds

3.3 *: Class Mammalia*

3.3.1 : General characters and examples -

- **a.** Aquatic mammals, e.g. Dolphin
- **b.** Egg-laying mammals, e.g. Duck-billed platypus
- **c.** Pouched mammals, e.g. Kangaroo
- **d.** Toothless mammals, e.g. Sloth
- **e.** Gnawing mammals, e.g. Squirrel
- **f.** Primates, e.g. Lemur

3.3.2 : Adaptations in aquatic mammals with examples.

Unit 4: Type study - Shark *(15 lectures)*

Learning objectives:

To study in depth one vertebrate animal type i. e. general characteristics and salient features of animal type - shark.

Learning outcome:

Learners will get an idea of vertebrate animal life after studying one representative animal Shark.

4.1 : Habit & habitat, distribution, external characters and classification, and economic importance.

4.2 : Skin, exoskeleton, endoskeleton, Digestive system, respiratory system, blood vascular System, nervous system, receptor organs, urogenital system, copulation, fertilization and development.

T. Y. B. Sc. Semester VI (Practical)

Course Code: USC6ZOP1

Core Course 15

1. *Group - Protochordata*

Subphylum Urochordata -

a. Class Larvaceae, e.g. Oikopleura

b. Class Ascidiacea, e.g. Ciona

c. Class Thaliacea, e.g. Salpa

Subphylum Cephalochordata:

a. Class Leptocardii, e.g. Branchiostoma (Amphioxus)

2. *Subphylum Vertebrata:*

i. Division Agnatha

a. Class Ostracodermi, e.g. Pharyngolepis,

b. Class Cyclostomata, e.g. Petromyzon

ii. Division- Gnathostomata

- Superclass - Pisces:

a. Class Placodermi e.g.Bothriolepis

b. Class Chondrichthyes- e.g.. Rhinobates . Chimaera

c. Class- Osteichthyes -e.g.Protopterus , Catfish

- Superclass - Tetrapoda :

a. Class Amphibia, e.g. Ichthyophis, Alytes, Triton

b. Class Reptilia: e.g. Geochelone (Indian star tortoise) ,Sphenodon ,Varanus, Alligator

3. *Class Aves:*

E.g. Archaeopteryx, Ostrich, Penguin, Flamingo, Vulture, Hornbill

4. *Class Mammalia*

E.g. Duck-billed platypus, Dasyurus (Tiger cat), Dugong, Flying Squirrel, Gorilla.

5. *Shark: Study of endoskeleton of shark:*

a. Axial- skull and vertebral column

b. Appendicular- pelvic and pectoral fins, pelvic and pectoral girdle.

6. Visit to local fish market/Aquarium/ zoo/ National park/Any other relevant placeto observe Chordate animals.

References and Additional Readings

1. Modern text book of Zoology – Vertebrates; Professor R.L. Kotpal; Rastogi publication;Third Edition 2012
2. Vertebrate Zoology for Degree students; V. K. Agarwal; S.Chand Publication; 2012
3. Fundamentals of Zoology, Dr. K.C. Ghosh and Dr. B. Manna,New Central book Agency (P) Ltd.
4. Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication.
5. Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition
6. Chordate Zoology, E.L.Jordan, P.S. Verma, S. Chand & Company Ltd.
7. The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press Third edition, 2006
8. Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar Campus Book International, First edition, 2005

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester VI Paper II and Practical II

T. Y. B. Sc. Semester VI (Theory)

Course Code: USC6ZO2

Core Course 16

Molecular Biology, Genetic Engineering,

Human Genetics and Bioinformatics

Unit I: Molecular Biology *(15 Lectures)*

Learning Objectives:

- *To introduce learner to chemical and molecular processes that affect genetic material.*
- *To make learner understand the concept of DNA damage and repair, and how gene control is necessary for cell survival.*

Desired outcome:

- *Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material.*
- *The course shall prepare learner to recognize the significance of molecular biologyasa basis for the study of other areas of biology and biochemistry.*
- *Learner shall also understand related areas in relatively new fields of geneticengineering and biotechnology.*

***1.1** : Types of mutation*

1.1.1 : Point mutations – substitution, deletion and insertion mutations

- Substitution mutations – silent (same-sense), missense and nonsense mutations, transition and transversion
- Deletion and Insertion mutations – frameshift mutations

1.1.2 : Trinucleotide repeat expansions – fragile X syndrome, Huntington disease

1.1.3 : Spontaneous mutation – tautomeric shifts, spontaneous lesions

1.2 : Induced mutations/mutagens/mutagenic agents/Nucleic acid damage1.2.1:

Physical agents:

- Ionizing radiation (X-rays, α, β and γ rays)
- Non-ionizing radiation (UV light)

1.2.2: Chemical agents:

- Base analogs (5-bromouracil)

- Intercalating agents (ethidium bromide)
- Deaminating agents (nitrous acid)
- Hydroxylating agents (hydroxylamine)
- Alkylating agents (mustard gas)
- Aflatoxin (aflatoxin B_1)

1.2 *: Preventative and repair mechanisms for DNA damage*

1.2.1 : Mechanisms that prevent DNA damage – superoxide dismutase and catalase

1.2.2 : Mechanisms that repair damaged DNA – direct DNA repair (alkyl transferases, photoreactivation, excision repair)

1.2.3 : Postreplication repair – recombination repair, mismatch repair, SOS repair

1.3 *: Eukaryotic gene expression*

1.3.1 : Regulatory protein **domains**– zinc fingers, helix-turn-helix domain and leucine zipper

1.3.2 : DNA methylation

Unit II: Genetic Engineering *(15 Lectures)*

Learning Objective:

- *To introduce learner to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms.*

Desired outcome:

- *The learners shall get acquainted with the vast array of techniques used to manipulate genes which can be applied in numerous fields like medicine, research, etc. for human benefit.*

2.1 *: Tools in Genetic Engineering*

2.1.1 : Enzymes involved in Genetic Engineering:
Introduction, nomenclature and types of restriction enzymes with examples, Ligases– *E. coli* DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase

2.1.2 : Vectors for gene cloning: General properties, advantages and disadvantages of cloning vectors - plasmid vectors(pBR322), phage vectors (λ Phage), cosmid vectors (c2XB),

2.1.3 : Cloning techniques: Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

2.2 *: Techniques in Genetic Engineering*

2.2.1 : PCR techniques: Principle of polymerase chain reaction (PCR), Applications of PCR

2.2.2 : Sequencing techniques: DNA sequencing: Maxam-Gilbert method, Sanger's Dideoxy method, Recent high throughput method, Protein sequencing: Edman's method Applications of sequencing techniques

2.2.3 *: Animal Cell culture*

Unit III: Human Genetics **(15 Lectures)**

Learning Objectives:

- *To introduce learner with genetic alterations in human genome and their diagnosis.*

Desired outcome:

- *The learners shall become aware of the impact of changes occurring at gene level on human health and its diagnosis.*

3.1 *: Non-disjunction during mitosis and meiosis*

3.1.1 : Chromosomal Aberrations: Structural: Deletion: types, effects and disorders; Translocation: types: Robertsonian and non-Robertsonian, disorders; Inversion: types, effects and significance; Duplication and their evolutionary significance (multigene families)

Numerical: Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy)

3.2 *: Genetic Disorders*

3.2.1 : Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism

3.2.2 : Single gene mutation: Cystic fibrosis

3.2.3 : Multifactorial: Breast Cancer

3.2.4 : Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome

***3.3** : Diagnosis*

3.3.1 : Prenatal Diagnosis (Amniocentesis) and chorio-villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT),

3.3.2 : Genetic counselling: Psycho-social aspects for the individual and the family in connection with genetic investigations

Unit IV: Bioinformatics *(15 Lectures)*

Objectives:

- *To introduce learner to bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.*

Desired outcome:

- *Learner shall become aware of the computational point of view of studying the genomes.*

***4.1** : Introduction*

4.1.1 : Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed)

4.1.2 : Applications of Bioinformatics

***4.2** : Databases – Tools and their uses*

4.2.1 : Biological databases (With reference to Zoological Databases):

4.2.2 : Primary sequence databases:
Nucleic acid sequence databases **(**GenBank, EMBL-EBI, DDBJ)Protein sequence data bases (UniProtKB, PIR, PDB)

4.2.3 : Secondary sequence databases:
Derived databases - PROSITE, BLOCKS**,**Structure databases and bibliographic databases

***4.3** : Sequence alignment methods*

4.3.1 : BLAST, FASTA

4.3.2 : Types of sequence alignment (Pairwise & Multiple sequence alignment)

4.3.3 : Significance of sequence alignment

4.3.4 : Predictive applications using DNA and protein sequences: Evolutionary studies: Concept of phylogenetic trees convergent and parallelevolution

4.3.5 : Functional Proteomics: Different types of protein chip (detecting and quantifying), applications of Proteomics

4.3.6 : Metabolomics: Concept and applications

4.4. *: Predictive applications using DNA and protein sequences (5 L)*

4.4.1 : Evolutionary studies: Concept of phylogenetic trees convergent and parallel evolution **4.4.2:** Functional Proteomics: Different types of protein chip (detecting and quantifying),applications of Proteomics

4.4.3: Metabolomics: Concept and applications

T. Y. B. Sc. Semester VI (Practical)

Course Code: USC6ZOP1

Core Course 16

1. Isolation & Estimation of RNA by Orcinol method.
2. Isolation & Estimation of DNA by Diphenylamine method.
3. Separation of Genomic DNA by Agarose gel electrophoresis.
4. Colorimetric estimation of proteins from given sample by Bradford's method.
5. Problems related to Restriction endonucleases.
6. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical & structural variations in chromosomes (no cutting of chromosomes):
    a. Turner's syndrome
    b. Klinefelter's syndrome
    c. Down's syndrome
    d. Cri-du-chat syndrome
    e. D-G translocation
    f. Edward's syndrome
    g. Patau's syndrome
7. Packaging of glassware for tissue culture.
8. Aseptic transfer techniques.
9. Calculation of mitotic index from the photograph or stained preparation of onion roottip or cancer cells.
10. Exploring BLAST tool (nucleotide sequence comparison).
11. Exploring the integrated database system at NCBI server and querying (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT).
12. Exploring bibliographic database PubMed (Data Mining-Downloading a research paperon subject of interest, use of operators (AND, OR & NOT).

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2. Molecular Biology; David Freifelder; Narosa Publishing House; 2008
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6. Genetics; M.W. Farnsworth; Harper and Row Publishers, Inc., USA; 1978
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4. Gene Cloning – An Introduction; Brown .T.A; Fourth Edition; Wiley-Blackwell; 2011
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10. Microbiology; Fifth Edition; Pelczar, M.J. et al; Tata McGraw-Hill Co., New Delhi; 2001

11. Introduction to Protein Structure; Second Edition; Branden C. and Tooze J.; Garlan Publishing; 1999

12. Proteins; Second Edition; Creighton T.E.; W.H. Freeman; 1993

13. Proteomics - Protein Sequence to Function; Pennington, S.R and M.J. Dunn; Viva Books; 2002

14. Genetic engineering – Principles and Practice; Sandhya Mitra; Macmillan India Ltd., New Delhi

15. Biotechnology – Fundamentals and Applications; Third Enlarged Edition; S.S. Purohit;Student Edition, Jodhpur; 2005

16. Biotechnology – Expanding Horizons; B.D.Singh; Kalyani Publishers, Ludhiana

17. A textbook of Biotechnology; R.C.Dubey; S.Chand and Company Ltd., New Delhi

18. Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013

Human Genetics

1. Genetics – A Molecular Approach; Third Edition; Peter J. Russell; Pearson Education, Inc. (Benjamin Cummings), San Francisco; 2010

2. Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988

3. Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylorand Francis Group, New York; 2007

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17. Systems Metabolic Engineering; Dr. Christoph Wittmann, Sang Yup. Lee; Springer; 2012
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19. Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008
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21. Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009
22. Introduction to Bioinformatics; First Edition; S. SundaraRajan and R. Balaji; Himalaya Publishing House, Mumbai; 2002
23. Molecular Biology – Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates,Phil Turner & Mike White; Garland Science; 2013

Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester VI

Paper III and Practical III

T.Y.B.Sc. Semester VI (Theory)

Course Code: USC6ZO3

Core Course 17 Developmental biology

Course objectives:

- *To learn the basics of developmental biology.*
- *To comprehend fertilization process and study different patterns of cleavage and formation of embryo.*

Course outcomes:

- *Learners can familiarize with early and later stages of development.*

Unit 1: **History & Basic concepts of development** **(15 Lectures)**

Learning Objectives:

To learn the history and understand basic concepts of development in animals

Desired outcome:

Learners can understand embryo development by studying the important process of cell differentiation, stages of development and morphogenesis.

1.1 : Overview of how the modern era of developmental biology emerged through multidisciplinary approaches

1.2 : Stages of development- zygote, blastula, gastrula, neurula

1.3 : Cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map

1.4 : Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development

1.5 : Pattern formation- axis specification, positional identification (regional specification)
1.6. Morphogenetic movements

Unit 2: Early and Late Embryonic Development

Learning Objectives:

To learn the process of early and late embryonic development in animals.

Desired outcome:

Learners get acquainted with process of early and late embryonic development in animals.

2.1. *Early Embryonic Development*

- Gametogenesis
- Egg membranes
- Fertilization
- Changes in gametes
- Monospermy and polyspermy
- Planes and patterns of cleavage
- Early development of frog
- Fate maps
- Embryonic induction and organizers

2.2: Late Embryonic Development

Fate of Germ Layers; Implantation of embryo in humans, Placenta (Structure, types andfunctions of placenta)

Unit 3: Post Embryonic Development and Implications of Developmental Biology

(15 lectures)

Learning Objectives:

To learn post Embryonic Development and Implications of Developmental Biology

Desired outcome:

Learners get acquainted with post Embryonic Development and Implications of Developmental Biology.

3.1 *: Post Embryonic Development*

- Metamorphosis: Changes, hormonal regulations in amphibians;
- Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each);
- Ageing: Concepts and models

3.2 *: Implications of Developmental Biology*

- Teratogenesis: Teratogenic agents and their effects on embryonic development;

  Stem cell culture, Amniocentesis.

Unit 4: Chick Embryology *(15 lectures)*

Learning Objectives:

To introduce to the learners the basics of developmental biology with reference to chick asa model and also understand experiments related to it.

Desired outcome:

Learners will be able to understand the processes involved in embryonic development andits application.

4.1. *Development of Chick-*

- **a.** Structure of Egg and Sperm
- **b.** Fertilization, cleavage, blastulation and Gastrulation
- **c.** Fate map of blastula
- **d.** Structure of 24 hrs. Chick embryo.
- **e.** Structure of 33 hrs. Chick embryo.
- **f.** Structure of 48 hrs. Chick embryo.
- **g.** Structure of 72 hrs. Chick embryo.

4.2. *Chick Foetal membranes or extra embryonic membranes*
(Amnion, Chorion, Allontois and Yolk sac) & their significance.

T.Y.B.Sc. Semester VI (Practical)Course

code: USC6ZOP2

Core Course 17

1. Study of types of eggs: Eggs of Insects, Amphioxus, Frog and Chick with the help of Permanent slides/ Model/museum specimens/CD/Chart)
2. Study of Cleavage, Blastula and Gastrula: Amphioxus with the help of CD/Chart/Model/Permanent slides
3. Study of whole mounts and sections of developmental stages of frog through permanent slides:
    a. Cleavage stages
    b. Blastula
    c. Gastrula
    d. Neurula
    e. Tail-bud stage
    f. Tadpole (external and internal gill stages)
4. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 24, 28, 33, 36, 48, 72, and 96 hours of incubation.
5. Study of the developmental stages and life cycle of Drosophila from stock culture.
6. Study of Histological structures of placenta (permanent slide or microphotographs)
    1) Epitheliochorial
    2) Endotheliochorial
    3) Hemochorial
    4) Syndesmochorial
    5) Hemoendothelial
7. Study of human embryology: Principle and mechanism of ultra sound or ultra-sonography with the help of photograph/flow-chart/Chart
8. Visit to IVF center and submission of report.

References and Additional Readings

1. An Introduction to Embryology 1981, Balinsky B.L., Saunders College,Philadelphia.
2. Developmental Biology; Patterns/Principles/Problems, 1982, Saunders J. W. Collier MacMillan, Publishers, London.
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8. Sunderland, Massachusetts, USA. Balinsky, B.I. (2008).
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Syllabus for T.Y.B.Sc.

Program B.Sc.

Course: ZOOLOGY

Semester VI Paper IV and Practical IV

T.Y.B.Sc. Semester VI (Theory)Course

Code: USC6ZO4 Discipline Specific

Elective 18

Wild life conservation and Management

Objective - To equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation and management issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases.

Learning objective - The students will be able to:

- Develop an understanding of how animals interact with each other and their natural environment and ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues
- Develop the ability to work collaboratively on team-based projects and demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wildlife technician
- Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management and develop an ability to analyse, present and interpret wildlife conservation management Information.

Unit-I: Value of wildlife and need for its conservation 15 Lectures

1.1. Definition, value and importance of wildlife; Types of ecosystems. Causes of depletion of wildlife;
1.2. Inventory and classification of wetland and animal inhabitants; Population vulnerability analysis and its components; Factors responsible for the extinction of animals;
1.3. Types of protected areas and the concept of zoning within the protected areas;
1.4. Wildlife Sanctuaries and National Parks in India: general strategies and issues; Theories of population dispersal;
1.5. Animal movement, concept of home range and territory; Tracking movement by remote sensing and GIS.

Unit-II: Population and prey-predator dynamics 15 lectures

2.1 Wildlife conservation, ethics and importance of conservation;

2.2. Impact of topography, geology, soil and water on wildlife; Impact of habitat destruction and fragmentation on wildlife;

2.3. Biological parameters such as food, cover, forage and their impact on wild life;

2.4. Population attributes; concepts of exponential and logistic growth rates of wildlife;

2.5. Density dependent and independent population regulation; Impact of introduced species on pre-existing flora and fauna of wildlife;

2.6. Identification and estimation of wild animals by fecal sample analysis, hair identification, pug marks and census methods. Predator-prey models and impact of predation.

Unit-III: Wildlife Conservation **15 Lectures**

3.1. Wildlife conservation objectives- strategies and issues;

3.2. Captive breeding techniques and translocation and reintroduction;

3.3. Inviolate area and critical habitats and their impact on wildlife;

3.4. Different terrestrial habitats of wildlife in India;

3.5. Restoration of degraded habitat;

3.6. Damage caused by wildlife in India and its mitigation; Sick animal refuges in protected areas.

Unit-IV: Rehabilitation and management **15 Lectures**

4.1. Type of wildlife management-manipulative, custodial;

4.2. Management of over abundant wild animal populations causing damages to nearby inhabitants and their crops and animals;

4.3. Tools and techniques to control the menace of wild animals; man wildlife conflict resolution and mitigation;

4.4. Management of exotic and invasive wetland species in India. Habitat manipulation– control and regulation of grazing.

4.4. Weed eradication; Major diseases of domestic and wild animals and their control and impact of wild life tourism

T.Y.B.Sc. Semester VI (Practical)

Course code: USC6ZOP2

Course 18

1. Identification of

   a. Flora,
   b. Mammalian fauna,
   c. Avian fauna,
   d. Herpeto-fauna.

2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (
   a. Compass, Binoculars,
   b. Spotting scope,
   c. Range Finders,
   d. Global Positioning System,
   e. Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field;
4. Identification of animals through pug marks, hoof marks, scats, pellet groups, nest, antlers etc.
4. Demonstration of different field techniques for flora and fauna.

5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird

   A. direct and

   B. indirect evidences.

6. Estimation of phosphates from sample water.

7. Estimation of BOD and COD from sample water.

8. Estimation of Nitrates from sample water.

9. Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.

10. Comparative study of sound intensity in different places by Decibel meter.

11. Study of threatened animal species inhabiting Indian continent with reasons for decline- Great Indian bustard, One-horned rhinoceros, Royal Bengal tiger, Blackbuck, lion tailed macaque, Nilgiri Thar, Asiatic lion, Snow leopard, Gharial, and Gangetic dolphin.

13. Study tour/Visit to Zoo/Sanctuary/National Park/Research institute.

REFERENCES AND ADDITIONAL READINGS

T. Y. B. Sc. Semester VI

Course Code: USC6ZO4

References and Additional Readings:

Environment management

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- Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055
- A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation
- New Delhi 110002
- Environmental Biotechnology - Basic Concepts and Application; InduShekhar Thakur; I. K. International Pvt. Ltd. New Delhi 110016
- Text book of environmental science; S. C. Santra

Wildlife management

- Wild life management; Rajesh Gopal
- Wildlife Management and Conservation - Contemporary Principles and Practices**;** Paul R. Krausman and James W. Cain III
- Wildlife Ecology, Conservation, and Management; John M. Fryxell,Anthony R. E. Sinclair, Graeme Caughley

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Syllabus of T.Y.B.Sc. Zoology (Fishery Biology)

Choice Based Credit & Grading System (60:40)

w.e.f. Academic Year 2023-24

Sr. No.	**Heading**	**Particulars**
1	Title of Course	Fishery Biology
2	Eligibility for Admission	T.Y.B.Sc. with subject Zoology
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (60:40)
8	Status	Revised
9	To be implemented from Academic year	2023-24

CONTENTS

Fishery Biology (Applied Component) (Credit Based Semester and Grading System)

(To be implemented from the Academic Year 2023- 2024)

Semester V

Oceanography, Aquaculture Practices, Marketing and Finance

Theory (Any four units to be opted)				
Course	**Unit**	**TOPIC**	**Credits**	**L/Week**
USC5ZO5	1	Oceanography	2	4
	2	Crafts and Gear		
	3	Farming of Major Carps		
	4	Introduction to other Commercial Aquaculture Practices in Fresh Water		
	5	Culture of Shell fishes and Fin-Fish		
	6	Quality Control and Packaging		
	7	Marketing and Finance		
	8	Case Study and Simulation		
Practical				
USC5ZOP3		Practical's based on Course **USCFB501**	2	4

Semester VI

Marine resources, Post-harvest and Farm Engineering

Theory (Any four units to be opted)				
Course	**Unit**	**TOPIC**	**Credits**	**L/Week**
USC6ZO5	1	Marine Fin-fish of India	2	4
	2	Marine Shellfish of India		
	3	Nutrition		
	4	Diseases		
	5	Preservation and Processing		
	6	Byproducts and Value-added Products		
	7	Farm Engineering		
	8	Open Unit		
Practical				
USC6ZOP3		Practicals based on Course **USCFB601**	2	4

Semester V: Theory

Course code: USC5ZO5

Skill Enhancing Course 1

Oceanography, Aquaculture Practices, Marketingand Finance

Lectures 60

Credits 2

(Any four units to be opted)

Unit 1: Oceanography

***Learning Objective*:**

- *To study different instruments and equipments in navigation and oceanography*
- *To introduce physical, chemical and biological oceanography*

Desired *outcome:*

- *Learner shall understand and learn about the use of sea safety, navigational equipments and oceanographic instruments*
- *Learner shall understand basic physical, chemical and biological oceanography*

1.1 *: Navigational and sea safety equipments*

i) Life saving devices

ii) Global Positioning System (GPS)

iii) Rudder

iv) Signaling devices

1.2 *: Oceanographic Instruments*

i) Niskin water sampler

ii) Peterson's grab

iii) Dredges

iv) Fish finding instruments / Methods

v) Remote sensing

vi) CTD device

1.3 *: Introduction to basic physical, chemical and biological oceanography*

Unit 2: Crafts and Gear

Learning Objective:

- *To study the process of boat building, materials used and various types of diesel engines*

- *To study various types of nets used in fishery*

Desired outcome:

- *Learner shall comprehend boat building techniques and design of engines used in mechanized boats*
- *Learner shall understand the operations of various types of nets and fishing method*

2.1 : Basic boat building (parts, design, material used), methods of protection from foulers and borers

2.2 *: Basic studies of marine engines:*

i) Outboard and Inboard Engines

ii) Winch and Deck Side Equipment

2.3 *: Operations:*

i) Gill, Trawl, Purse seine Nets

ii) Hooks and Lines

iii) Non-conventional Fishing Methods such as

- Light Fishing
- Hose Pipe Fishing
- Electric Fishing

Unit 3: Farming of major carps

***Learning Objective*:**

- *To study and develop skills in breeding techniques, hatchery, nursery and management of various carps*
- *To study and explore various techniques used in fishery and poly culture practices*

***Desired outcome*:**

- *Learner will understand breeding techniques and skills for culture of major carps*
- *Learner will comprehend hatchery and nursery management of major carps*

3.1 *: Breeding techniques of major carps and common carp*

3.2 : Hatchery and nursery management of:

- Major carps:

i) IMCs: *Labeo rohita* (Rohu), *Catla catla* (Catla), *Cirrhinus mrigala* (Mrigal)

ii) Exotic carps: *Hypophthalmichthys molitrix* (Silver carp), *Ctenopharyngodon idella* (Grass carp)

iii) *Cyprinus carpio* (Common carp)

3.3 *: Mono-culture and polyculture practices:*

i) Extensive

ii) Semi-intensive

iii) Intensive

Unit 4: Introduction to other commercial aquaculture practices in fresh water

***Learning Objective*:**

- *To develop skills and understanding of breeding and rearing of sewage-fed fishery, Basa cat fish and Tilapia by novel ways*

Desired *outcome:*

- *Learner will be equipped to carry out entrepreneurial operations or gain confidence to work in freshwater prawn unit*
- *Learner will gain knowledge about how to breed and rear ornamental fishes and commercially viable fish species*

4.1 *: Macrobrachium rosenbergii* (Freshwater prawn)

i) Breeding, life cycle, hatchery management

ii) Monoculture of *Macrobrachium rosenbergii*

iii) Composite culture of major carps and *Macrobrachium rosenbergii*

4.2 *: Ornamental fishes – breeding and rearing:*

i) Egg layers:

- *Danio spp.* (Danio)
- *Pterophyllum spp.* (Angel)
- *Symphysodon spp.* (Discus)
- *Paracheirodon innesi* (Neon tetra)

- Flower horn (Hybrid variety)
- *Betta splendens* (Siamese fighter)

ii) Live bearers:

- *Poecilia reticulate* (Guppy)
- *Xiphophorus hellerii* (Swordtail)
- *Poecilia velifera* (Tangerine)
- *Poecilia sphenops* (Molly)
- *Xiphophorus maculatus* (Platy)

4.3 *: Breeding and rearing of:*

- Sewage-fed fishery of air breathing fish: *Pangasianodon hypophthalmus* (Striped catfish), *Clarius spp.*, *Heteropneustes spp.* and *Anabas spp.*
- *Pangasius bocourti* (Basa Catfish)
- All meal (Less bones) *Tilapia* – GIFT (Genetically Improved Farmed *Tilapia)*

Unit 5: Culture of shell fishes and fin-fish

***Learning Objective*:**

- *To study breeding techniques, hatchery and management of fin-fish and shell fishes*
- *To study rearing practices of fin-fish and shell fishes*
- *To study culture of brackish water shrimp*

Desired *outcome:*

- *Learner shall understand breeding techniques, hatchery and management of fin- fish and shell fishes*
- *Learner shall understand the rearing techniques*

5.1 *: Breeding, hatchery, nursery management and rearing (extensive, semi-intensive, intensive)*

i) Fin-fish – *Lates calcarifer* (Sea bass)

ii) *Litopenaeus vannamei* (Brackish water prawn or Pacific white shrimp)

iii) *Scylla serrata* (Giant mud Crab)

iv) *Pinctada vulgaris* (Pearl)

Unit 6: Quality control and packaging

***Learning Objective*:**

- *To comprehend various aspects of quality control and packaging involved in fish processing and marketing*

Desired *outcome:*

- *Learner will be oriented towards understanding the various stages of quality control*
- *Learner will gain knowledge about the postmortem changes, spoilage mechanisms and methods involved in evaluating the freshness and quality of fishes and prawns / shrimps*
- *Learner shall comprehend the value of maintaining and taking sanitary precautions duringthe processing and packaging operations*

***6.1** : Post mortem changes and mechanism of spoilage*

i) Hyperaemia

ii) *Rigor mortis*

iii) Autolysis

iv) Rancidity

***6.2** : Brief methods for evaluating freshness and quality of fish and prawns / shrimps*

i) Organoleptic

ii) Microbial

iii) Chemical

***6.3** : Sanitary operations*

i) Maintenance of hygiene of food contact surfaces, storage and equipment

ii) Water quality, ice, sewage and waste water disposal and effluent treatment plant

***6.4** : Various packaging materials used in freezing and canning industry*

i) Polyolefin

ii) Wax duplex carton

iii) Master carton

iv) Can

v) Lacquered can

vi) Retort

vii) Freezing procedures including hygienic washing, dressing

6.5 *: Quality Policy and Quality Analysis: ISO 22000/HACCP/ BRC/IFS*

Unit 7: Marketing and finance

***Learning Objective*:**

- *To acquaint and instils knowledge of the fundamentals of marketing and finance required for entrepreneurship in fishery related enterprises and co-operatives*

Desired outcome:

- *Learner shall acquire knowledge about traditional marketing practices and role of co-operatives in selling fish*
- *Learner shall be exposed to the avenues and procedure for raising funds forFishery related entrepreneurial practices*

7.1 : Traditional marketing vis-a-vis role of fishery co-operatives with reference to operations at Satpati, Sasoon dock and Karanja

7.2 *: Global marketing and Export-Import procedures and role of Marine ProductsExports Development Authority (MPEDA)*

7.3 : i) Fund raising:

- Financial institutions
- Schemes and subsidies
- Basic accounting
- Costing and feasibility report

: ii) Role of NABARD (National Bank for Agriculture and Rural Development) for refinancing and NFDB (National Fishery Development Board, Hyderabad) for funding through the State Government

Unit 8: Case Study and Simulation

Case Study and Simulation is one of the eight units and hence may or may not be opted by the college. If opted, teachers in consultation with the students shall select the case studies for this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/ Institutes have to select the topics as per their needs and available resources. It is pertinent to note that the case studies and simulations shall be operational and availablein the syllabus only till it comes under the scope of internal assessment.

Learning Objective:

- *To inculcate entrepreneurial abilities and skills so as to make the learner confident and prepare them to raise new projects and venture in the realm of fishery biology*
- *To understand the concepts and to develop the acumen of the learner in a better way*
- *To assess varying dimensions while taking decisions in fishery biology*

Desired outcome:

- *Learner will gain technical and financial knowledge in fishery biology business ventures*
- *Learner will develop better acumen so as to take wise and necessary decisions while participating in fishery biology related projects*

(Any eight from suggested below or more, developed by teacher)

a) Sawantwadi New Fish Market developed through NFDB funding
b) Trilok foods, an RTE industry established as PPP through DST funding
c) Sewage-fed fishery; Kolkata model
d) Pancham Aquaculture
e) Naik Oceanic
f) Aquaponics, Hydroponics
g) Mahseer Ranching at Dehu
h) Integrated fish farm goatery, piggery, poultry, dairy, etc.
i) Juchandra Village

Semester V Practical

Course code: USC5ZOP3

Skill Enhancement Course 1

1) Identification and functioning of oceanographic instruments:

- Niskin water sampler
- Peterson's Grab
- Dredge

2) Identification of various stages of development of carps and study of sexual dimorphism in adults.

Indian major carps:

- *Labeo rohita* (Rohu)
- *Catla catla* (Catla)
- *Cirrhinus mrigala* (Mrigal)

Exotic carps:

- *Cyprinus carpio* (Common Carp)
- *Hypophthalmichthys molitrix* (Silver Carp)
- *Ctenopharyngodon idella* (Grass Carp)

3) a) Identification of *Litopenaeus vannamei* (Pacific white shrimp) and *Macrobrachium rosenbergii* (Freshwater prawn

b) Study of sexual dimorphism in adults

4) Identification of fishes:

- *Anabas testudineus* (Climbing perch)
- *Clarius batrachus* (Walking catfish)
- *Boleophthalmus spp.* (Mudskipper)
- *Pangasianodon hypophthalmus* (Iridescent shark)
- *Pangasius bocourti* (Basa catfish)
- *Tilapia* (GIFT)

5) Identification of:

A) Ornamental fishes:

- *Pterophyllum spp.* (Angel)

- *Xiphophorus hellerii* (Swordtail)
- *Paracheirodon innesi* (Neon tetra)
- *Betta splendens* (Siamese fighter)
- *Danio spp.* (Danio)
- *Symphysodon spp.* (Discus)
- Flower Horn (Hybrid variety)

B) Aquatic plants:

- Ludwigia
- Cabomba
- Corkscrew *Vallisneria*
- Aquarose
- Amazon Sword plant

C) Aquarium accessories:

- Aerator
- Under Gravel Filter
- Internal Filter
- External / Canister Filter
- Food dispensers

6) Study of models and functioning of D 81 hatchery, Shirgur's hatcheries and Chinese hatchery.

7) Organoleptic tests for fish and prawn / shrimp

8) Total Plate Count (TPC) of bacteria from fish

9) Identification of packaging materials:

- Waxed duplex carton
- Master carton
- Simple cans
- Coated [Lacquered] cans
- Polyolefin

- Retort

10) Estimation of toxins and moulting retardant

- H_2S (qualitative)
- Ammonia (qualitative)
- Ca (quantitative)
- Mg (quantitative)

11) Photographic documentation of fishery biology related topics.
Submission of 5 hard and soft copies of 5 original photographs taken by the learner(exit details required)

12) Assignment (may be submitted in a group not exceeding three students)

Please refer the Annexure I for the suggested topics for assignment for Course code USACFBIO5P1.

**Note – The practicals may be conducted by using specimens authorized by the wild life and such other regulating authorities though it is strongly recommended that thesame should be taught by using photographs/audio-visual aids/simulations/ modelsetc. as recommended by the UGC and as envisaged in the regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.*

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee appointed by a Competent Authority / Body from time to time, every college should constitute the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and

2) A Dissection Monitoring Committee (DMC) to ensure that no dissections or mountings are done using animals.

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener / Chairperson)

ii) Two Senior Faculty Members of the concerned Department

iii) One Faculty of related department from the same College

iv) One or two members of related department from neighbouring colleges.

USE OF ANIMALS FOR ANY EXPERIMENT /DISSECTION /MOUNTING IS BANNED. SIMULATIONS, AUTHORIZED PERMANENT SPECIMENS/SLIDES, CHARTS, MODELS AND OTHER INNOVATIVE METHODS ARE ENCOURAGED.

Semester VI: Theory

Course code: USC6ZO5

Skill Enhancing Course 2

Marine resources, Post-harvest and Farm Engineering

Lectures 60

(Any four units to be opted)

Credits 2

Unit 1: Marine Fin-fish of India

***Learning Objective*:**

- *To study coastal and deep-sea fishes*
- *To study commercial potential and major landing centres*

Desired *outcome:*

- *Learner shall understand deep sea and coastal fishes.*
- *Learner shall understand commercial potential and know about the major landing centres of the fishes*

1.1 *: Coastal fisheries:*

i) *Pampus argenticus* (Silver pomfret)

ii) *Parastromateus niger* (Black pomfret)

iii) *Eleutheronema tetradactylum* (Threadfin)

iv) *Protonibea diacanthus* (Two-spined Jewfish or Ghol)

v) *Nemipterus japonicus* (Blackmouth splitfin)

vi) *Rastrelliger kanagurta* (Mackerel)

vii) *Scomber guttatus* (Seerfish or Surmai)

viii) *Sardinellal ongiceps* (Indian Oil Sardine)

1.2 *: Deep sea fisheries (more than 45 fathoms) of Indian exclusive economic zone*

- *Thunnus alalunga* (Longfin tuna)
- *Sarda orientalis* (Striped bonito)

1.3 *: Commercial potential and major landing centers of the above fishes*

Unit 2: Marine shell fish of India

***Learning Objective*:**

- *To develop an in-depth understanding of crustacean and molluscan fisheries*

Desired outcome:

- *Learner shall understand crustacean and molluscan fisheries*
- *Learner shall understand the performance of landing centers of above fisheries*

2.1 *: Crustacean fisheries*

i) *Penaeus monodon* (Giant tiger prawn)

ii) *Fenneropenaeus indicus* (Indian prawn)

iii) *Metapenaeus affinis* (Jinga shrimp)

iv) *Parapenaeopsis stylifera* (Kiddi shrimp)

v) *Acetes indicus* (Jawala paste shrimp)

vi) *Panulirus polyphagus* (Mud spiny lobster)

vii) *Scylla serrata* (Giant mud crab)

2.2 *: Molluscan fisheries*

i) *Crassostrea spp.* (Oyster)

ii) *Sepia pharaonis* (Pharaoh cuttlefish)

iii) *Loligo duvaucelii* (Indian squid)

2.3 *: Commercial potential and major landing centers of the above shell fishes*

Unit 3: Nutrition

***Learning Objective*:**

- *To study, acquaint and discover the growing market for fish nutrition*

Desired outcome:

- *Learner will get acquainted with basics of nutritional requirements at various developmental stages of fish and crustaceans*

3.1 : Nutritional requirements at various stages of development of fish and crustaceans

3.2 : Culture of natural feed:

i) *Chaetoceros*

ii) *Infusoria*

iii) *Artemia*

iv) *Brachionus*

v) *Daphnia / Moina spp.*

3.3 Algology – Identification and culture of commercially important nutritious algae andits products

3.4 Formulated / Pelleted feed – Understanding the composition and use of formulated

feed for fish and prawns / shrimps at various stages

Unit 4: Diseases

***Learning Objective*:**

- *To acquire knowledge of the various aspects of diseases affecting fishes*

Desired *outcome:*

- *Learner will be oriented towards understanding causes, pathogenicity, prophylaxis and preventive measures of various fish diseases and physiological disorders*

4.1 Viral diseases, prophylaxis and preventive measures

4.2 Bacterial, fungal, protozoan infections and treatment

4.3 Crustacean infections and treatment

4.4 Physiological disorders (Dropsy) / diseases and treatment

Unit 5: Preservation and Processing

***Learning Objective*:**

- *To derive knowledge about various fish preservation and processing methods*

Desired *outcome:*

- *Learners will acquire the knowledge and would put in to practice the preservation and processing techniques for commercial ventures*

5.1 Traditional methods and their modifications:

i) Icing

ii) Drying

iii) Salting

5.2 i) Introduction to refrigeration: Types and properties of refrigerants

i) Types of freezers:

a. Brine
b. Air blast
c. Tunnel
d. Contact plate
e. Cryo-quick
f. IQF: Individual Quick Freezing

ii) Freezing Procedures:

a. PUD (Peeled and Un-deveined)
b. DV (Deveined)

5.3 Principle and steps involved in can reform and canning of fish and shrimp in various

media.

5.4 Equipment and utensils used in seafood processing

Unit 6: By-products and Value-Added Products

***Learning Objective*:**

- *To acquire knowledge of fish by-products, value-added products and good manufacturing practices*

Desired *outcome:*

- *Learner will gain sound knowledge about the fish by-products and value-added products*
- *Learner will explore good manufacturing practices while manufacturing these products*

6.1 Proximate composition of fish meat and products

6.2 Introduction to by-products

i) Fish protein concentrate

ii) Fish maws / Isinglass

iii) Fish hydrolysates

iv) Chitin, Chitosan

v) Glucosamine hydrochloride

vi) Gelatin

vii) Fish silage

viii) Surimi and imitation products

ix) Pearl essence

6.3 Different types of value-added products from fish and shell fish

i) Fish / Prawn / Shrimp pickle

ii) Fish wafers

iii) *Acetes indicus* (Prawn) chutney

iv) Fish soup powder

v) Fish / Crab steaks

vi) RTE (Ready To Eat)

vii) Battered and breaded products

viii) Marinated tandoori prawns

ix) Prawn curry

6.4 Good manufacturing practices: Health and training of personnel, hygiene

Unit 7: Farm engineering

***Learning Objective*:**

- *To acquire knowledge about farm engineering and novel fish culture practices*

Desired *outcome:*

- *Learner will understand the selection process of hatchery sites and various types of designs and construction of aquaculture farm practices*
- *Learners will comprehend the uses of equipment and accessories involved in aquaculture farms*

7.1 Site selection, designing and construction of hatchery and farms for extensive, semi-intensive and intensive freshwater / brackish-water aquaculture

7.2 i) Raft culture

ii) Rope culture

iii) Pen culture

iv) Cage culture with special reference to *Rachycentron canadum* (Cobia)

7.3 Equipment and accessories used in various aqua farms

Unit 8: Open Unit

Open unit is one of the eight units which may or may not be opted by the college. Teachers in consultation with the students shall define syllabus under this unit every year, if required, and shall seek endorsement of the Head and the Principal.

Colleges/institutes have to select the topics as per their needs and available resources. It is pertinent to note that the open unit shall be operational and available in the syllabusonly till it comes under the scope of internal assessment.

Learning Objective:

- *To teach any one of the units prescribed in the syllabus with more details and in-depth knowledge leading to specialization in the capsule of units selected.*
- *To incorporate the topics of special need of the area which are otherwise not covered in the syllabus.*
- *To give scope to creativity and wisdom of a teacher who wants to deal with the latest developments in the subject without waiting for the university to revise the Syllabus.*

Semester VI Practicals Course code: USC6ZOP3

Skill Enhancing Course 2

1) Identification of marine fishes.

- *Pampus argenticus (Silver pomfret)*
- *Parastromateus niger (Black pomfret)*
- *Eleutheronema tetradactylum (Threadfin)*
- *Protonibea diacanthus (Two-spined Jewfish or Ghol)*
- *Nemipterus japonicus (Blackmouth splitfin)*
- *Rastrelliger kanagurta (Mackerel)*
- *Scomber guttatus (Seerfish or Surmai)*
- *Sardinella longiceps (Indian Oil Sardine)*
- *Thunnus alalunga* (Longfin tuna)

2) Identification of Crustaceans and Molluscs.

- *Penaeus monodon* (Giant Tiger Prawn)
- *Fenneropenaeus indicus* (Indian prawn)
- *Metapenaeus affinis* (Jinga shrimp)
- *Parapenaeopsis stylifera* (Kiddi shrimp)
- *Acetes indicus* (Jawala paste shrimp)
- *Panulirus polyphagus* (Mud spiny lobster)
- *Scylla serrata* (Giant mud crab)
- *Crassostrea spp.* (Oyster)
- *Sepia pharaonis* (Pharaoh cuttlefish)
- *Loligo duvaucelii* (Indian squid)
-

3) Preparation of formulated feed for fish and prawn.

4) Identification of parasitic infections in aquatic organisms.

- Fungal – Dermatomycosis
- Bacterial – Fin/Tail rot and Dropsy
- Protozoan – Costiasisand White Spot
- Crustacean – Argulosis

5) Fish dressing, filleting, prawn peeling – PUD, DV and grading.

6) Fish morphometry – Length weight relationship of a suitable fish.

7) Preparation of Surimi, Fish protein concentrate.

8) Preparations of fish burger, fish fingers, fish/prawn pickle, fish chutney, fish curry.

9) Preparation of Chitin – Chitosan, Pearl essence.

10) Identification of various farm equipment such as:

- Feeding cups / Trays
- Paddle wheel aerator
- Fountains
- Sluice gate models
- Elbow pipe outlets

11) Study of models of raft, pen, cage culture and materials used in rope culture.

12) Project – Feasibility / Scientific.

13) Field Visit Report.

Please refer the Annexure II for the suggested field visits and Annexure – III for suggested topics for projects for Course code USACFBIO6P1.

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References and Additional Reading

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25. Prawn and Prawn Fisheries by Kurian and Sebestian.
26. Project Management by Prasanna Chandra.
27. Refrigeration and air conditioning By C. P. Arora published in 1981.
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29. Text Book of Fish Biology and Indian Fisheries by Dr. R. P. Parihar, Central Pub.House, Allahabad.
30. The Book of Indian Shells by Deepak Apte – Oxford Uni. Press.
31. Wealth of India – Vol. IV – CSIR Pub.

For Additional and Latest Information on the topics, various Web Sites can be visited.