

M. Sc. ZOOLOGY – Syllabus

Syllabus as Per the Choice Based Credit System (CBCS)

&

Learning Outcomes-based Curriculum Framework (LOCF)

(Curriculum Effective from the academic year 2023- 2024)



Submitted by

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DEPARTMENT OF ANIMAL SCIENCE

Manonmaniam Sundaranar University,

Tirunelveli

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1. VISION AND MISSION OF UNIVERSITY:

Vision

- " To provide quality education to reach the un-reached "

Mission

- To conduct research, teaching and outreach programmes to improve conditions of human living
- To create an academic environment that honours women and men of all races, caste, creed, cultures and an atmosphere that values intellectual curiosity, pursuit of knowledge, academic freedom and integrity
- To offer a wide variety of off-campus educational and training programs, including the use of information technology, to individuals and groups.
- To develop partnership with industries and government so as to improve the quality of the workplace and to serve as catalyst for economic and cultural development
- To provide quality / inclusive education, especially for the rural and un-reached segments of economically downtrodden students including women, socially oppressed and differently abled

2. VISION AND MISSION OF DEPARTMENT

Vision

- To attain Academic Excellence in Animal Science and Manpower Development

Mission

- To provide quality education and research in the area of Animal Science
- Generating Research Grant & Establishing high end research facilities.
- Understanding the impact of Global warming on distribution, diversity and metabolic process of animals
- Enhancing the animal health through novel eco-friendly bio-molecules from renewable and bio-waste resources.
- Assessing Genetic variations and Barcoding of Animals

3. PREAMBLE

It is now evident that animals are abundantly distributed in diversified environments. On diversity aspect also animals are numerous, and so many aspects of animal life have been uncovered. More than 99 percent of all species, amounting to over five billion species, that have evolved on Earth are estimated to be extinct. Estimates on the number of Earth's current species range from 10 million to 14 million of which about 1.2 million have been documented over 86 percent have not yet been described. Scientists have reported that animals occupied 63% of the life in this planet. One trillion species are estimated to be on Earth of which only one-thousandth of one percent described.

Study of Zoology is the basic for understanding of the fauna of the world. Zoology is the branch of biology that includes the study of animals and animal life, including the taxonomy and diversity of animals, evolutionary significance, functional morphology, their physiology, reproduction, genetical hereditary lineages and their curative measure.

Zoology has diversified into a countless of allied sciences including cell and molecular biology, microbiology, biochemistry and immunology. Zoological Knowledge and theories are applicable to maintain health and diversity of animal and also to control the epidemic diseases. Various types of living organisms are closely associated in a particular environment and interaction of prey-predator relationship, food chain in the biodiversity. Various by-products of animals such as coral, pearl, honey, wax, silk, lac, shell of turtle, bones, feather, tusk, leather and fur are of high demand. These products can be increased from our knowledge. The improvement of farm/domestic animals is one of the major tasks of zoologists. Application of zoological science in fisheries, cattle, poultry farming and pests management in agriculture and stored food grains are well known. It is the study of economic zoology for the higher production of food crops and fisheries to meet the challenge of protein rich food materials at the reasonable cost. An education in Zoology enables one to start a career working in any of the broad levels of life, from working on the cellular level, to working on a specific species or individual animal, or all the way up to working on total ecosystems or the whole biosphere.

Scope for Zoologist

The Service of the trained zoologist is the need of the hour because of the development of advanced technologies in uncountless areas. Due to global warming and climate change and also due to pollution, environment is getting deteriorate day by day. Both national and State pollution control board required the service of Zoologist for the proper assessment of environmental damage (EIA study) and also to propose strategies for environment management and systematic documentation. Zoologists are also hired in various National and International agencies involved in zoological survey and conservation like WWF, IUCN, ZSI, WII, NBA, MoEF. Zoologists do have scope in Zoo keeping, Zoo Curation, Wildlife services, Botanical gardens, National parks, nature reserves, universities, laboratories, aquariums, animal clinics, fisheries and aquaculture, museums, research, pharmaceutical Companies, veterinary hospitals and Food Corporation of India (FCI) etc. Zoologist are also engaged as Animal Behaviorists, Animal breeders, Animal Trainers, Animal Caretakers, Animal and Wildlife Educators, Conservationists, Documentary Maker, Forensic Experts, Lab Technicians, Researcher, Wildlife Biologists, Veterinarian, and many more. Thus the scope of applied Zoology is innumerable. Zoologist can also work in Zoological Teaching and Research, Medicine, Dentistry, Veterinary Medicine, Medical Technology, Nursing, Museum Work, Environmental Science and Conservation. Further, channels like National Geographic, Animal Planet, Discovery Channel is in constant need of Zoologists for research and documentaries.

Eligibility for Admission:

Those who have passed and secured ≥ 50 percentage marks in the following courses *viz.*, B.Sc. Zoology, B. Sc. Advanced Zoology, B.Sc. Applied Zoology, B.Sc. Animal Science and Biotechnology, B.Sc. Advanced Zoology and Biotechnology, B.Sc. Life Science and B.Sc. Biology (Hons.) from recognized University are eligible to apply.

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF)
Guideline Based Credits and Hours Distribution System
For all Post – Graduate Courses including Lab Hours
First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
I	Core-I :Structure and Function of Invertebrates	5	5
	Core-II : Comparative Anatomy of Vertebrates	5	5
	Core – III : Lab courses on Invertebrates and Vertebrates	2	3
	Core – IV : Lab courses on Biochemistry and Biostatistics	2	6
	Elective –I Discipline Centric : Biochemistry	3	6
	Elective-II : Generic: Biostatistics	3	5
		20	30

Semester-II

Part	List of Courses	Credits	No. of Hours
II	Core-V : Cell and Molecular Biology	5	5
	Core-VI : Developmental Biology	5	5
	Core–VII: Lab courses on Cell and Molecular Biology & Developmental Biology	2	6
	Elective-III: Discipline Centric: a)Economic Entomology (b)Poultry farming (c)Dairy farming	3	3
	Elective -IV Generic: Research Methodology	3	5
	Skill Enhancement Course (SEC-1) : MOOCS	2	3
	Internship/ Industrial Activity	2	-
		22	27

Second Year – Semester – III

Part	List of Courses	Credits	No. of Hours
III	Core-VIII: Genetics	5	5
	Core-IX : Evolution	5	5
	Core – X: Animal Physiology	5	5
	Core –X I (Industry Module): Medical lab technology	3	3
	Core XII: lab courses on Genetics, Evolution and Animal Physiology	3	6
	Elective –V:Discipline Centric : a)Apiculture (b) Sericulture (c) Vermiculture	3	3
	Skill Enhancement (SEC-II): MOOCS	2	3
		26	30

Semester-IV

Part	List of Courses	Credits	No. of Hours
IV	Core-XIII: Immunology	5	5
	Core –IV: Ecology	5	5
	Project with viva voce	7	12
	Elective-VI:(Industry/Entrepreneurship)20% Theory 80% Practical): a)Aquaculture (b)Fish processing Technology (c)Mushroom Processing: Value Added products	3	4
	Skill Enhancement course (SEC-III): a) Animal Behaviour (b)Animal Cell Biotechnology (c)Stem Cell Biology	2	4
	Extension Activity	1	-
	Total 91 Credits for PG Courses	23	30

5. EVALUATION SCHEME

Practical Examination:

M.Sc. Zoology Core Practical Examination having the following marks:

Internal – 50

Major Practical	=	20 marks
Minor Practical	=	10 marks
Spotters (ABC&D) 4 x 5	=	20 marks

Total = **50 marks**

External – 50

Major Practical	=	15 marks
Minor Practical	=	10 marks
Spotters (ABC&D) 4x5	=	20 marks
Record & Viva-voce	=	5 marks

Total = **50 marks**

Theory Examination:

The M.Sc. Zoology core and Elective theory Examination having the following marks.

Internal Marks – 25

Test	=	15 marks
Assignment	=	5 marks
Seminar	=	5 marks

Total = **25 marks**

External Marks – 75

Section A: 10x 1 (Q.No. 1 to 10)	=	10 marks
Section B: 5 x 5 (Q.No. 11 to 15)	=	25 marks
Section C: 5 x 8 (Q.No. 16 to 20)	=	40 marks

Total = **75 marks**

Evaluation of performance of students is based on ten-point scale grading system as given below

S.No	PERCENTAGE OF MARKS	LETTER GRADE	GRADE POINT	PERFORMANCE
1	90-100	O+	10	Outstanding
2	80-89	O	9	Excellent
3	70-79	A+	8	Very Good
4	60-69	A	7	Good
5	55-59	B+	6	Above average
6	50-54	B	5	Pass
7	0-49	RA	-	Reappear
8	0	AA	-	Absent

$$\text{Cumulative Grade Point Average} = \frac{\Sigma(C \times GP)}{\Sigma C}$$

CGPA for a semester is awarded on cumulative basis by including all the courses upto that semester provided the candidate has passed all he courses

MANONMANIAM SUNDARANAR UNIVERSITY, TIRUNELVELI
DEPARTMENT OF ANIMAL SCIENCE
M.SC DEGREE EXAMINATIONS-APRIL 2023

Time: 3 hours

II Semester

Max.marks: 75

PART-A

Answer ALL the questions. Each question carries equal marks. 10 X 1= 10 Marks

- 1 “Ontogeny repeats Phylogeny” proposed by
a) Muller b)Swammerdon c)Haeckal d)Aristotle K1 CO1
- 2 Find out the odd one
b)Biogenetic law- Swammerdon b) Organizer effect- Hans Speeman K1 CO1
c)Mosaic theory- William Roux d)Germplasm theory-August weismann
- 3 In cell differentiation, the Heart developed from the following layer
a)Ectoderm b)Endoderm c)Mesoderm d)Both B & C K2 CO2
- 4 In epiboly movement, Anterio-Posterior extension of blastomeres is seen in
a)Chick & Lizard b)Reptiles & Birds c)Echinoderm & Teleost d) Both B & C K2 CO2
- 5 An animals lay hard shelled eggs are referred as
a) Oviparous b)Ovo-viparous c)Viviparous d) None of them K2 CO3
- 6 The cleavage furrow passes through animal-vegetalaxis of the ovum
a) Equatorial Plane b)Meroplasticplanec)Vertical Planed) Horizontal Plane K3 CO3
- 7 The hormone inducing cell death during metamorphosis of amphibians
a) T3 & T4 b) T3 c) T2 d)Both B & C K2 CO2
- 8 Holometabolous type of development is seen in
a)Dragon fly b)Butterfly c)Silver fish d) Grasshopper K2 CO2
- 9 Technique for handling of gamete/embryo outside the body to achieve a pregnancy is called
a)IVF b)GIFT c) ICSI d)ART K2 CO2
- 10 Planaria exhibit the following type of asexual reproduction
a)Regeneration b)Budding c) Fragmentation d) All the above K2 CO2

PART-B

Answer any FIVE questions, Choosing either (a) or b).5 X 5= 25 Marks

- | | | | |
|----|--|----|-----|
| 11 | a)What is induction? Explain the theory of organizer effect in amphibian.(or)
a) Explain the contribution of Aristotle in the area of embryology. | K1 | CO1 |
| 12 | a) Explain the spermatogenesis process. (or)
b) write about the process of oogenesis. | K2 | CO2 |
| 13 | a) Clarify the sperm specific attraction of sperm in Sea urchin.(or)
b) Explain the process of vitallogenesis. | K3 | CO3 |
| 14 | a)Briefly explain the hormonal control of insect metamorphosis.(or)
b) Explain the axis and pattern formation in Drosophila. | K3 | CO3 |
| 15 | a) Asexual reproduction in animals.
b) Explain the sex determination mechanism. | K3 | CO3 |

PART-C

Answer any FIVE question, either (a) or (b).

5 X 8 = 40 Marks

- | | | | |
|----|--|----|-----|
| 16 | a) Discuss the contribution of scientist in the development of Embryology. (or)
b)Give an account in the cell division process. | K1 | CO1 |
| 17 | a) Explain in details about the gametogenesis. (or)
b) Illustrate the synthesis and storage of maternal transcripts. | K2 | CO2 |
| 18 | a) Enumerate the Species specific sperm attraction in mammals. (or)
b) Give an account on the process of Blastulation. | K3 | CO3 |
| 19 | a) Give detailed account on the cell proliferation process. (or)
b) Describe the hormonal control of amphibian metamorphosis. | K3 | CO3 |
| 20 | a) Explain in detail about cryopreservation technique. (or)
b)Explain the sperm abnormalities . | K3 | CO3 |

7. PROGRAMME OUTCOME (POS)

The programme aims to

1. Develop an individual from rural, unreached socio-economically downtrodden society with academic integrity, values and ethics.
2. Impart high level of education and understand the multidisciplinary, innovative, contemporary knowledge and will be able to do independent and applied research to be competent at national and international level.
3. Motivate and develop a passion for lifelong learning with capability in technique and analytical methods in the core and applied research.
4. Impart skill based, value added, employable, entrepreneurial, research oriented programmes to be self reliant.
5. Offer a milieu for basic and advanced research to develop research outputs that are transferrable technologies, patents and publications.
6. Offer courses and impart hands on scientific training for designing and execution of experiments to acquire higher education, research skills and employability in the reputed regional, national and international institutions

8. PROGRAMME SPECIFIC OUTCOMES (PSO)

After the successful completion of M.Sc. Zoology programme, the students will be able to

PSO1	Identify the diversity of organisms, differentiate them phylogenetically, morphologically and understand their habit and habitat, evolutionary significance, and their economic importance
PSO2	Understand the cellular and molecular mechanisms of organisms, know the microbial interactions and biochemical modifications in various organisms.
PSO3	Understand the cell differentiation, genetic inheritance, developmental process of an organism, and know the modern techniques viz. rDNA, Tissue engineering and the Artificial Reproductive Technology process.
PSO4	Learn the basics of the animal physiology, know the immune cells and immune organs, process of innate and acquired defence mechanisms and their role in allergy and organ transplantation.
PSO5	Design the experiments, know the methods of data collection and execute the experiments with modern instruments and interpret the data with recent statistical tools.
PSO6	Acquire knowledge on computational biological tools, know the biological database and sequence analysis methods, able to do molecular modelling and pharmacophore generation.
PSO7	Understand the structure and functional properties of manmade ecosystems, impact of climate change and global warming on living organisms, and conservation of natural resources, able to do EIA analysis.
PSO8	Acquire skill based aquaculture techniques, value added post harvest storage methods of fishery biology, employable animal husbandry techniques, and entrepreneurial apiculture and sericulture methods. Economic importance of animal species.

Course Objectives:		
The main objectives of this course are:		
1.	To understand the concept of classification and their characteristic features of major group of invertebrates.	
2.	To realize the range of diversification of invertebrate animals.	
3.	To enable to find out the ancestors or derivatives of any taxon.	
4.	To know the functional morphology of system biology of invertebrates.	
Course I	:	Core I
Course title	:	Structure and Function of Invertebrates
Credits	:	5
Pre-requisite:		
Students should know the taxonomical classification of invertebrate animals in relation to their functional morphology.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to:		
1.	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	K1 & K2
2.	Understand the evolutionary process. All are linked in a sequence of life patterns.	K2 & K4
3.	Apply this for pre-professional work in agriculture and conservation of life forms.	K3 & K5
4.	Analyze what lies beyond our present knowledge of life process.	K4 & K6
5.	Evaluate and to create the perfect phylogenetic relationship in classification.	K5 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Units	
I	Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy
II	Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic

	movement in Coelenterata, Annelida and Echinodermata
III	Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration
IV	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda); Trends in neural evolution
V	Invertebrate larvae: Larval forms of free living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters
Reading list	
1. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.	
Recommended texts	
1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024. 2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi. 3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.	

Mapping with Programme Outcomes*										
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	S	M	S	S	S
CO2	S	S	M	M	S	S	M	M	S	S
CO3	S	M	S	M	S	S	M	M	S	S
CO4	S	M	S	M	S	S	M	M	S	M
CO5	S	M	S	M	S	S	M	M	S	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.	
2.	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.	
3.	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals	
4.	Imparting conceptual knowledge about the animal life in the air and their behaviours.	
5.	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.	
Course I	:	Core II
Course title	:	Comparative Anatomy of Vertebrates
Credits	:	5
Pre-requisite:		
Students with knowledge and comprehension on zoology.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to:		
1.	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	K1 & K2
2.	Understand the evolutionary process. All are linked in a sequence of life patterns.	K2 & K4
3.	Apply this for pre-professional work in agriculture and conservation of life forms.	K3 & K5
4.	Analyze what lies beyond our present knowledge of life process.	K4 & K6
5.	Evaluate and to create the perfect phylogenetic relationship in classification.	K5 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	
I	Origin of vertebrates: Concept of Protochordata; The nature of vertebratemorphology; Definition, scope and relation to other disciplines; Importance of the study of vertebratemorphology.
II	Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structureandfunctionsofskinanditsderivatives; Glands, scales, horns, claws, nails, hoofs, feathers andhairs.
III	General plan of circulation in variousgroups; Blood; Evolution ofheart; Evolution of aortic arches and portalsystems. Respiratorysystem: Characters of respiratorytissue; Internal and external respiration; Comparative account of respiratoryorgans
IV	Skeletalsystem: Form, function, body size and skeletal elements of thebody; Comparative account of jawsuspensorium, Vertebral column; Limbs andgirdles; Evolution of Urinogenital system in vertebrateseries.
V	Senseorgans: Simplereceptors; Organs of Olfaction andtaste; Lateral linesystem; Electroreception. Nervous system: Comparative anatomy of the brain in relation to itsfunctions; Comparative anatomy of spinalcord; Nerves-Cranial, Peripheral and Autonomous nervoussystem.
Reading list	
1. Swayam Prabha https://www.swayamprabha.gov.in/index.php/program/archive/9	
2. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.	
3. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.	
Recommended texts	
1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.	
2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.	
3. Ekambaranatha Ayyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.	
4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.	

Mapping with Programme Outcomes*										
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	S	M	S	M	S	M	S
CO2	S	L	L	S	M	S	M	M	M	M
CO3	S	M	L	S	M	S	M	L	M	M
CO4	S	L	L	S	L	S	M	L	M	L
CO5	S	M	L	S	S	S	M	S	M	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Understanding the different systems in invertebrates & vertebrates.	
2.	Learning about various animal species, their phylogenetic affinities and their adaptive features	
3.	Imparting conceptual knowledge about the salient features and functional anatomy.	
4.	Developing the skill in mounting techniques of the biological samples.	
5.	Gaining fundamental knowledge on the skeletal system	
Course I	:	Core III
Course title	:	Lab Course on Invertebrates & Vertebrates
Credits	:	2
Pre-requisite:		
Basic knowledge on the animals living in different habitats		
Expected Course Outcome:		
On the successful completion of the course, student will be able to:		
1.	Understand the structure and functions of various systems in animals	K2 & K4
2.	Learn the adaptive features of different groups of animals	K1 & K2
3.	Learn the mounting techniques	K2 & K3
4.	Acquire strong knowledge on the animal skeletal system	K2 & K4

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

INVERTEBRATES

Dissection

- Earthworm : Nervous system
- Pila* : Digestive and nervous systems
- Sepia* : Nervous system
- Cockroach : Nervous system
- Grasshopper : Digestive system and mouth parts
- Prawn : Appendages, nervous and digestive systems

Crab : Nervous system

Study of the following slides with special reference to their salient features and their modes of life

1. *Amoeba*
2. *Entamoeba histolytica*
3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria* larva
7. *Tape worm (Scolex)*
8. *Ascaris* T. S.
9. Mysis of prawn

Spotters

1. Scorpion
2. *Penaeus indicus*
3. *Emerita (Hippa)*
4. *Perna viridis*

Mounting

- Earthworm : Bodysetae
Pila : Radula
Cockroach : Mouth parts
Grasshopper : Mouth parts

CHORDATES

Study the nervous system of Indian dog shark - Dissection

1. Nervous system of *Scoliodon laticaudatus* – 5th or Trigeminal nerve
2. Nervous system of *Scoliodon laticaudatus* – 7th or Facial nerve
3. Nervous system of *Scoliodon laticaudatus* – 9th and 10th
or Glossopharyngeal & Vagus nerve

Study of the following specimens with special reference to their salient features and their modes of life

1. *Amphioxus* sp. (Lancelet)
2. *Ascidia* sp. (sea squirt)

3. *Scoliodon laticaudatus* (Indian dog shark)
4. *Trygon* sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus* (Cat fish)
7. *Belone cancila* (Flute fish)
8. *Exocoetus poecilopterus* (Flying fish)
9. *Mugil cephalus* (Mullet)
10. *Tilapia mossambicus* (Tilapia)
11. *Rachycentron canadum* (Cobia)
12. *Tetrodon punctatus* (Puffer fish)
13. *Dendrophis* sp. (Tree snake)

Study of the different types of scales in fishes

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

Study of the frog skeleton system (Representative samples)

1. Entire skeleton
2. Skull
3. Hyoid apparatus
4. Pectoral girdle and sternum
5. Pelvic girdle
6. Fore limb
7. Hind limb

Mounting

1. Weberian ossicles of fish

Text Books:

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

Reference Books:

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjee, P. Chattopadhyaya. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

Mapping with Programme Outcomes*										
Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	M	S	M	S
CO2	S	M	L	S	M	S	M	M	M	M
CO3	M	M	L	S	L	S	M	L	M	M
CO4	S	S	L	S	L	S	M	L	M	L
CO5	S	S	M	L	M	S	M	S	M	M

*S-Strong; M-Medium; L-Low

ELECTIVE-I (DISCIPLINE GENERIC): BIOCHEMISTRY

Semester	I
Course Type	ELECTIVE-I (DISCIPLINE GENTRIC):
Title of the Course	BIOCHEMISTRY
Course Code	
Teaching Hours	72 Hours/ Semester : 4 Hours/ week

	BIOCHEMISTRY	Credits: 3	Max. Marks: 100
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Course Prerequisites:

The student should have basic knowledge on principles, concepts of biochemistry and structure of biomolecules.

CODE: NZOC21	BIOCHEMISTRY	L	T	P	C
		4	-	-	4
Course Objectives	<ul style="list-style-type: none"> ➤ To explore the chemistry of living organisms and other molecular basis for the changes occurring in living cells. ➤ To understand the metabolism of biomolecules. ➤ To diagnose and manage disease through analysis of blood, urine and other body fluids. 				
Unit I	CARBOHYDRATE	14 hours			
Classification, structure, properties and functions – Metabolism of carbohydrate : Glycolysis – TCA cycle – Glycogenolysis – Glycogenesis – Gluconeogenesis – HMP shunt pathway – Oxidative Phosphorylation.					
Unit II	PROTEINS AND ENZYMES	15 hours			
Proteins : Structure – Classification and properties of amino acids – Structure of protein (Ramachandran plot, Primary, secondary, Tertiary, Quaternary, Domain, Motif & Folds) – Types of Bonds (Vanderwaals, electrostatic, hydrogen and hydrophilic bonds) – Biological significance – Enzymes : Types, classification and properties of enzymes – Enzyme kinetics - Enzyme inhibition – Mechanism of Enzyme catalysis – Isoenzymes - Coenzymes – Enzyme regulation – Inborn errors of metabolism.					
Unit III	LIPIDS	14 hours			
Classification – structure, properties and biological functions of lipid – Biosynthesis of fatty acids, Triglycerides, Triacylglycerol, cholesterol, Phospholipids, Ketogenesis – Long chain fatty acids – Beta oxidation of fatty acids.					
Unit IV	NUCLEIC ACIDS	14 hours			
Structure of nucleic acids – helix (A,B,Z), tRNA and microRNA – Synthesis and degradation of purine and pyrimidines (De novo and salvage pathways) – Vitamins: Classification, Structure and metabolism of vitamins.					

Unit V	HORMONES AND REGULATION	15 hours
Structure, classification, hormones and their receptors – Steroid hormone receptor, peptide hormone receptor, signalling through G-protein coupled receptors – Signal transduction pathway, cAMP, cGMP, phosphatidyl, inositol and calcium as secondary messenger – Hormonal regulation and signal transduction.		
Reference Books		
<ul style="list-style-type: none"> ➤ Frunton J.S. Simmonds, S. General, G. And Dol, R.H. 1987. Outlines of Biochemistry, John Wiley & Sons. ➤ Dubey, R.C. 1989. Biochemistry, MacMillan Publishing company. NY. ➤ Jain, J.L., Jain, S. and Jain, N., 2000. Fundamentals of Biochemistry, S. Chand & Company. ➤ RastoBiogi, S.C., 2003. Biochemistry (2nd Edition), Tata McGraw Hill Publishing Company Ltd. ➤ Voet, D. and Voet, J.G., 2004. Biochemistry, John Wiley & Sons, USA. ➤ David L. Nelson and Michael M. Cox., 2004. Lehninger Principles of Biochemistry, W.H. Freeman & Company, USA. ➤ Garrett, R.H. and Grisham, C.M., 2016. Biochemistry Cengage Learning Inc, USA. ➤ Satyanarayana, U. and Chakrapani, U., 2022. Biochemistry (6th Edition), Elsevier India. 		
Web Source:	<ul style="list-style-type: none"> ➤ https://bio.libretexts.org/Bookshelves/Biochemistry/Supplemental Modules (Biochemistry)/6. Lab Notes Part 2/6.2%3A Enzyme kinetics ➤ https://opentextbc.ca/biology/chapter/18-1-types-of-hormones/#:~:text=There%20are%20three%20basic%20types,such%20as%20estradiol%20and%20testosterone. ➤ https://en.wikipedia.org/wiki/Vitamin ➤ https://bio.libretexts.org/Bookshelves/Biochemistry/Book%3A_Biochemistry_Free_For_All_(Ahern_Rajagopal_and_Tan)/02%3A_Structure_and_Function/2.08%3A_Structure_and_Function_-_Lipids_and_Membranes 	

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to –	Cognitive Level
CO1	Understand the structure, function and metabolic pathways of carbohydrates	K1, K2
CO2	Learn the classification, structural organization of proteins, types of bonds involved in protein stabilization and to understand types of enzymes, mechanism of enzyme action, regulation and inhibition.	K2, K4, K5
CO3	Acquire knowledge on the basic lipid biochemistry and further to understand the properties, biological functions and important disorders of lipid metabolism.	K2
CO4	Know the structure of nucleic acids, various forms of DNA, RNA and understand the structure and metabolism of vitamins.	K1, K2
CO5	Learn about the structure of endocrine glands, different types of hormones, receptors and its role in signal transduction.	K1, K2,

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	H	M	L	L	L	L	L
CO2	L	H	L	H	M	H	L	L
CO3	L	H	L	L	L	L	L	L
CO4	H	L	M	L	L	M	L	L
CO5	L	M	H	M	L	L	L	L

(H-High, M-Medium, L-Low)

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Biostatistics.	
Course	:	Elective II : Generic
Course title	:	Biostatistics
Credits	:	3
Pre-requisite:		
Students should be aware of importance of analysis of quantitative and qualitative information from biological studies.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	Clear understanding of design and application of biostatistics relevant to experimental and population studies.	K2 & K3
II	Acquired skills to perform various statistical analyses using modern statistical techniques and software.	K3 & K4
III	Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis.	K5 & K6

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	INTRODUCTION TO BIOSTATISTICS: Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.
II	MEASURES OF CENTRAL TENDENCY: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.
III	PROBABILITY AND SAMPLING: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions, Sampling distribution – confidence interval – Errors – Levels of Significance – Chi-square test.
IV	HYPOTHESIS TESTING: Student ‘t’ test - paired sample and mean difference ‘t’ tests. Correlation: Types - Karl Pearson's Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.
V	ANALYSIS OF SOFTWARE TOOLS: Types of Anova (one way and two-way analysis of variance). Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS), ORIGINPRO.
Reading list	
<ol style="list-style-type: none"> 1. Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447. 2. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407. 3. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363. 4. Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264. 	
Recommended texts	
<ol style="list-style-type: none"> 1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48. 2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467. 3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859. 4. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660. 	

5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
6. Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp-443.
7. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
8. Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	S	S	M	S	M	M
CO2	S	S	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S	S	L
CO4	M	M	S	L	M	M	M	S	L	M
CO5	M	M	S	L	M	S	M	L	S	M

*S-Strong; M-Medium; L-Low

Semester	I
Course Type	Core-IV
Title of the Course	Lab Courses on Biochemistry and Biostatistics
Course Code	
Teaching Hours	72 Hours/ Semester : 3 Hours/ week

Core-IV	Lab Courses on Biochemistry and Biostatistics	Credits: 2	Max. Marks: 100
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Course Prerequisites:

The students should know the basics of biochemistry & knowledge on the cell structure and functions of various organisms.

CODE: NZOL21	BIOCHEMISTRY & CELL AND MOLECULAR BIOLOGY	L	T	P	C
		0	-	4	2
Course Objectives	<ul style="list-style-type: none"> ➤ To determine the biomolecules by qualitative and quantitative method. ➤ To separate compounds by chromatography and prepare buffers. ➤ To understand different types of cells and their structure 				

	<ul style="list-style-type: none"> ➤ To analyze the biochemical parameters of blood. ➤ To learn the karyotyping of organisms and understand the mitosis and meiosis process.
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List of Practical

BIOCHEMISTRY	-36 Hours
<ul style="list-style-type: none"> ➤ Preparation of Buffers: Phosphate and Citrate Buffer. ➤ Qualitative analysis of biomolecules (proteins, carbohydrates and lipids). ➤ Estimation of protein ➤ Estimation of lipids ➤ Estimation of carbohydrates ➤ Estimation of Glucose ➤ Estimation of Urea ➤ Estimation of Creatinine ➤ Determination of aminoacids in body fluids of cockroach using paper chromatography ➤ Determination of aminoacids through thin layer chromatography. 	
BIOSTATISTICS	- 36 Hours
<ul style="list-style-type: none"> ➤ Binomial distribution using two coins ➤ Binomial distribution using three coins ➤ Measurement of central tendency: mean , median and mode ➤ Test of significance: t-test, Chi-Square test ➤ Standard deviation and standard error of mean ➤ ANOVA; One way ANOVA and two way ANOVA ➤ Correlation Coefficient ➤ Rank Correlation Coefficient ➤ Regression Analysis; height and weight relationship of students and Length and weigh relation of fish. ➤ Structuring data for use in SPSS ➤ Different types of graph using ORIGIN software ➤ Presentation of data in the form of diagram Pie chart, Bar diagram, Histogram, Pictogram, Cartogram, Line graph, Scatter plot, Frequency curve, Polycon 	

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to –	CognitiveLevel
CO1	Analyze the biomolecules in the tissue and blood samples.	K4
CO2	Separate aminoacids and bioactive compounds using chromatography technique and to estimate glucose, urea and creatinine	K2, K4, K5
CO3	Enable to handle different types of microscope used in biological research, understand the functional differentiation of eukaryotic and prokaryotic cells.	K1, K2
CO4	Acquire knowledge on the structure of blood components and blood biochemical parameters such as blood counting,	K3

	grouping and ESR.	
CO5	Analyze the mechanism of mitosis, meiosis and enumerate the structure of polytene chromosome of chironomous larvae.	K4, K3

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	H	L	M	M	L	L	M
CO2	L	H	L	M	L	L	L	L
CO3	H	H	M	L	L	M	L	M
CO4	M	H	M	H	L	M	L	M
CO5	M	H	H	L	L	L	M	M

(H-High, M-Medium, L-Low)

SEMESTER-II

Course Objectives:		
The main objectives of this course are:		
1.	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.	
2.	To realize involvement of various cellular components in accomplishing cell division.	
3.	To enable a successful performance in cell biology component of CSIR-UGC NET.	
4.	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.	
Course I	:	Core V
Course title	:	Cellular and Molecular Biology
Credits	:	5
Pre-requisite:		
Students should have knowledge of the basic cellular structures and their salient functions in prokaryotic and eukaryotic cells.		
Expected Course Outcome:		
Upon completion of this course, students could		
1.	Understand the general concepts of cell and molecular biology.	K2
2.	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features.	K1 & K2
3.	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.	K3 & K4
4.	Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.	K5
5.	Understand the general concepts of cell and molecular biology.	K2

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutoplasm - cell organelles; cell theory; Diversity of cell size and shapes.
II	Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.
III	Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells; Genetic maps.
IV	Cell communication and cell signaling: Membrane- associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.
V	Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, apoptosis; therapeutic interventions of uncontrolled cell growth.
Reading list	
<ol style="list-style-type: none"> 1. Plopper, G., D. Sharp, and E. Sikorski. 2015. Lewin's Cells (Third Edition), Jones & Bartlett, New Delhi, pp-1056 2. Plopper, G. 2013. Principles of Cell Biology, Jones & Bartlett, Maryland, pp-510 	
Recommended texts	
<ol style="list-style-type: none"> 1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765. 2. Lodish, H., C. A. Kaiser, A. Bretscher, <i>et al.</i>, 2013. Molecular Cell Biology (Seventh Edition), Macmillan, England, pp-1154 3. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734 4. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia, pp-566 5. Loewy, A.G., P. Siekevitz and J. R. Menninger, <i>et al.</i>, 1991, Cell Structure and Function (Third Edition), Saunders, Philadelphia, pp-947 6. Watson, J. D., N.H. Hopkins, J.W. Roberts, <i>et al.</i>, 1987, Molecular Biology of the Gene (Fourth Edition), Benjamin/Cummings, California, pp-1163 	

7. Han, S. S. and J. Holmstedt. 1979, Cell Biology, McGraw Hill, pp-319
8. Alberts, B., A. Johnson, J. Lewis, <i>et al.</i> , 2015, Molecular Biology of the Cell (Sixth Edition), Garland Science, New York, pp-1342
9. Clark, D.P., 2005. Molecular Biology, Elsevier, China, pp-784
10. Tropp, B. 2008. Molecular Biology Genes to Proteins (Third Edition), Jones & Bartlett, US, pp-1000

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	L	L	L	S	S	S	M	M	M
CO2	M	M	M	S	S	S	S	M	S	M
CO3	S	S	S	M	M	S	M	M	L	S
CO4	M	M	S	L	S	S	L	M	S	S
CO5	S	M	M	S	S	S	S	M	S	S

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.	
2.	Learn the principles, methods and applications of cryo-preservation of gametes and embryo.	
Course I	:	Core VI
Course title	:	Developmental Biology
Credits	:	5
Pre-requisite:		
Students have fundamental knowledge in developmental biology.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	Define the concepts of embryonic development	K1
2.	Observe various stages of cell divisions under microscope	K2 & K3
3.	Understand the formation of zygote	K4
4.	Differentiate the blastula and gastrula stages	K4 & K5
5.	Learn the distinguishing features of three different germ layers and formation of various tissues and organs	K4

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians
II	Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Spermmaturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation - Parthenogenesis
III	Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, <i>Amphioxus</i> , Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers
IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - <i>Bicoid</i> and <i>Nanos</i> proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes
V	Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema – Types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and senescences: Biology of senescences- cause of aging- mechanism involved in apoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation

Reading list	
1.	Balinsky, B. I. 1981. Introduction to Embryology (5 th Edition), CBS College Publishers, New York, pp-782.
2.	Gilbert. S. F. 2006. Developmental Biology, 8 th Edition, INC Publishers, USA, pp-785.
3.	Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.
4.	Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.
5.	Subramoniam, T.2011. Molecular Developmental Biology (2 nd Edition), Narosa Publishers, India, pp-364.
6.	www.easybiologyclass.com > developmental-biology-e
7.	www.studocu.com > document > lecture-notes > view
8.	ocw.mit.edu > courses > 7-22-developmental-biology-f.
Recommended texts	
1.	Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.
2.	Slack J.M.W. 2012. Essential Developmental Biology (3 rd Edition), Wily-Blackwell Publications, USA, pp-496.
3.	Mari-Beffa, M. and J.Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	L	S	M	L	M
CO2	S	S	S	S	S	L	S	S	S	S
CO3	S	M	S	S	S	S	S	L	L	M
CO4	S	S	S	S	S	M	S	S	S	L
CO5	S	S	S	M	S	S	S	L	L	M

*S-Strong; M-Medium; L – Low

Course Objectives:		
The main objectives of this course are:		
1.	Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, genetics and developmental biology into practical understanding.	
Course I	:	Core VII
Course title	:	Lab Course in Cell Biology and Developmental Biology

Credits	:	2
Pre-requisite:		
Students should have acquired basic knowledge relevant to this particular lab course.		
Expected Course Outcome:		
Upon completion of this lab course, students		
1.	Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.	K2
2.	Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.	K3
3.	Develop handling - skills through the wet-lab course.	K6
4.	Learn the method of culturing of <i>Drosophila</i> and identification of their wild and mutant strains	K1 & K2
5.	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities	K1 & K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

CELL AND MOLECULAR BIOLOGY

1. Determination of cell size using micrometer
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the *Chironomus*
5. Detection of sex chromatin
6. Identification of blood cells in the haemolymph of the cockroach
7. Isolation of genomic DNA from eukaryotic tissue
8. Isolation of total RNA from bacterial cells/tissues
9. Agarose gel electrophoresis of DNA
10. SDS-Polyacrylamide gel electrophoresis

DEVELOPMENTAL BIOLOGY

Gametogenesis - Observation of gametes from gonadal tissue sections

- i. Oogenesis:
 - ✓ Section through ovary of shrimp, fish, frog and mammals
- ii Spermatogenesis:
 - ✓ Section through testis of shrimp, fish, calotes and mammals

Fertilization

- iii Induced spawning in polychaete worm *Hydroids elegans*
- iv *In vitro* fertilization and development in a polychaete worm *Hydroids elegans*
- v Observation of egg developmental stages in *Emerita emeritus*

Embryogenesis

- vi Observation and whole mount preparation of the chick blastoderm - 18 hours of development
- vii Chick embryonic stage - 24hours of development
- viii Chick embryonic stage - 48hours of development
- ix Chick embryonic stage - 72hours of development
- x Chick embryonic stage - 96hours of development

Histological observation: Section through various developmental stages in chick embryo

Experimental Embryology

Regeneration in Frog Tadpoles

- xi Blastema formation
- xii Demonstration of regenerative process in tadpole

Metamorphosis

- xiii Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine

Cryopreservation

xiv Demonstration of cryopreservation of gametes of fin fish/shell fish

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	S	L	L	M
CO2	S	S	S	S	S	M	M	M	M	M
CO3	S	S	M	S	S	L	S	M	L	M
CO4	M	M	L	M	L	M	M	S	M	L
CO5	S	S	M	L	S	M	L	S	S	S

*S-Strong; M-Medium; L – Low

Course Objectives:		
The main objectives of this course are:		
1.	Students should acquire a fairly good understanding about the life of insects and their classification.	
Course I	:	Elective III (Discipline Centric):
Course title	:	a)Economic Entomology
Credits	:	3
Pre-requisite:		
The students with a basic background in biological sciences with a special emphasis on the study of insects including systematic, beneficial insects, destructive insects, integrated pest management and insects of medical and veterinary importance.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
I	Understand taxonomy, classification and life of insects in the animal kingdom.	K1 & K2
II	Know the life cycle, rearing and management of diseases of beneficial insects.	K2 & K3
III	Know the type of harmful insects, life cycle, damage potential and	K2 & K3

	management of pests including natural pest control	
IV	Recognize insects which act as vectors causing diseases in animals and human.	K2 & K4
	Overall understanding on the importance of insects in human life.	K2 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**-Create

Units	
I	Overview of insects and insect taxonomy: Insects and their biological success - Man and insects; Basic concepts in Insect Taxonomy and classification.
II	Beneficial insects: Silkworms - types, life history, disease management and rearing methods - Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive - Lac insects-life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders.
III	Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.
IV	Pest management/Control strategies: Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.
V	Vector biology: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures

Reading list

1. Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.
2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
3. Ross. H.H. 1965. A Text Book of Entomology, John Wiley & Sons Inc., New York, pp-746.

Recommended texts

1. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.

3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564.
4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
6. Mani, M.S. 1982. General Entomology. Oxford & IBH Publishing Co., pp-912.
7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS & Chapman and Hall, London, pp-827.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	M	M	S	L	M
CO2	S	S	M	S	S	S	S	S	S	L
CO3	S	M	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	M	S	M	M
CO5	S	S	S	M	M	S	M	L	S	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Vermiculture.	
Course I	:	Elective III (Discipline Centric):
Course title	:	b) Poultry Farming
Credits	:	3
Pre-requisite:		
Students should be aware of economic and cultural importance of Poultry farming.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	To understand the various practices in Poultry farming. To know the needs for Poultry farming and the status of India in global market.	K2 & K3
II	To be able to apply the techniques and practices needed or Poultry farming.	K1, K2 & K3
III	To know the difficulties in Poultry farming and be able to propose plans against it.	K5 & K6

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming
II	Management of chicks - growers and layers - Management of Broilers.- Preparation of project report for banking and insurance.
III	Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.
IV	Poultry diseases-viral, bacterial, fungal and parasitic(two each); symptoms, control and management; Vaccination programme.
V	Selection, care and handling of hatching eggs - Egg testing.Methods of hatching.- Brooding and rearing - Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.
Reading list	
<ol style="list-style-type: none"> 1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi 2. 2. Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition. Biotech Books, New Delhi" 3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow." 4. Life and General Insurance Management" 	
Recommended texts	
<ol style="list-style-type: none"> 1. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India. 2. http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf 3. https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf 4. http://ecoursesonline.iasri.res.in/course/view.php?id=335 5. https://swayam.gov.in/nd2_nou19_ag09/preview 	

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	L	L	L	L	S	S	L	L
CO2	S	L	M	M	S	M	M	M	S	S
CO3	S	M	M	M	S	S	S	S	M	M
CO4	S	S	S	L	S	S	S	S	S	S

CO5	S	S	M	S	S	S	M	L	S	M
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*S-Strong; M-Medium; L – Low

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Vermiculture	
Course I	:	Elective III (Discipline Centric):
Course title	:	c) Dairy Farming
Credits	:	3
Pre-requisite:		
Students should be aware of economic and cultural importance of Dairy farming.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	To understand the various practices in Dairy farming. To know the needs for Dairy farming and the status of India in global market.	K2 & K3
II	To be able to apply the techniques and practices needed for Dairy farming.	K1, K2 & K3
III	To know the difficulties in Dairy farming and be able to propose plans against it.	K5 & K6

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Introduction to Dairy Farming-Advantages of dairying- Classification of breeds of cattle-Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination-Dairy cattle management-General Anatomy.
II	Construction of Model Dairy House - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management
III	Feedstuffs available for livestock- Roughages -Concentrates - Energy rich concentrates -Protein rich concentrates - Mineral Supplements - Vitamin Supplements -Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant dairy animals - Feeding pregnant heifer.
IV	Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.
V	Contagious disease - Common Bacterial - Protozoal - Helminth and Viral Diseases -

Parasitic Infestation - Vaccination - Biosecurity.
Reading list
<ol style="list-style-type: none"> 1.The Veterinary Books for Dairy Farmers by Roger W. Blowey. 2. Hand Book of Dairy Farming by Board Eiri. 3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990 4. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai. 5. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.
Recommended texts
<ol style="list-style-type: none"> 1. https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises %20Dairy%20unit.htm 1 2. https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Tata,+S.N.,+ed%22 3. 15. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi. 4. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	L	L	S	S	M	S	L	M
CO2	M	S	S	S	M	S	M	L	S	S
CO3	M	S	S	S	S	S	S	S	S	M
CO4	M	S	S	S	M	M	L	L	M	M
CO5	S	S	S	M	S	M	S	L	S	S

*S-Strong; M-Medium; L – Low

Course Objectives:	
The main objectives of this course are:	
1.	Students understand the basic principle, methodology and applications of widely used instruments in biological sciences.

Course I	:	Elective IV (Generic
Course title	:	Research Methodology
Credits	:	3
Pre-requisite:		
Students should know the fundamentals of basic methods employed in experimental biology.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	Understand the importance of pH in biological research	K1
2.	Learn the working principles of different instruments	K2
3.	Gain the knowledge on techniques of micro and macro molecules separation.	K2 & K4
4.	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy	K3 & K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**- Create

Units	
I	Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry.
II	Histology, Histochemistry, Bioinformatics and Electron microscopy.
III	Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.
IV	Centrifuges, Chromatography, Electrophoresis, ELISA and blotting.
V	Principles and Applications of tracer techniques in biology, Animal cell culture techniques.
Reading list	
<ol style="list-style-type: none"> 1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758. 2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715. 3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330. 	
Recommended texts	
<ol style="list-style-type: none"> 1. Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440. 2. Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, 	

pp-376.

3. Wolf, G. 1964. Isotopes in Biology, Academic Press, pp-173.

4. Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.

5. Pantin, C. F. A. 1948. Microscopical Techniques, Cambridge University Press, London.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	S	M	S	M	M
CO2	S	S	M	S	S	S	M	M	M	S
CO3	S	M	S	S	S	S	S	S	S	L
CO4	S	S	S	S	S	M	S	S	S	M
CO5	S	S	S	M	M	S	M	L	S	M

*S-Strong; M-Medium; L-Low

SEMESTER-III

Course Objectives:		
The main objectives of this course are:		
1.	Understanding DNA as genetic material, fine structure of DNA & RNA molecules, as well as physico-chemical properties of macromolecules.	
2.	Gain insight into sequential events occurs during protein synthesis.	
3.	Learn the structure and function of chromosome and chromosomal basis of genetic disorders.	
4.	To acquire knowledge about microbial genetics	
5.	To provide information about rDNA technology and its application.	
Course I	:	Core IX
Course title	:	Genetics
Credits	:	5
Pre-requisite:		
Basic knowledge on molecular biology and genetics		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	Explain the organization and functions of genetic material in the living system.	K1 & K2
2.	Understand various sequential processes in protein synthesis	K1 & K2
3.	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.	K2 & K4
4.	Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.	K2 & K5
5.	Understand the principle and application of rDNA technology for the welfare of human being.	K2 & K3

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Structure, properties and functions of genetic materials: DNA as the genetic Materials - Basic structure of DNA and RNA, alternate and unusual forms of DNA - Physical and Chemical properties of nucleic acid, base properties, denaturation and renaturation, T _m and cot values, hybridization.

II	Genetic code - Methods of deciphering the genetic code and general features of the code word dictionary. Chromosomal genetics: Molecular structure of chromosomes - Variation in chromosome number and structure - Chromosome nomenclature - Chromosomal syndromes.
III	Microbial Genetics: Genetics of Virus - Viral chromosome, Lytic cycle, Lysogenic cycle - Bacterial genetics - Bacterial genome - Gene transfer mechanisms in bacteria and virus - conjugation, transduction and transformation
IV	Recombinant DNA technology: Recombinant DNA technology - Overview - Tools for Recombinant DNA Technology – Vectors - types - Techniques used in recombinant DNA technology - generation of DNA fragments - Restriction endonucleases, DNA modifying enzymes, Ligases
V	Introduction of rDNA into host cell - calcium chloride mediated gene transfer - <i>Agrobacterium</i> mediated DNA transfer, electroporation, microinjection, liposome fusion, particle gun bombardment - Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare - Environment, Medicine and Agriculture
Reading list	
<ol style="list-style-type: none"> 1. Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740. 2. Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th Edition, McGraw Hill Publisher, pp-880. 3. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd Edition). Pearson/Benjamin Cummings, San Francisco, pp-850. 4. https://onlinecourses.swayam2.ac.in/cec21_bt02/preview 5. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code 	
Recommended texts	
<ol style="list-style-type: none"> 1. Griffiths, A. J. F., H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York. 2. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784. 3. Watson, J. D., T. A. Baker, S. P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2003. Molecular Biology of the Gene, (5th Edition). Cold Spring Harbor Laboratory Press, pp-912. 4. Klug, W. S. and M. R. Cummings, C. A. Spencer. 2005. Concepts of Genetics, Benjamin-Cummings Publishing Company. 5. Harti, D. L. 2002. Essential Genetics, A Genomic Perspective, Jones & Bartlet. 6. Krebs, J.E., E.S. Goldstein, S.T. Kilpatrick. 2018. Lewin's Genes XII, Jones & Bartlet Publisher, pp-613. 7. Watson, J. D., T. A. Baker S. P. Bell, A. Cann, M. Levine and R. Losick, 2014. Molecular Biology of Gene 7th Edition, Pearson Education RH Ltd. India. 	

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	L	S	S	S	L	M	S
CO2	S	M	M	M	S	M	M	M	L	S
CO3	M	S	L	L	M	S	M	L	S	L
CO4	S	M	S	M	M	S	S	S	S	S
CO5	S	S	S	M	E	S	M	S	M	M

*S - Strong; M - Medium; L - Low

Course Objectives:		
The main objectives of this course are:		
1.	To critically analyze the concepts of evolution.	
2.	Understand the factors responsible for origin and generation of diversity among living beings and	
3.	To develop strategies for sustenance of life on this planet	
4.	To critically analyze the concepts of evolution in order to	
Course I	:	Core X
Course title	:	Evolution
Credits	:	5
Pre-requisite:		
Students shall have basic knowledge on the diversity of animals, biology including morphological, anatomical, physiological and embryological features of various phyla and their environment.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.	K1 & K3
2.	Study the origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.	K1 & K2
3.	Understand the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.	K2 & K3

4.	Comprehend the origin of new genes and proteins; Gene duplication and divergence.	K2 & K4
5.	Appreciate the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift	K4 & K5

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	DARWINISM AND LAMARKISM: Emergence of evolutionary thoughts: Lamarckism and Darwinism, Neo-Lamarckism, Biological species concepts – concepts of variation, adaptation, struggle, fitness and natural selection, Group and kin selection – Mendelism - Spontaneity of mutations - The evolutionary synthesis.
II	EVOLUTION OF CELLS : Origin of cells and unicellular evolution: Origin of basic biological molecules - Abiotic synthesis of organic monomers and polymers - Concept of Oparin and Haldane - Experiment of Miller (1953) - The first cell - Evolution of prokaryotes - Origin of eukaryotic cells - Evolution of unicellular eukaryotes, origin of unicellular and multi cellular organisms.
III	PALEONTOLOGY AND EVOLUTIONARY HISTORY: The evolutionary time scale - Eras, periods and epoch - Major events in the evolutionary time scale -- Stages in primitive evolution including <i>Homo sapiens</i>
IV	MOLECULAR EVOLUTION: Molecular divergence, Molecular drive, - Molecular tools in phylogeny - Protein and nucleotide sequence analysis - Origin of new genes and proteins - Gene duplication and divergence, micro and macro evolution, DNA barcoding.
V	POPULATION GENETICS : Populations, Gene pool, Gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift- Adaptive radiation - Isolating mechanisms – Speciation - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Co-evolution - Altruism and evolution

Reading list

1. Bergstrom, C. T. and L. A. Dugatkin. 2012. Evolution, Second Edition. W.W. Norton & Company, International Student Edition, pp-756.
2. Jobling, M., E. Hollox, M. Hurles, T. Kivisild and C. T. Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garland Sciences, London, pp-650.
3. Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.
4. <https://www.flipkart.com/books/evolution~contributor/pr?sid=bks>
5. <http://www.evolution-textbook.org/>
6. <https://onlinelibrary.wiley.com/journal/15585646>
7. <http://darwin-online.org.uk/>

Recommended texts
1. Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers, pp-722.
2. Hall B. K. and B. Hallgrimsson. 2014. Strickberger's Evolution. Fifth Edition, Bartlett Learning, An Ascend Learning Company, pp-642.
3. Barton, N.H., D. Briggs, J.A. EisenDavid,D.B. Goldstein and N.H. Patel. 2007. Evolution. Cold Spring Harbor Laboratory Press, pp-833.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	L	S	M	L	M
CO2	S	S	L	S	S	L	S	S	S	S
CO3	S	M	S	S	S	S	S	L	L	M
CO4	S	S	S	S	S	M	S	S	S	L
CO5	S	S	S	M	M	S	S	L	L	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Students acquire the basic knowledge on physiology of different organs in animals and human.	
2.	Understand the functions of different systems such as digestion, excretion, blood circulatory system, respiration and nervous system of animal relating them to structure and functions of various organs.	
Course I	:	Core XI
Course title	:	Animal Physiology
Credits	:	5
Pre-requisite:		
Students should know the fundamentals of structure and functions of organs and organ systems of animals.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	Understand the functions of different systems of animals	K1
2.	Learn the comparative anatomy of heart structure and functions	K2
3.	Know the transport and exchange of gases, neural and chemical regulation of respiration	K2 & K4

4.	Acquire knowledge on the organization and structure of central and peripheral nervous systems	K3 & K5
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K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Units	
I	CIRCULATION: Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, hemoglobin, immunity, hemostasis. Cardiovascular system : Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above
II	RESPIRATION : Respiratory system: Respiratory gases, uptake, respiratory pigments, O ₂ & Co ₂ dissociation curves, Comparison of respiration in different species, anatomy and physiology of respiratory tract, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
III	NERVOUS SYSTEM: Nervous system: Neurons, action potential, nerve impulse transmission, neurotransmitters, nerve conduction, synapse, gross neuro-anatomy of the brain and spinal cord, neurons, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response.
IV	DIGESTIONAND EXCRETION: Digestive system: Digestion, Salivary glands, intestinal glands, osmotic and ionic stress, osmoregulation, absorption, energy balance, BMR. Excretory system: Physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.
V	HORMONES AND REPRODUCTION: Endocrinology and reproduction: Endocrine glands – Pituitary,Thyroid, Adrenal and Islets of Langerhans, basic mechanism of hormone action, functions, hormones and diseases;reproductivehormones, hormone disorders, gametogenesis, ovulation, neuroendocrine regulation. Thermoregulation: Comfort zone, body temperature-physical, chemical, neural regulation, acclimatization: Stress and adaptation

Reading list

1. Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592
2. Hoar, S.W. 1983,General and Comparative Physiology,Prentice Hall Publication, pp-928.
3. Randall, D., W. Burggren, K. Frenchand R. Eckert.2001, Animal Physiology Mechanisms and Adaptations, New York : W.H. Freeman and Co., pp-

4. Nelson K. S. 1997. Animal Physiology: Adaptation and Environment, Cambridge University Press, pp- 617.
5. Dantzler, W.H. 1997. Comparative Physiology (Handbook of Physiology), Volumes I and II. Edited by William H. Dantzler. pp - 1824 Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.
6. https://swayam.gov.in/nd1_noc20_bt42/preview
7. <https://www.classcentral.com/course/swayam-animal-physiology-12894>
8. https://swayam.gov.in/nd1_noc20_hs33/preview

Recommended texts

1. Shepherd, G. M. 1994. Neurobiology, OUP USA Publisher, pp-774.
2. Hainsworth, F.R. 1981. Animal Physiology: Adaptation in function, Addison Wesley Longman Publishers, pp-669.
3. Mcfarland, D. 1999. Animal Behaviour: Psychobiology, Ethology and Evolution, Longman Publisher, pp-592.
4. Gordon, M.S. *et al.*, 1977. Animal Physiology: Principles and Adaptation, New York, Third Edition.
5. Ahearn, G.A. *et al.*, 1988. Advances in Comparative and Environmental Physiology – 2, Springer Publishers, pp-252.
6. Hill, R.W. 1976. Comparative Physiology of Animals: Environmental Approach, Longman Higher Education Publisher, pp-656.
7. Withers, P.C. 1992. Comparative Animal Physiology, Brooks/Cole Publisher, pp-900.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	L	S	M	S	S
CO2	S	S	M	S	S	S	S	M	S	S
CO3	S	M	S	S	S	M	L	S	M	S
CO4	S	S	S	S	S	L	M	S	S	M
CO5	S	S	S	M	M	M	M	L	L	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Students should understand the different protocols and procedures to collect clinical samples.	
Course I	:	Core Industry Module
Course title	:	Medical Laboratory Techniques
Credits	:	3
Pre-requisite:		
Students should have a basic knowledge about medical laboratories and the works carried out by them.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.	K2 & K3
II	Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.	K3, K4 & K5
III	Evaluate the hematological and histological parameters of biological samples.	K3, K4, K5 & K6

K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create

Units	
I	Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice - hygiene and health issue - physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.
II	Composition of blood and their function- collection of blood & lab procedure-haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.
III	Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome-Computer tomography(CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET.
IV	Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography- Electroencephalography (EEG).
V	Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.

Reading list
<ol style="list-style-type: none"> Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai. Guyton and Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.
Recommended texts
<ol style="list-style-type: none"> Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeyppee brothers, New Delhi. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia.Published by Tata McGraw-Hill Education Pvt. Ltd., Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	L	L	M	M	L	M
CO2	S	S	M	S	S	S	L	M	S	S
CO3	M	S	S	S	S	S	S	S	S	L
CO4	S	S	M	M	L	M	L	M	M	S
CO5	M	M	S	S	M	S	L	L	S	S

*S - Strong; M - Medium; L-Low

Semester	III
Course Type	CORE PRACTICAL XII
Title of the Course	GENETICS, EVOLUTION AND ANIMAL PHYSIOLOGY
Course Code	
Teaching Hours	72 Hours/ Semester : 4 Hours/ week

CODE:	GENETICS, EVOLUTION AND ANIMAL PHYSIOLOGY	Credits: 3	Max. Marks: 100
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Course Prerequisites: The students should have basic knowledge on mechanism of genetic interaction , evolutionary history and basic principle of physiological function of an organism.
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CODE: NZOL32	GENETICS, EVOLUTION AND ANIMAL PHYSIOLOGY	L	T	P	C
		0	-	4	3
Course Objectives	<ul style="list-style-type: none"> ➤ To know the transmission of hereditary traits among individual in a family ➤ To acquire knowledge on gene pool and gene frequency ➤ To know the methods to analyse the RQ, gaseous exchange and osmosis. ➤ To impart knowledge on evolutionary significance of organism ➤ To understand how to evolve the new species and pattern of evolution 				
GENETICS				36 Hours	
<ul style="list-style-type: none"> ➤ Mendelian experiments: Monohybrid cross, Dihybrid cross and Trihybrid cross by using coloured beads. ➤ Analyze Hardy-Weinberg equilibrium with partial selection on recessive allele. ➤ Analyze Hardy-Weinberg equilibrium with complete selection on recessive allele ➤ Concept of Genetic drift in a small population. ➤ Analyze the quantitative inheritance (Height and Weight of human beings and Serration of neem leaves) ➤ Analysis the finger print of class population ➤ Pedigree Analysis: <ul style="list-style-type: none"> ○ Transmission of autosomal recessive trait ○ Transmission of autosomal dominant trait ○ Transmission of sex linked recessive trait ○ Transmission of Y linked dominant trait ○ Muscular dystrophy ➤ Preparation of human karyotype. ➤ Identification of syndromes (Down, Klinefelter and Turner) from karyotype photographs showing clinical features of each syndrome case. ➤ Mounting of salivary glands of Drosophila larvae / Chironomous larva. Analysis of banding pattern. ➤ Localization of Barr body in the Buccal smear - squamous epithelial cells of female. ➤ Preparation of culture media. Culture of Drosophila - Methods of maintenance. ➤ Sex identification of at least four mutants. ➤ Serial homology in appendages of Prawn. 					
EVOLUTION				36 hours	
<ul style="list-style-type: none"> ➤ Geological time scale ➤ Evolutionary Experiment : Chemical origin of life -Urey Miller experiment ➤ Speciation <ul style="list-style-type: none"> - Allopatric, parapatric, sympatric - Darwin finches, HMS Beagle ➤ Evolution of man, reptiles, birds, horse, elephant, dinosaur ➤ Connecting link <ul style="list-style-type: none"> - Annelida – Arthropoda - Birds – reptiles ➤ Evidence of evolution <ul style="list-style-type: none"> - Homologous and Analogous - Fossil evidence 					

<ul style="list-style-type: none"> - Living fossil – Limulus ➤ Phylogenetic tree ➤ Molecular clock
ANIMAL PHYSIOLOGY
<ul style="list-style-type: none"> ➤ Influence of temperature on Oxygen consumption of a fish ➤ Influence of salinity on oxygen consumption of a fish ➤ Estimation of salt gain by a fish ➤ Estimation of salt loss by a fish ➤ Estimation of Haemoglobin in frog’s blood ➤ Influence of temperature on enzyme activity and measurement of activation energy ➤ Influence of pH on amylase activity ➤ Influence of substrate concentration on amylase activity ➤ Preparation of urate crystals of cockroach ➤ Preparation of haemin crystals ➤ Assay of acid/alkaline phosphatase enzyme ➤ Calculation of Body mass index.

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to–	Cognitive Level
CO1	Know the preparation of karyotypes of metaphase chromosome of human and identify the disease causing gene by karyotyping.	K1, K2
CO2	Acquire knowledge on genetic drift or bottle neck principle operating on a small population.	K2, K4
CO3	Construct the family chart for the sex linked inheritance	K1, K2
CO4	Know the evolutionary history of living system and understand the connecting link between the phyla.	K2, K4
CO5	Acquire knowledge on the construction of phylogenetic tree to understand the evolutionary history.	K1, K2

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	L	M	L	L	H	L	L
CO2	H	L	M	L	M	H	L	L
CO3	H	L	M	L	L	H	L	L
CO4	H	L	M	L	M	H	L	L
CO5	H	L	M	L	L	H	L	L

(H-High, M-Medium, L-Low)

ELECTIVE V: (DISCIPLINE CENTRIC): a) APICULTURE

Semester	III
Course Type	ELECTIVE V
Title of the Course	a)APICULTURE
Course Code	
Teaching Hours	54 Hours/ Semester : 3 Hours/ week

NZOEB	APICULTURE	Credits: 3	Max. Marks: 100
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Course Prerequisites:
Inclination for taking up Bee Keeping as a self employment activity

CODE: NZOEB	APICULTURE	L	T	P	C
		3	-	-	3

Course Objectives

- Will gain the knowledge of different species and races of honey bees
- Will be able to identify flora and location of sites for Bee hives
- Understand the requirement of different bee species and preparing flowering calendar.
- Understand the using Bee boxes including cleaning of Boxes and various tools and equipment used in Bee keeping
- Understand the importance of health and hygiene in Bee keeping

Unit- I	HISTORY OF BEE KEEPING	8 hours
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Introduction to Apiculture - scope, importance - History of bee keeping: Definition, Bee keeping in worldwide, In India. Traditional bee keeping, Modern beekeeping, Urban or backyard beekeeping- Apiculture development in India - institutions involved. Role of Central Honey Bee Research & Training Institute.

Unit II	LIFE CYCLE OF HONEY BEE	10 hours
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Honey Bee morphology, Anatomy and Life cycle - Basic concepts of morphology of Honey bees - indigenous, exotic-Honey bee species and identification. Origin, systematic and distribution of honey bees. Types of honey bees, Species of honey bees. Bee identification-Social organization in honey bees: Colony life and social organization – Queen, drone, worker. Annual biological cycle of the bee colony.

Unit III	PESTS AND DISEASES MANAGEMENT	12hours
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Honeybee Enemies and Diseases-Bee enemies and diseases: An introduction, Bee enemies – Wax Moth, Ants, Wasps, Microorganisms, Pests. Diagnosis and Identification. - Mites attacking honey bees: Varroa mites, Mite Biology, Controlling Varroa Mites, Mechanical control, Mite-tolerant stocks, Biopesticides, Chemical (synthetic pesticide) treatments. - Bacterial, viral, fungal & protozoan diseases: Bacterial disease - American Foulbrood, European Foulbrood, Viral disease - Deformed Wing Virus, Sacbrood Virus, Black Queen Cell Virus, Kashmir Bee Virus, Acute Bee Paralysis Virus; Fungal disease - Chalkbrood, Stonebrood; Protozoan disease - *Nosemosis*, *Nosema cerana*.

UnitIV	PROPERTIES OF HONEY	12hours
Honey - its properties and application in various fields- Honey - its medicinal properties - application in various fields - other valuable by products of honey bees-Value added honey products. Properties of honey products, Nutrients and composition of honey, Acid content and flavor effects.-Types of value added honey product		
Unit V	HONEY PROCESSING AND ECONOMICS	12hours
Honey Processing and Bee Hive Products-Honey extraction & handling - Quality control standards - Honey testing kit -Processing of honey. Other valuable by products of honey bees-Bee venom & Royal jelly extraction. Economics of bee keeping: Economics in small scale and large scale bee keeping. Economic Value of Commercial Beekeeping. - Preparing bankable bee keeping project: Steps involved in starting a beekeeping project, Funding sources for beekeeping projects.		
Reference Books		
<ul style="list-style-type: none"> ➤ Prost, P. J. 1962. Apiculture. Oxford and IBH, New Delhi. ➤ Bisht D.S.,2000 Apiculture, ICAR Publication. ➤ Singh S., 2002.Beekeeping in India, Indian council of Agricultural Research, New Delhi. ➤ Delaplane, K.S. 2006. Honey Bees and Beekeeping: A Year in the Life of an Apiary, 3rd Edition. ➤ Ross, C., 2007. The Georgia Center for Continuing Education, Athens, USA. Natural Beekeeping : Organic Approaches to Modern Apiculture, White River Junction, London, UK. ➤ Dadant C.P., Dadant C.C., Dadant M.G., Dadant J.C. (eds.) 2011. The Hive and The Honeybee. Dadant and Sons, Inc. Hamilton, USA. Sammataro D., Avitabile A. The Beekeeper's Handbook, 4th edition. Cornell University Press, USA. 		
Web Source:	https://onlinecourses.swayam2.ac.in/nos19_as10/preview http://ecoursesonline.iasri.res.in/course/view.php?id=166	

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to–	Cognitive Level
CO1	Analyze major trends in a given economic sector / sub-sector and identify Business Opportunities	K1, K2
CO2	Develop effective personal management skills like time management and communication skills.	K1,K2
CO3	Devise a simple marketing and sales strategies and plan for a small business	K1,K2
CO4	Knowledge on the processing of honey and byproducts of honey.	K1, K2
CO5	Work out Business plan and economics of the project	K1,K2

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	L	L	L	L
CO2	M	H	L	L	L	L	L	L
CO3	H	L	L	M	L	L	L	L
CO4	H	H	L	L	L	L	L	L
CO5	M	H	L	L	L	L	L	L

(H-High, M-Medium, L-Low)

Semester	III
Course Type	ELECTIVE V-Discipline generic
Title of the Course	b) SERICULTURE
Course Code	
Teaching Hours	54 Hours/ Semester : 3 Hours/ week

	SERICULTURE	Credits: 3	Max. Marks: 100
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Course Prerequisites:

Inclination for taking up sericulture as a self employment activity

CODE:	b) SERICULTURE	L	T	P	C
		3	-	-	3
Course Objectives	<ul style="list-style-type: none"> ➤ Will gain the knowledge of different species and races of silkworm ➤ Understand the using of silkworm in Textile industry ➤ Known the hands on training of silk reeling technology tie up with silk industry 				
Unit- I	GENERAL INTRODUCTION	8 hours			
Scope and Importance of sericulture-sericulture in India-Role of central Silk Board-Life Cycle of <i>Bombyx mori</i> - Classification based in number of larval moults and voltinism and cocoon colour shape-Morphology of <i>Bombyx mori</i> (egg-larval-pupa-adult)-Silk gland –Non mulberry Silkworm					
Unit II	MORICULTUE	10 hours			
Morphology of mulberry plant-High yielding varieties-optimum conditions for mulberry growth-planting –irrigation- manuring –pruning –harvesting and storing of mulberry leaves-Common diseases of mulberry (causative agent, symptoms and treatment).					

Unit III	GRAINAGE TECHNOLOGY	12hours
Egg breeding stations-procedure in Grainage-silkworm rearing –rearing house- rearing appliances-rearing operations		
UnitIV	DISEASES MANAGEMENT	12hours
Causative organism, symptoms and treatment for Bacterial diseases (Flacherie, Septicemia, Sotto)-fungal diseases (muscardine)Viral diseases (infectious flacherie, Gattine, Grasserie) and protozoan disease (Pebrine)-Genetic reistance of the silk worm, Bombyx mori to bacterial and viral diseases-silkworm transgenesis and application.		
Unit V	SILK REELING	12hours
Cocoon marketing-characteristics of cocoon-cocoon stifling-Types and storage of stifled cocoons-reeling operations-reeling appliances (country charka, cottage basin)-raw silk testing.		
Reference Books		
<ol style="list-style-type: none"> 1. Ganga,G and Sulochan Chetty, 1991.An Introduction to Sericulture. Oxford IBH Publ. PVT. LTD., New Delhi. 2. Hisao Aruga. Principles of Sericulture. Oxford IBH Publ. PVT. LTD., New Delhi. 3. G.Rangasamy et al., (1972). Mulberry cultivation-Central Sericulture Research and Training Institute, Mysore. 4. Ullal,S. And narasimhana, M.N. Hand Book of Practical Sericulture-CSB, Bombay 		
Web Source:	https://www.silkboard.in.org http://ecoursesonline.iasri.res.in/course/view.php?id=166	

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to–	Cognitive Level
CO1	Analyze major trends in a given economic sector / sub-sector and identify Business Opportunities	K1, K2
CO2	Develop effective personal management skills like time management and communication skills.	K1,K2
CO3	Devise a simple marketing and sales strategies and plan for a small business	K1,K2
CO4	Knowledge on the processing of silk and byproducts of silk.	K1, K2
CO5	Work out Business plan and economics of the project	K1,K2

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Course Objectives:	
The main objectives of this course are:	
1.	Students should know basic concepts in Vermiculture.

Course	:	ELECTIVE-V (DISCIPLINE CENTRIC)
Course title	:	c) Vermiculture
Credits	:	3
Pre-requisite:		
Students should be aware of economic and cultural importance of Vermiculture.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	To understand the various practices in vermiculture. To know the needs for Vermiculture and the status of India in global market.	K2 & K3
II	Able to apply the techniques and practices needed for vermiculture.	K1, K2 & K4
III	To know the difficulties in Vermiculture and be able to propose plans against it.	K5 & K6

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Earthworms - Taxonomic position, external features - shape, size, colour, segmentation, setae & clitellum. Body wall, coelom- locomotion,digestive, circulatory, respiratory, excretory & nervous system. Reproductive system-Male & Female, copulation, cocoon formation & fertilization, development of earth worm. Vermitechnology- Definition, history, growth and development in other countries & India, significance.
II	Vermiculture - definition, common species for culture; Environmental parameters; culture methods – wormery - breeding techniques; indoor and outdoor cultures - monoculture and polyculture - merits and demerits.
III	Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage.
IV	Applications of vermiculture - Vermiculture Bio-technology, vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.
V	Potentials and constraints for vermiculture in India. Marketing the products of vermiculture - quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing. Economic importance of Earthworms: In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food.
Reading list	
1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India	

Press, Goa, India.

2. Bhatnagar & Patla, 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi
3. Mary Violet Christy, 2008. Vermitechnology, MJP Publishers, Chennai.
4. Aravind Kumar, 2005. Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
5. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.

Recommended texts

1. <https://agritech.tnau.ac.in/sericulture/>
2. <https://www.agrifarming.in/vermiculture-process-techniques-worm-farming>
3. 11. Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	M	L	L	L	L	S	L	L	L
CO2	L	S	S	S	S	S	L	S	S	S
CO3	M	S	S	S	S	S	L	S	S	L
CO4	L	S	S	S	M	S	M	S	S	M
CO5	S	S	M	S	L	L	L	M	L	M

*S - Strong; M - Medium; L- Low

SEMESTER-IV

Course Objectives:		
The main objectives of this course are:		
1.	To impart conceptual understanding of functional organization of immune system and its responsiveness in health and disease.	
2.	To enable a successful performance in Immunology component of CSIR-UGC NET.	
Course I	:	Core XII
Course title	:	Immunology
Credits	:	5
Pre-requisite:		
Students would have basic knowledge in animal science, particularly functional anatomy, cell biology and developmental biology.		
Expected Course Outcome:		
Students would have acquired clear knowledge on		
1.	Various basic concepts in immunology and organization of immune systems.	K2
2.	Mechanisms of immune response in health and their defects in various diseases.	K2 & K4
3.	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.	K3 & K5
4.	Vaccinology and its importance in disease management	K3

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Introduction to Immunology:An overview; Scope of immunology, recognition of self and non-self as a basic functional feature of immune system; Concepts of external and internal defense systems; External (first line / innate) defense system: components, distribution, salient functions; Internal (second line / acquired) immune system: cellular and humoral immune components-distribution, salient functions-primary and secondary immune responses;

	Immune tissues / organs: types, anatomical location, structure and development; lymphocyte traffic during development; Types of immunity: innate and acquired - types, functional features; concept of adaptive immunity
II	Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications
III	Major effector components of cellular immune system: Lymphocytes - types, morphology, clones; sub-populations, distribution, B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance
IV	Major effector components of humoral immune system: Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and functional characteristics of various antibody classes; Generation of diversity; Monoclonal antibodies: definition, production and applications; Antibody engineering and its applications. Complement system - Components, three major activation pathways, and immune functions including anaphylaxis and inflammation. Cytokines - Definition and salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions. Interferons - Origin, types and functions
V	Diseases and immune responses: Hypersensitivity: definition, Types I to IV and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Vaccines: types, preparations, efficacies and recent developments
Reading list	
<ol style="list-style-type: none"> 1. Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York, pp-670. 2. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7th edition), Mosby / Elsevier, Philadelphia, pp-472 3. Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6th edition), W. B. Saunders, Philadelphia, pp-564 4. Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406. 	
Recommended texts	
<ol style="list-style-type: none"> 1. Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362 2. Janeway, C. A and P. Travers. 1997. Immunology, Garland Publ. Inc., London, pp-904 3. Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp-366 4. Parham, P. 2009. The Immune System (Third Edition), Garland Science, USA, pp-506 	

5. Weissman, I. Hood, L. Wood, W. 1978. Essential Concepts in Immunology, the Benjamin/Cummings, California, pp-165.
6. Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology (Second Edition), the Benjamin/Cummings, California, pp-558.
7. Coica, R and Sunshine, G. 2009. Immunology A Short Course (Sixth Edition), John Wiley & Sons, USA, pp-391.
8. Doan, T. Melvold, R. Viselli, S. *et al.*, 2013. Immunology (Second Edition), Lippincott Williams & Wilkins, Maryland, pp-376.
9. Owen, J. A. Punt, J. Stanford, S. A. 2013. Kuby Immunology (7th Edition), Macmillan, England, pp-692.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	S	S	S
CO2	S	S	M	S	S	S	M	M	S	S
CO3	S	M	M	S	S	S	S	S	S	M
CO4	M	S	M	M	S	S	S	S	S	M
CO5	M	S	S	S	M	S	M	S	S	M

*S-Strong; M-Medium; L-Low

Course Objectives:		
The main objectives of this course are:		
1.	Knowing the ecology and climatic changes at world level and its impact on natural resources.	
2.	Understanding the contributing factors for pollution in the environment and the ways in controlling and restoring to natural conditions	
Course I	:	Core XIV
Course title	:	Ecology
Credits	:	5
Pre-requisite:		
Students should know about the fundamentals and studied the ecology of living organisms.		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
1.	Learn about the ecosystem, biotic communities and utilizing the energy processing	K2
2.	Study the various community and population and population	K2 & K3

	control	
3.	Understand the fundamentals of climatic conditions and its impact on environment	K2 & K6
4.	Realizing the nature of pollution and the ways for its control/reduction	K4 & K5
5.	Impact of environmental studies on solid waste management	K2 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Units	
I	The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
II	Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (<i>r</i> and <i>K</i> selection); concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations - action taken to control population explosion.
III	Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax
IV	Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
V	Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Reading list

1. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.
2. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.
3. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.
4. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill

Boston, 5th Edition.

5. Online courses.nptel.ac.in / noc 19 - g e 23/preview
6. Class central.com/course/swayam -ecology - and environment – 14021.

Recommended texts

1. Odum, E.P. 1893. Basic Ecology, Saunders & Co., Philadelphia, pp-383.
2. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.
3. United Nations Environment Programme (UNEP). 1995. Global Biodiversity Assessment, Cambridge University Press, pp-1140.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	M	S
CO2	S	S	M	M	L	S	S	S	M	M
CO3	S	M	M	L	M	S	L	L	S	L
CO4	M	M	S	S	M	L	L	S	S	S
CO5	M	S	S	M	S	M	L	M	L	S

*S - Strong; M - Medium; L – Low

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Aquaculture.	
Course I	:	Elective VI (Industry/Entrepreneurship) (20 % Theory + 80 % practical)
Course title	:	a) Aquaculture
Credits	:	3
Pre-requisite:		
Students should know the fin fishes and shell fishes of commercially important candidate species.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	To develop knowledge on the fish farm and their maintenance. Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques	K1& K2

II	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture	K3 & K4
III	Identifies the different fishes diseases, diagnosis and their management strategies. Understands Ornamental fishes and central aquaculture organizations	K5 & K6

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Importance of aquaculture- Present status, prospects and scope in India. Freshwater aquaculture- Brackishwater aquaculture- Mariculture - Metahaline culture in India. Types of fish culture -Types of fish ponds for culture practice. Topography, site selection - water quality - soil condition and quality – structure and construction design and layout - inlet and outlet. Water quality management for aquaculture. Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays – Fishing gears used in aqua farming.
II	Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial seed production – Breeding under control conditions, induced breeding technique, larval rearing, packing and transportationCommercial substitute for pituitary extracts. Classification of fish feed- Artificial feedsTypes, Feed - formulation - feeding methods. Live feed- Microalgae, Rotifer, Artemia and their culture.
III	Shrimp hatchery technology - Hatchery design, brood stock management, spawning, larval rearing, Shrimp developmental stages, algal culture, packing and transportation. Shrimp culture technology - extensive culture methods semi- intensive - intensive culture methods - Biofloc technology - Culture operations (water quality, feed and health management) - harvesting, preservation and marketing. Brackish water fish culture. Edible and Pearl oyster culture - pearl production. Crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber - their by-products. Types of Seaweeds - species and methods of culture – by-products
IV	Fish and Shrimp diseases and health management – infectious diseases - Bacterial, Fungal, Viral, Protozoan; Non-infectious - environmental and nutritional diseases. Diseases diagnosis, prevention and control measures.
V	Types of ornamental fishes (freshwater and marine), their breeding behavior and biology. Oviparous, Ovo-viviparous and Viviparous fishes. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations- CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA and its activities.

Reading list	
1.	Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd.
2.	Santhanam, R. (1990). Fisheries Science. Daya Publishing House.
3.	Sinha, V.R. P. and Srinivastava, H. C. (1991). Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi.
4.	Yadav, B. N. (1997). Fish and fisheries. Daya Publishing house, New Delhi.

Recommended texts	
1.	Das M. C. and Patnaik, P. N. (1994) Brackish water culture. Palani paramount Publications, Palani, T. N.
2.	Day, F (1958). Fishes of India , VoL I and Vol. II. William Sawson and Sons Ltd., London.
3.	Jhingran, V. G. (1991). Fish and Fisheries of India. Hindustan Publishing Co., India
4.	Maheswari. K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P).

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	S	S	M	M	S
CO2	S	S	S	M	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	S	S	M
CO4	S	S	M	S	S	S	S	M	M	S
CO5	S	S0	M	S0	M	S	M	L	S	S

*S-Strong; M-Medium; L-Low

**ELECTIVE VI: Industry/Entrepreneurship
b) FISH PROCESSING TECHNIQUES**

Semester	IV
Course Type	ELECTIVE VI
Title of the Course	b) FISH PROCESSING TECHNIQUES
Course Code	
Teaching Hours	54 Hours/ Semester : 3 Hours/ week

CODE:	FISH PROCESSING TECHNIQUES	Credits: 3	Max. Marks: 100
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Course Prerequisites:

The student should have a basic knowledge on fish biology.

CODE:	FISH PROCESSING TECHNIQUES	L	T	P	C
		3	-	-	3
Course Objectives	<ul style="list-style-type: none"> ➤ To learn the scope and importance of fish processing techniques ➤ To give detailed insight into various aspects of freezing of fish. ➤ To provide understanding on chemical, bacterial and sensory changes during freezing and storage techniques. 				
Unit I	FUNCTIONAL PROPERTIES OF SEAFOODS	10 hours			
Functional properties of seafood proteins: Solubility, emulsification, viscosity, water holding, stability- Sarcoplasmic proteins: Heme proteins, Myoglobin, Hemocyanins, parvalbumins, antifreeze proteins, pigments, enzymes- hydrolases, oxidoreductases- Collagen in fish muscle-skin characteristics of seafood collagen.					
Unit II	FREEZING TECHNIQUES	10 hours			
Technological aspects of freezing: Slow and rapid freezing, Methods of freezing, comparison of various freezing methods, selection of a freezing method, product processing, packaging and different types of freezers-Determination of freezing points from time- temperature plots-preparation of fish for freezing.					
Unit III	FISH CANNING AND SPOILAGE	10 hours			
Introduction to canning and its historical developments-Advantages of canning in relation to other preservation methods- Raw materials and sub materials, their characteristics and suitability for canning- Spoilage of canned foods - types, causes and preventive measures-hygiene and sanitation and waste disposal.					
Unit IV	PACKAGING AND TRANSPORTATION	12 hours			
Introduction to packaging-Importance of packaging in fish processing, functions, objectives and requirements- Properties of packaging materials- Types of packaging materials for canned foods, metal containers (Tin Plate, TFS, Aluminium cans) and retortable pouches- Safety and legislation aspects of packing- Labelling and bar coding- Principles of packaging fresh produce handling and transportation- Transportation of frozen fish-Packaging for retail sale and storage.					
Unit V	FISH BY PRODUCTS AND WASTE UTILIZATION	12 hours			
Fish meal: Dry reduction and wet reduction methods specification of storage-Fish oil body oil liver oil extraction purification preservation storage application-Fish silage acid silage fermented silage application-Fish maws, fish glue, fish gelatin, isinglass, pearl essence- Shrimp wastes chitin, chitosan-production uses-Biochemical and pharmaceutical products.					
Reference Books					
<ul style="list-style-type: none"> ➤ Clucas IJ. 1981. Fish Handling, Preservation and Processing in the Tropics. Parts I, II. FAO. ➤ Andrew CC. 1990. Food Refrigeration Processes. Elsevier. ➤ Regenssein JM & Regenssein CE. 1991. Introduction to Fish Technology. Van Nostrand Reinhold. ➤ Hall GM. (Ed). 1992. Fish Processing Technology. Blackie. 					

<ul style="list-style-type: none"> ➤ KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House. Balachandran KK. 2001. Post-harvest Technology of Fish and Fish Products. Daya Publ. House. ➤ Gopakumar K. (Ed.). 2002. Text Book of Fish Processing Technology. ICAR. ➤ Nambudiri DD. 2006. Technology of Fishery Products. Fishing Chimes. 	
Web Source:	<ul style="list-style-type: none"> ➤ https://www.youtube.com/watch?v=e9kZmwRZHas ➤ https://www.youtube.com/watch?v=At4dDZQbnoA

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to –	Cognitive Level
CO1:	Understand the functional properties of seafood proteins and know the pigments, enzymes, hydrolases, oxidoreductases, collagen and skin characteristics of seafood.	K1, K2
CO2:	Be familiar with the technological aspects of freezing, processing, packaging - Determination of freezing points from time- temperature plots- preparation of fish for freezing.	K1, K2
CO3:	To know the advantages of canning in relation to other preservation methods and understand the spoilage of canned foods - types, causes and preventive measures- hygiene and sanitation and waste disposal.	K1, K2
CO4:	Understand the Importance of packaging in fish processing, - Properties of packaging materials, Labelling and bar coding - methods of transportation of frozen fish.	K1, K2
CO5:	Know the procedure on fish liver oil extraction, purification, preservation, storage application. Usage of shrimp wastes chitin, chitosan-production and its pharmaceutical importance.	K1, K2

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	L	L	L	L	L	L	H
CO2	L	L	L	L	L	L	L	H
CO3	L	L	L	L	L	L	L	H
CO4	L	L	L	L	L	L	L	H
CO5	L	L	L	L	L	L	L	H

(H-High, M-Medium, L-Low)

ELECTIVE VI: Industry/Entrepreneurship
c) MUSHROOM PROCESSING: VALUE ADDED PRODUCTS

Semester	IV
Course Type	ELECTIVE VI
Title of the Course	c)MUSHROOM PROCESSING: VALUE ADDED PRODUCTS
Course Code	
Teaching Hours	54 Hours/ Semester : 3 Hours/ week

	MUSHROOM PROCESSING: VALUE ADDED PRODUCTS	Credits: 3	Max. Marks: 100
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Course Prerequisites: Have basic knowledge of the aseptic handling in microbiology and entrepreneurial interest

CODE:	MUSHROOM PROCESSING: VALUE ADDED PRODUCTS	L	T	P	C
		3	-	-	3

Course Objectives	<ul style="list-style-type: none"> ➤ To teach the types of mushroom, life cycle, nutritive, medicinal value of mushroom in ➤ To teach the infrastructural requirements for mushroom culture ➤ To make understand the edible and medicinal mushroom production ➤ To teach the Disease management and Post harvest processing in mushroom cultivation ➤ To teach the various value added products from Mushroom
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Unit I	MORPHOLOGY AND IMPORTANCE OF MUSHROOM	10 hours
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Introduction to Mushroom –Role in nature and society, Basic structure and morphology of mushroom, Nutritive value of mushroom, Medicinal mushroom-Pharmaceutical value Types of mushroom (Edible, Non-edible and poisonous), Life cycle of mushroom, Identification of wild mushroom

Unit II	INFRASTRUCTURE, SKILL AND REQUIREMENTS FOR ARTIFICIAL CULTURE OF MUSHROOM	10 hours
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farm, -Spawn Unit, Production Unit, Cropping Unit and post-harvest handling unit, Machinery, Equipments and instruments in mushroom production and processing, Farm Design for mushroom production unit –Layout and construction materials, Laboratory requirements – Instruments and equipments, Pure culture of mushroom and its preservation techniques, Raw materials, Formulation and Sterilization

Unit III	COMMERCIAL PRODUCTION OF EDIBLE MUSHROOM AND MEDICINAL MUSHROOM	12 hours
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Spawning and casing and culture practice of White button mushroom (*Agaricus bisporus*), Ingredients, formulation of substrate preparation and crop management of oyster mushroom (*Pleurotus ostreatus*), Traditional and modern cultivation technologies of paddy straw mushrooms (*Volvariella volvacea*), Cultivation of milky mushroom (*Calocybe indica*), Production technology of the medicinal mushrooms: *Lentinus edodes* (Shiitake) and *Ganoderma*

lucidum (Reishi), *Flammulina velutipes* (Winter mushroom) and *Cordyceps militaris* (Entomopathogenic fungus)

Unit IV	POST HARVEST TECHNOLOGY OF MUSHROOM AND DISEASE MANAGEMENT	10 hours
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Growth regulators for mushroom yield enhancement, Quality traits and consumer acceptability, Post-harvest handling of fresh mushrooms, Recycling of spent mushroom waste, Microbial diseases of mushroom and their managements-bacterial, fungal and moulds and fungal diseases, Pest mushroom management (Insect and nematode)

Unit V	VALUE ADDED PRODUCTS AND MUSHROOM MARKETING	12 hours
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Ingredients and preparation of Mushroom soup powder ,mushroom nuggets, Mushroom ketch-up, Mushroom candy, mushroom pickle and mushroom preserve (murabba),mushroom Chips, Art of mushroom cooking : Mushroom tomato soup, mushroom onion soup, mushroom pakoda ,kadai mushroom, mushroom curry, mushroom tomato sauce,mushroom cabbage salad,mushroom dum biryani, Marketing of mushroom :Global and domestic, Entrepreneurial capital, SWOT analysis ,Licences legal frame work , Government Schemes

ReferenceBooks

- Marimuthu, T. et al. 1991. Oster Mushroom. Department of Plant Pathology. Tamil Nadu Agricultural University, Coimbatore.
- Nita Bhal, 2000. Handbook on Mushrooms. 2nd ed. Vol. I and II. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
- Pandey R.K, S. K Ghosh, 1996. A Hand Book on Mushroom Cultivation. Emkey Publications.
- Pathak, V. N. and Yadav, N. 1998. Mushroom Production and Processing Technology. Agrobios, Jodhpur.
- Tewari Pankaj Kapoor, S. C., 1988. Mushroom Cultivation. Mittal Publication, New Delhi.
- Tripathi, D.P., 2005. Mushroom Cultivation, Oxford & IBH Publishing Co. PVT.LTD, New Delhi.
- Pathak, V.K., Nagendra Yadav and Maneesha Gaur, 2000. Mushroom Production and Processing Technology/ Vedams Ebooks Pvt Ltd., New Delhi.

Web Source:	<ul style="list-style-type: none"> ➤ https://en.wikipedia.org/wiki/Mushroom ➤ https://en.wikipedia.org/wiki/Edible_mushroom
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Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to –	CognitiveLevel
CO1	Will understand the structure and morphology of mushroom, Nutritive value of mushroom, Pharmaceutical value Types of mushroom -Life cycle of mushroom	K1, K2
CO2	Will know the different units in Mushroom cultivation-Machinery, Equipments and instruments in mushroom production, Farm Design for mushroom production- Pure culture of mushroom and its preservation techniques, Raw materials and Sterilization	K1,K2
CO3	Will understand the pawning and casing and culture	K1,K2

	practice-Ingredients, formulation of substrate preparation and crop management of oyster mushroom, Traditional and modern cultivation technologies of paddy straw mushrooms.	
CO4	Will understand the Growth regulators for mushroom yield enhancement, Post-harvest handling of fresh mushrooms, Recycling of spent mushroom waste, Microbial diseases of mushroom and their management.	K1, K2
CO5	Will understand the Value added products preparation of Mushroom, Marketing of mushroom :Global and domestic, Entrepreneurial capital, SWOT analysis, Licenses legal frame work , Government Schemes	K1,K2

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create.

Mapping with PSO:

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	L	L	L	L
CO2	M	H	L	L	L	L	L	L
CO3	H	L	L	M	L	L	L	L
CO4	H	H	L	L	L	L	L	L
CO5	M	H	L	L	L	L	L	L

(H-High, M-Medium, L-Low)

Skill Enhancement Course [SEC] – III

Course Objectives:		
The main objectives of this course are:		
1.	Students should understand basic concepts in Animal behaviour.	
Course I	:	Skill Enhancement Course [SEC] – III
Course title	:	a)Animal behavior
Credits	:	2
Pre-requisite:		
Students should be aware of ecology and the animals in their respective environments.		
Expected Course Outcome:		
Upon completion of this course, Students would have		
I	Recall and record genetic basis and evolutionary history of behaviour.	K1 & K2
II	Analyse and identify innate, learned and cognitive behaviour and differentiate between various mating systems.	K3 & K4

III	Classify movement and migration behaviours and explain environmental influence upon behaviour.	K1, K4 & K5
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K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.
II	Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.
III	Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.
IV	Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of honey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals: Languages and mental representation, non-verbal communication in human, mental images, Intelligence, tool use and culture, Animal awareness and Emotion.
V	Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo-transduction; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases – Chronopharmacology, chronomedicine, chronotherapy.

Reading list

1. David McFarland, 1985. Animal Behaviour, Longman Scientific & Technical, UK. 576pp.
2. Harjindra Singh, 1990. A Text Book of Animal Behaviour, Anomol Publication, 293pp.
3. Hoshang S. Gundevia and Hare Govind Singh, 1996. Animal Behaviour, S. Chand & Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. Biological Rhythms. Narosa Publishing House, Delhi.

Recommended texts

1. Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2. Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3. Davis E. Davis, 1970. Integral Animal Behaviour, Mac Millan Company, London, 118pp.
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	L	M	M	L	L
CO2	S	M	L	L	S	L	M	M	L	M
CO3	M	L	M	L	S	S	M	S	M	S
CO4	S	S	S	S	M	S	L	L	L	M
CO5	S	L	L	L	M	L	L	S	M	S

*S - Strong; M - Medium; L- Low

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	H	M	L	M	L	L	L	L
CO2	M	H	L	L	L	L	L	L
CO3	H	L	L	M	L	L	L	L
CO4	H	H	L	L	L	L	L	L
CO5	M	H	L	L	L	L	L	L

(H-High, M-Medium, L-Low)

SEC-III: b) ANIMAL CELL BIOTECHNOLOGY

Semester	IV
Course Type	SEC-III
Title of the Course	b)ANIMAL CELL BIOTECHNOLOGY
Course Code	
Teaching Hours	54 Hours/ Semester : 3 Hours/ week

	ANIMAL CELL BIOTECHNOLOGY	Credits: 3	Max. Marks: 100
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Course Prerequisites:

The student should have a basic knowledge on genes, genetic engineering, microbiological aseptic practices.

CODE: NZOEPA	ANIMAL CELL BIOTECHNOLOGY	L	T	P	C
		3	-	-	3

Course Objectives	<ul style="list-style-type: none"> ➤ To give understanding on cell culture, requirements for animal cell laboratory ➤ To teach the concepts of tissue culture, organ culture tissue engineering its ethics and applications ➤ Tools used in genetic engineering, transgenic animal and their applications ➤ Concepts and applications of genetic engineering RNA interference (RNAi), Antisense oligodeoxynucleotide Technology, gene knock out/ gene targeting; generation of transgenic animals ➤ Assisted reproductive technology, animal conservation, Good laboratory practices. 	
Unit I	INTRODUCTION & SCOPE OF ANIMAL CELL CULTURE	8 hours
Introduction and History of Cell Culture, types of cell culture, Laboratory Requirements for Animal Cell Culture in animal cell biotechnology, Media & Reagents Used in Animal Cell Biotechnology, Instruments and analytical techniques; Secondary Cell Culture and Cell Lines and Application of Animal Cell Culture.		
Unit II	BASICS OF ANIMAL CELL CULTURE	10 hours
The basic concept of tissue culture, Organ culture & applications, Different organ culture methods, Applications of organ culture; The basic concept of tissue engineering; Materials required for tissue engineering & their selection criteria; Applications of tissue engineering in generation of various organs; Ethical implication of tissue engineering.		
Unit III	MODIFYING ENZYMES AND USES IN ANIMAL CELL BIOTECHNOLOGY	14 hours
Modifying enzymes, different classes of modifying enzymes and their uses in animal cell biotechnology/ genetic engineering- Basic concept of transgenic animals, method of transgenic animal creation, ethical, social and legal concern related to transgenic animals, applications of transgenic animals in medicine, agriculture and industrials- Methods for construction of recombinant animal viral vectors for gene transfer into cell lines; structure of different animal viral vectors. application and future perspective of animal viral vectors		
Unit IV	CONCEPTS OF GENETIC ENGINEERING	12 hours
Concept of Genetic Engineering, Methods in genetic engineering, Applications of Genetic Engineering, Future prospects of Genetic Engineering- Gene Expression in Eukaryotes Techniques in manipulation of gene expression in eukaryotes, RNA interference (RNAi), Antisense oligodeoxynucleotide Technology, Designed transcription factor- Collection and Purification Process of Recombinant Proteins- gene knock out/ gene targeting; generation of transgenic mouse, Applications of the gene knock out/ targeting.		
Unit V	ASSISTED REPRODUCTIVE TECHNOLOGIES	10 hours
Sperm and Embryo sexing and disease transmission; Pregnancy Diagnosis in Animals; Stem Cell Technology and Therapeutics; Cell Cryopreservation and Animal Conservation; Animal cell		

culture, Tissue culture, Biosafety level, Different level of Bio-safety, Good Laboratory Practice Ethical Issues related to the Animal Cell

ReferenceBooks

- Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K and J.D. Watson. 1994. Molecular Biology of the Cell. (3rd Edn.), Garland Publishing Inc., New York.
- Ed. John R.W. 2000. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press.
- Griffith, A.J.F., Wessler, S. and R. Carroll. 2000. An Introduction to Genetic Analysis (7th Edn.), W.H. Freeman & Co.
- Srinivastava, A. K., Singh, R. K. and M. P. Yadav. 2005. Animal Biotechnology, Oxford and IBH Publishing Co. CFA Bryce Pvt. Ltd.
- Yadav, P.R. and R. Tyagi. 2006. Biotechnology of Animal Tissue. Discovery Publishing House, New Delhi.
- Ramadass, P. 2008. Animal Biotechnology: Recent Concepts and Developments. MJP Publishers, India.
- Ian Freshney, R. 2010. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, John Wiley and Sons

Web Source:

- <https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g==>

Course Outcomes (COs):

Course Outcome	After the Completion of the Course, the student will be able to –	CognitiveLevel
CO1	Know the history of animal cell culture, laboratory requirements, equipments and media requirements for animal cell culture and applications of animal cell culture technique.	K1, K2, K3
CO2	Understand the basic concept of tissue culture, organ culture, tissue engineering, application of tissue engineering in organ generation and ethical implication in tissue engineering.	K2,K4,K5
CO3	Types modifying enzymes their uses in animal cell biotechnology. concept of transgenic animals , ethical, social and legal concern related to transgenic animals, applications of transgenic animals, Construction of recombinant animal viral vectors, different animal viral vectors. application of animal viral vectors	K1,K2,K3,K6
CO4	Concept & Methods of Genetic Engineering, manipulation of gene expression in eukaryotes, generation of transgenic animals; RNA interference (RNAi), Antisense oligodeoxynucleotide Technology - gene knock out/ gene targeting, Applications of the gene knock out/ targeting.	K1, K2, K3
CO5	Pregnancy Diagnosis in Animals; Sperm and Embryo sexing; Stem Cell Technology and Therapeutics; Cell Cryopreservation and Animal Conservation; GLP Ethical Issues related to the Animal Cell culture.	K2, K3,K4

K1- Remember; K2- Understand; K3- Apply; K4- Analyze; K5- Evaluate; K6- Create

Mapping with PSO:

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	L	M	H	M	L	L	L	L
CO2	M	H	H	L	L	L	L	L
CO3	M	H	H	H	L	L	L	L
CO4	M	H	H	H	L	L	L	L
CO5	M	H	H	M	L	L	L	L

(H-High, M-Medium, L-Low)

SEC-III: c) Stem Cell Biology

Course Objectives:		
The main objectives of this course are:		
1.	Students should know understand the basics of stem cells	
Course I	:	SEC-III
Course title	:	c) Stem cell biology
Credits	:	2
Pre-requisite:		
Students should understand the basics of stem cells and its applications		
Expected Course Outcome:		
On the successful completion of the course, student will be able to		
I	Understand the basic knowledge of stem cells and their origin	K1 & K2
II	Differentiating the embryonic and adult stem cells	K3 & K4
III	Understand and apply the current stem cell therapies for their research	K5

K1- Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

Units	
I	Introduction to stem cell biology: Stem cell definition, origin and hierarchy, stem cell properties, Identification and Characterization, potency and differentiation, niche of stem cell, overview of different stem cell types (embryonic stem cells, adult stem cells and induced pluripotent stem cells).
II	Embryonic stem (ES) cell: Characterization and properties of ES cells , pluripotency and self-renewal of ES cells; molecular mechanisms regulating pluripotency and maintenance of the stem state, progressive differentiation of ES cells into ectoderm lineage organs (skin, brain and nerve), mesoderm lineage organs (heart, kidney, muscle, bone and blood), and endoderm lineage organs (lung, liver, stomach, pancreas and intestine).
III	Adult stem cells: Mesenchymal stem cells (MSCs) - sources, properties (plasticity, homing and engraftment), potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells (iPSCs); role of Yamanaka factor in

	iPSCs.
IV	Stem cell and aging: aging theory; cell cycle; telomere and telomerase; senescence of stem cell; role of stem cell in aging; tissue repair and regeneration of adult stem cell.
V	Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.

Reading list

1. Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.), Jones & Barlett Publishers.
2. Lanza, R. and A. Atala. 2005. Essentials of Stem Cell Biology. Academic Press, pp-712.
3. Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc, pp-429.
4. Lanza, R. *et al.* 2004. Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.
5. Institute of Medicine, 2002. Stem cells and the future of regenerative medicine. National Academy Press, pp-112.
6. Marshak, D., R.L. Gardner and D. Gottlieb. 2001. Stem Cell Biology, Cold Spring Harbour Monograph Series, 40, pp-550.
7. Booth, C. 2003. Stem Cell Biology and Gene Therapy, Cell Biology International, Academic Press.

Recommended texts

1. Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. 2001. Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.
2. Sell, S. and Totowa, N.J. 2004. Stem Cells Handbook, Humana Press, pp-534.
3. Sullivan, S., C. A. Cowan and K. Eggan. 2007. Human Embryonic Stem Cells: The Practical Handbook, Wiley Publishers, pp-424.
4. Battler, A., and Leo, J. 2007. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer Publication, pp-422.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	S	M	S	M	M

CO2	S	S	M	S	S	S	S	S	S	L
CO3	S	M	S	S	S	S	M	L	S	M
CO4	S	S	S	S	S	M	M	S	L	M
CO5	S	S	S	M	M	S	S	S	S	S

*S-Strong; M-Medium; L-Low