M.Sc.,

ZOOLOGY

SYLLABUS

FROM THE ACADEMIC YEAR

2023-2024

TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION, CHENNAI – 600 005

S.NO.	SEM	SUB CODE	PAPER	HOURS/WEEK	CREDIT	EXAM HOURS	MARKS		
							INTERNAL	EXTERNAL	TOTAL
1	**I**	23PZO1	**CC I** -Structure and Function of Invertebrates	**7**	**5**	**3**	**25**	**75**	**100**
2	**I**	23PZO2	**CC II -** Comparative Anatomy of Vertebrates	**7**	**5**	**3**	**25**	**75**	**100**
3	**I**	23PZO3P	**CC III -** Zoology Practicals-I	**6**	**4**	**4**	**25**	**75**	**100**
4	**I**	23PZOE1A	CCE-I -**Molecules and their interaction relevant to Biology** / Bioinstrumentation	**5**	**3**	**3**	**25**	**75**	**100**
5	**I**	23PZOE2A	CCE-II –**Biostatistics** / Microbiology	**5**	**3**	**3**	**25**	**75**	**100**
6	**II**	23PZO4	CC-IV- Cellular and Molecular Biology	**6**	**5**	**3**	**25**	**75**	**100**
7	**II**	23PZO5	CC- V- Developmental Biology	**6**	**5**	**3**	**25**	**75**	**100**
8	**II**	23PZO6P	**CC VI** -Zoology Practicals-II (Cellular & Molecular Biology and Developmental Biology)	**6**	**4**	**4**	**40**	**60**	**100**
9	**II**	23PZOE3A	CCE-III -**Economic Entomology** / Fishery Biology	**4**	**3**	**3**	**25**	**75**	**100**
10	**II**	23PZOE4A	CCE-IV- **Research Methodology** / Parasitology	**4**	**3**	**3**	**25**	**75**	**100**
11	**II**	23PZOSEI	SEC-I -Poultry Farming(Skill Enhancement Course)	**4**	**2**	**3**	**25**	**75**	**100**
12	**III**	23PZO7	CC-VII -Genetics	**6**	**5**	**3**	**25**	**75**	**100**
13	**III**	23PZO8	CC-VIII- Evolution	**6**	**5**	**3**	**25**	**75**	**100**
14	**III**	23PZO9	CC-IX -Animal Physiology& Immunology	**6**	**5**	**3**	**25**	**75**	**100**
15	**III**	23PZO10P	CC-X -Zoology Practicals -III (Genetics, Evolution, Animal Physiology & Immunology)	**6**	**4**	**3**	**25**	**75**	**100**

16	**III**	23PZOE5A	CCE-V - **Stem cell biology** / Api culture & Seri culture	3	**3**	**3**	**25**	**75**	**100**
17	**III**	23PZOSE-2	SEC-II- Dairy Farming(Skill Enhancement Course - II) (Online Objective)	3	**2**	**3**	**25**	**75**	**100**
18	**III**	23PIT	Internship/ Industrial Activity (30 hrs.)	-	**2**	**-**	**-**	**-**	**-**
19	**IV**	23PZO11	CC-XI- Environmental Biology	**6**	**5**	**3**	**25**	**75**	**100**
20	**IV**	23PZO12P	CC-XII- Zoology Practicals-IV	**6**	**5**	**4**	**25**	**75**	**100**
21	**IV**	23PZO13PW	Project with VIVA VOCE	**10**	**7**	**-**	**-**	**-**	**100**
22	**IV**	23PZOE6A	CCE-VI - **Aquaculture** / Vermiculture	**4**	**3**	**3**	**25**	**75**	**100**
23	**IV**	23PZOSE3	SEC-III - Animal Behaviour	**4**	**2**	**3**	**25**	**75**	**100**
24	**IV**	23PEA	Extension Activity	**-**	**1**	**-**	**-**	**-**	
			Total	**120**	**91**	**-**	**-**	**-**	**2200**

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., Zoology**
Programme Code	
Duration	**PG-2 years**
Programme Outcomes (Pos)	**PO1: Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context. **PO2: Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making. **PO3: Ethical Value** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities. **PO4: Communication Skill** Ability to develop communication, managerial and interpersonal skills. **PO5: Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals. **PO6: Employability Skill** Inculcate contemporary business practices to enhance employability skills in the competitive environment. **PO7: Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur. **PO8: Contribution to Society** Succeed in career endeavors and contribute significantly to society. **PO 9 Multicultural competence** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.

	PO 10: Moral and ethical awareness/reasoning Ability to embrace moral/ethical values in conducting one's life.
Programme Specific Outcomes **(PSOs)**	**PSO1 – Placement** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations. **PSO3 – Research and Development** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

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 Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) 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 withknowledge 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 vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology.
II	Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development ,general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.
III	General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs
IV	Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.
V	Sense organs: Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord; Nerves-Cranial, Peripheral and Autonomous nervous systems.

Reading list

1. SwayamPrabha 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	**:**	**Zoology Practical –I**
Credits	**:**	**4**
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 anddigestive systems
Crab : Nervous system

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

1. *Amoeba*
2. *Entamoebahistolytica*
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. *Penaeusindicus*
3. *Emerita* (*Hippa*)
4. *Pernaviridis*

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 *Scoliodonlaticaudatus* – 5thor Trigeminal nerve
2. Nervous system of *Scoliodonlaticaudatus* – 7thor Facial nerve
3. Nervous system of *Scoliodonlaticaudatus* –
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. *Scoliodonlaticaudatus*(Indian dog shark)
4. *Trygon*sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus*(Cat fish)
7. *Belonecancila*(Flute fish)
8. *Exocoetuspoecilopterus*(Flying fish)
9. *Mugilcephalus*(Mullet)
10. *Tilapia mossambicus*(Tilapia)
11. *Rachycentroncanadum*(Cobia)
12. *Tetrodonpunctatus*(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. Chatterjeee, P. Chattopadhya. 2011. Advanced Practical Zoology, ArunabhaSen 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

Course Objectives:		
The main objectives of this course are:		
1.	Students should know the fundamentals of biochemistry	
Course I	**:**	**Elective I (I/I)**
Course title	**:**	**Molecules and their interaction relevant to Biology**
Credits	**:**	**3**

Pre-requisite:

Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism and functions of biomolecules.

Expected Course Outcome:

On the successful completion of the course, student will be able to:

I	Learn the structure, properties, metabolism and bioenergetics of biomolecules	**K1 & K3**
II	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation	**K1 & K2**
III	Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers	**K2 & K3**
IV	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids	**K2 & K4**
V	Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures	**K5 & K6**

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

Units	
I	Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
II	Biomolecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

III	Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes
IV	Structural conformation of proteins and nucleic acids: Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA), t-RNA, micro-RNA).
V	Stabilizing interactions in biomolecules :Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.

Reading list

1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman & Co., New York, pp-1050.
2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.
3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.
4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.
5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.

Recommended texts

1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.
2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.
3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.
4. Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley & Sons (Asia) Pvt. Ltd., pp-1428.

Mapping with Programme Outcomes*

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

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

ELECTIVE – I (I/II)

BIO INSTRUMENTATION Credit – 3

Course objectives:

1. To understand the principle, working and the applications of the instruments used in biological sciences,
2. to acquire knowledge on the recent and advanced techniques used in the field of biological sciences

UNIT- I -MICROSCOPY

Principle and applications of Light microscope, Phase contrast microscope, Fluorescence microscope, Atomic force microscope, Scanning and Transmission Electron microscope (SEM and TEM).

UNIT -II – ANALYTICAL INSTRUMENTS

Principle and uses of analytical instruments: balances, pH meter, Electrophoresis techniques (native, SDS-PAGE, AGE). Principle and working of different types of centrifuge. Autoclave, laminar air flow, colony counter.

UNIT- III - CHROMATOGRAPHIC TECHNIQUES

Principle and applications of Chromatography, Paper Chromatography, Thin Layer Chromatography, Column chromatography - High Performance Liquid Chromatography (HPLC), Gas Chromatography Mass Spectrometry GC-MS,

UNIT -IV - ELECTROCHEMICAL TECHNIQUES

Principle and application of Spectrophotometry – UV visible spectrophotometer, Spectrofluorimeters – Flame photometry- Atomic Absorption Spectrophotometer, IR Spectroscopy,

UNIT -V- BLOTTING TECHNIQUES

Blotting technique: Southern blotting, Western blotting, ELISA and DNA finger printing. Biosensors and Biochips – Principle Hybridoma technology and monoclonal antibodies.

Course Outcome

CO 1	understand and analyse the principles and applications of microscopy and spectroscopy
CO 2	Understand the principles and application of various instruments for biological Science
CO 3	understand and analyse the principles of Micro techniques, Immunocytochemistry and photometry
CO 4	Understand and analyse the types of Chromatography
CO 5	Evaluate the application of various instruments and to uderstand and analyse the types of Electrophoresis

Mapping Course Outcomes with Programme Outcomes

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

REFERENCE BOOKS:

1. Daniel, M., (1992). Basic Biology, Wiley International, NewDelhi.

2. Das. A., (1996). Biophysics and Biological chemistry. Academic publishers, Calcutta.

3. P.K. Gupta (2010). Elements of Biotechnology (Rastogi publication), New Delhi.

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Biostatistics.	
Course I	**:**	**Elective II**
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	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: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.

IV	Hypothesis testing: Student'*t*' test - paired sample and mean difference'*t*' tests. Correlation: Types - Karl Pearsons 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 variance: one way and two way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).

Reading list

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

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

ELECTIVE (II/II)
MICROBIOLOGY **credit -3**

Course Objectives:

1. Know the structure, functions and classification of bacteria, viruses, fungi andyeast
2. Apply knowledge on the Cultivation and control ofmicroorganism
3. Understand the distribution ofmicroorganisms
4. Learn about the microorganisms and theirdetection
5. Understand the application of microorganisms in microbial technology

UNIT – I-HISTORY, STRUCTURE AND ECONOMIC IMPORTANT OF MICROBES

History and Scope of microbiology- Classification of microbes- Whittaker's five kingdom classification - Carl Woese's three domains concept-Types of culture – culture media-culture methods - culture techniques Sterilization. Structure of bacteria, virus, yeast and fungi, - Economic importance of bacteria and fungi. Maintenance of bacteria culture.

UNIT – II- MICROBIAL TECHNOLOGY

Mass production of rhizobium – Single Cell Protein (SCP) – Production of ethanol, citric acid – Antibiotics – Microbial toxins . Microbial Genetics**:** Recombination in Bacteria – Transformation – conjugation – Sexduction; Recombination in Bacteriophage – Transduction – Lytic and Lysogenic cycle.

UNIT – III- MICROORGANISMS AND ENVIRONMENT

Soil microbiology - interactions with the atmosphere. Distribution of Microorganisms in Aquatic environment – Microbial analysis of water samples- in fresh water and marine water. Microorganisms in sewage. Microorganism in extreme environments- thermophilic, methanogenic and halophilic. Photosynthetic bacteria, Cyanobacteria, bioleaching .

UNIT- IV- FOOD AND INDUSTRIAL MICROBIOLOGY

Food Microbiology: Microbes of milk and food, – Food preservation methods- Spoilage of food, fruits, vegetables, cereals, meat, egg, seafood and canned food *Salmonellosis,*- Food borne infections, food poisoning and intoxications (*Clostridium*, *Salmonella*, and

Staphylococcus) mycotoxins in food with reference to Aspergillus species. Industrial Microbiology: Production of lactic acids- hormones and enzyme – production of penicillin.

UNIT – V - MICROBIAL DISEASES

General account of Pathogenic Bacteria – prognosis, diagnosis and treatment for diseases caused by viruses (Yellow fever, Dengue, Corona) - Bacteria (Pneumonia, Whopping cough, leprosy, botulism,) Fungi (Cutaneous mycoses, , Athlete's foot, , Mycotoxicosis) and Protozoa (Malaria, Amoebic dysentery, Trypanosomiasis).

Course Outcome

CO 1	Classify the microbes and understand the structure and characteristic features of bacteria and other microbes
CO 2	Understand and analyze the growth, factors affecting growth, growth characteristics and requirements of bacteria and Identification of microbes
CO 3	Understand and apply the physical and chemical control measure, explains mode of action of antibiotics and lists the microbial diseases in farm animals.
CO 4	Understand and apply role of microbes in food and industries
CO 5	Understand and apply the beneficial role of microbes in biotechnology

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

REFERENCE BOOKS:

1. R.C. Dubey, D.U. Maheshwari (2005). A Text book of Microbiology .S.Chand and Company Ltd, New Delhi.
2. Burden, K.L. and R.P. Williams (6th Ed.) (1968). Microbiology. The Macmillan Co., London
3. Dawes, E.A. (Ed.) (1986). Energy conservation in bacterial photosynthesis. The Macmillan Co., London
4. Doelle, H.W. (Ed.) (1969). Fermentation by acetic acid bacteria and lactic acid bacteria. In: Bacterial metabolism. Academic Press. New York, London. 256 – 351 pp.
5. Gevaral .J, Tortora, Berdell R. Funne Christine L. Cara, (1994). Microbiology an Introduction-fifth edition, The Macmillan Co., London.
6. Hay, J.M. (Ed.) (1986). Modern Food Microbiology.CBS publishers, Delhi.622 pp.
7. Kumarasamy, P, A. Maharajan and V. Ganapiriya. (2012). Microbiology.
8. Reed, G. (4th Ed.) (1983). Prescott & Dunn's Industrial Microbiology. AVI Publishing Co.,
Inc.
9. Roberts, T.A. and F.A. Skinner (Eds.) (1983). Food Microbiology: Advances and Prospects, Academic Press, Inc. London, 393 pp.
10. Selle, A.J. (Ed.) (1967). Fundamental Principles of Bacteriology. Tata McGraw – Hill Publishing Company Ltd., New Delhi, 822 pp.

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 IV**
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 deutroplasm - 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

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

1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al*., 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, *et al*., 1991, Cell Structure and Function (Third Edition), Saunders, Philadelphia, pp-947
6. Watson, J. D., N.H. Hopkins, J.W. Roberts, *et al*., 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, *et al*., 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 V**
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, permatogenesis - 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, Sperm maturation and capacitaion 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, *Amphioxus*, 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 - *Bicoid* and *Nanos* 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 assosciated 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 (5th Edition), CBS College Publishers, New York, pp-782.
2. Gilbert. S. F. 2006. Developmental Biology, 8th 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 (2nd 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 (3rd 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 VI**
Course title	**:**	**Zoology Practical –II (Cellular &Molecular Biology and Developmental Biology)**
Credits	**:**	**4**
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 awares 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 *Drosophila* 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

CELLULAR AND MOLECULAR BIOLOGY

1. Measurement of the size of cells using ocular and stage micrometer
2. Mitosis in root meristematic cells of plants (squash preparation of onion root tip)
3. Preparation and observation of Cells in Onion peel
4. Enumeration of RBC and WBC cells using Haemocytometer
5. Isolation of genomic DNA from eukaryotic tissue
6. Isolation of total RNA from bacterial cells/tissues

7. Agarose gel electrophoresis of DNA
8. SDS-Polyacrylamide gel electrophoresis

SPOTTERS

9. Occular and Stage Micrometer
10. Giant chromosome-Lampbrush chromosome, Balbiani rings

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

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

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 (I/III)**
Course title	**:**	**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 management of pests including natural pest control	**K2 & K3**
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 andR.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. McGraw-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. Oxoford& 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

ELECTIVE III (II/III)

FISHERY BIOLOGY Credit – 3

Course Objectives

1. To explore the aquatic resources of the edible and economically important organisms.
2. To make use of the inland waters and marine potential to substitute the protein requirements by the human population.
3. To provide self-employment opportunities and knowledge for students.
4. Acquire basic knowledge on Oceanography.
5. Study the ecological and economic importance of marine flora and fauna.
6. Understand biodiversity and its conservation strategies of marine organisms.
7. Know the pharmacological importance of marine organisms.
8. Understand the various threats for marine life.

UNIT -I MARINE AND FRESH WATER FISHERIES

World and Indian fisheries, Marine fisheries – Sardines, Mackerals, Carangids and Sharks. Inland fisheries – Freshwater, riverine, reservoir, pond and cold water fisheries. Estuarine and brackish water fisheries- Crustacean fisheries, molluscan fisheries Deep sea fishing.

UNIT- II FISH MIGRATION

History of Ichthyology –.Fishes and their evolutionary history. Fish migration – Types of migratory fishes: Diadromous fishes - Anadromous, Catadramous and Amphidromous - Potomodromous and Oceanodromous fishes. Methods of migration - Factors influencing migration.

UNIT- III FISH POPULATION STUDIES

Assessment of fish stocks: marking and recapture method, area sampling method. Age and growth studies- length-frequency methods, scale method, otolith methods and other skeletal parts as age indicators. Length –weight relationship- condition factor.

UNIT- IV- CRAFTS AND GEARS

Principle and methods of exploitation of sea fishes- ingenious modern gears and crafts – Types of gears used in Indian fishery. Different Types of crafts used in Indian fishery. Material used for making of gears and crafts.

UNIT -V FISH PROCESSING AND MARKETING

Factors influencing spoilage of fishes Methods of fish preservation: curing, (drying, salting, smoking, chilling) accelerated freeze drying (AFD). Principles of canning of fish and fishery products.Packageing and marketing: trends of domestic and export marketing of fishes.

Course Outcomes

COI	Get knowledge about the production of cultivable candidate fish species
CO2	Understand the global, national, traditional and modern techniques related to fishes for food security
CO3	Applypracticalknowledge into the aquaculture field toenhance production level
CO4	Analyze students theoretical and technical knowledge useful for teaching, research, extension and entrepreneurship in the field of Aquaculture
CO5	Assess and evaluate the ecological and economic importance of marine organisms

Mapping Course Outcomes with Programme Outcomes

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

REFERENCE BOOKS:

1. Bose, A.N., Yang, C.T., and Misra, A. (1991) Coastal Aquaculture Engineering. Oxford and Ibh Publishing Co., Pvt. Ltd., New Delhi.
2. Chakrabarti, N.M., (1994) Diseases of Cultivable Freshwater Fishes and Their Control. International Books and Periodicals Supply Service, New Delhi.
3. Day, F., (1986). The Fishes Of India, Vols. I &II.Today and Tomorrow's Book Agency, New Delhi.
4. Govindan, T.K. (1992) Fish Processing Technology, Oxford AndIbh Publishing Co., Pvt. Ltd., New Delhi.

5. MPEDA Hand Book of Aquafarming (1992). Freshwater Fishes, Marine Products Export Development Agency, Kochi.

6. New, M.B., Tacon. A.G.J. and Csavas.I. (1993). Farm – Made – Aqua Feeds. Food and Agrilculture Organization of UnitedNations, Rome.

7. Santhanam, R., (1990). Fisheries Science, Daya Publishing House, New Delhi.

8. Seghal, K.K. (1992). Recent Researches in Cold WaterFisheries, Today and tomorrow's Publishers and Printers, New Delhi.

9. Sinha, V.R.P. (1993) A Compendium of Aquaculture Technologies for Developing Countries.
Center for Science and Technology and Oxford Publishing Co., Pvt., Ltd., New Delhi.

10. Pillai, T.V.R. (1993). Aquaculture: Principles and Practices. Fishing News Agency, London.
11. Raveendran. S., Muthukumaravel, K. Sathick O and Ramamurthy.V. (2011). Estuarine Biology.Aruma Publications, Koradacherry, Thiruvarur.

12. Biswas, S.P., (1993). Manual of Methods in Fish Biology, International Book Co. Absecon Highlands, New Jersey.

13. Jhingran, V.G., (1991). Fish and Fisheries of India.Hindustan Publishing Copr. New Delhi.

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 (I/IV)**
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 theimplications of GLP	**K1**
2.	Learn the working principles of different instruments	**K2**
3.	Gain the knowledge on techniques of histology and histochemistry	**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

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

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

ELECTIVE – IV (II/IV)

PARASITOLOGY Credit - 3

Objective:

1. To study the types of parasites, lifecycle and diseases.

UNIT-I

Parasitism: General consideration- Types of parasites - Type of hosts - Symbiosis and commensalism.

Protozoan parasites: Distribution, habit and habitat, structure life cycle and diseases caused by selected pathogenic protozoan parasites of man: Intestinal and urogenital protozoa: *Entameobahistolytica*(Amoebae) -*Balantidium coli* (Ciliates)-*Giardia lamblia*(Flagellates)-*Trichomonasvaginalis*

UNIT- II

Blood and tissue protozoa: Trypanosoma (*T. brucei and T. cruzi*)-Leishmania (*L. donovani, L. tropica,* Plasmodium (*P. malariae and P.vivax)*

UNIT –III

Helminth parasites - General characters, organization and larval forms of Platyhelminthes and Nemathelminthes.Intestinal helminthes:-*Ascarislumbricoides*(Large intestinal roundworm)-*Trichinellaspiralis*(Trichinosis)-*Trichuristrichiura*(Whipworm)

UNIT- IV

Blood and tissue helminthes: *Dracunculusmedinensis*(Guinea worm)-*Toxocaracanis*-*Ancylostomabraziliensis*, *Wuchereriabancrofti*(Filariasis)- Cestodes (Tapeworms): *Teniasolium*(Pork tapeworm)- *T. saginata*(Beef tapeworm)

UNIT –V

Trematodes (Flukes; Flatworms):- Blood flukes: *Schistosomamansoni*,

Intestinal flukes: *Fasciolopsisbuski*- Liver flukes, *Fasciola hepatica*-. Vector Biology: Vectors and its importance in transmission of parasites- Major malaria vectors of India.Arthropod and Ectoparasites.

Course Outcomes:

CO1	Analyze the basic information and General considerations aboutTypes Parasitism
CO2	Understand and Analyze theBlood and tissue protozoan parasites
CO3	Understand and Analyze theHelminth parasites
CO4	Understand and Analyze theBlood and tissue helminthes
CO5	Understand and Analyze the characteristic features of Trematodes

Mapping Course Outcomes with Programme Outcomes

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

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

TEXT BOOK

1. Chandler A.S. and ReadC.P., Introduction to Parasitology, Wiley, 1970.

REFERENCES

1. Chatterjee K.D., Parasitology, Chatterjee Medical Publishers, 1981.

2. Noble E.R and Noble G.A., Parasitology, Lea and Febiger, 1973.

3. SmythJ.D., Animal Parasitology,Cambridge University Press, 1996.

4. Gillespie Sand Richard D, Principles and Practice of Clinical Parasitology, John Wiley & SonsLtd., 2001.

5.Chiodini P.L. Moody A.H., Manser, D.W. and Livingstone C, Atlas of Medical Helminthology and Protozoology, 4th Ed., 2001.

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Vermiculture.	
Course I	**:**	**Skill Enhancement Course [SEC] - I**
Course title	**:**	**Poultry Farming**
Credits	**:**	**2**
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 andrearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.

Reading list

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

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

*S-Strong; M-Medium; L – Low

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 VII**
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 diseasescaused 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**

Units	
I	Mendel's Experiments – Monohybrid and Dihybrid cross - DNA as the genetic Materials - structure of DNA and RNA. Interaction of genes – Epitasis-Multiple alleles- ABO blood groups. Chemical properties of nucleic acid.
II	Genetic code – codon assignment - Characteristics of genetic code Chromosomal genetics: Structure of chromosomes - Variation in chromosome number and structure - Syndromes.
III	Microbial Genetics:- 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: Tools for Recombinant DNA Technology – Vectors - types - Techniques used in recombinant DNA technology - Restriction endonucleases, DNA modifying enzymes, Ligases.

V	Introduction of rDNA into host cell - calcium chloride mediated gene transfer - *Agrobacterium* mediated DNA transfer, electroporation, microinjection, liposome fusion. Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare

Reading list

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 Publsiher, 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

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, (5^{th} 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 in order to	
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 VIII**
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	Emergence of evolutionary thoughts: Lamarck and Darwin–concepts of variation, adaptation, struggle, fitness and natural selection –Mendelism - Spontaneity of mutations - The evolutionary synthesis
II	Origin of Life: 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 - Anaerobic metabolism, photosynthesis and aerobic metabolism
III	Paleontology and evolutionary history: The evolutionary time scale - Eras, periods and epoch - Major events in the evolutionary time scale - Origins of unicellular and multi cellular organisms. Evolution of man.
IV	The mechanisms: 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.
V	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 MEDIA 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 BalaRostogi, 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 IX**
Course title	**:**	**Animal Physiology& Immunology**
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**

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

Units	
I	Digestive system and Circulatory systen: Digestion and, absorption of carbohydrates, proteins and lipids, energy balance, BMR . Blood corpuscles, plasma and its function, ,haemoglobin, anatomy of human heart structure, ECG – its principle and significance, cardiac cycle, , neural and chemical regulation of Heart beat
II	Respiratory system and Excretory system::, anatomy of lungs, transport of gases, exchange of gases, regulation of respiration. Human kidney structure, physiology of excretion, urine formation, urine composition, , regulation of water balance
III	Nervous system & Endocrinology and reproduction : Neurons, action potential, , central and peripheral nervous system,. Sense organs: Vision, hearing Endocrine glands, hormones and diseases;, gametogenesis,and ovulation
IV	Introduction to Immunology : An overview; Scope of immunology, immune system: Antigens: Definition, characteristic features and classification; Antigenicity versus

	immunogenicity; Adjuvants: definition, types and applications. Lymphocytes - types, morphology, , MHC molecules and their immunologic significance.
V	Cellular and Humoral immune components Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and functional characteristics of various antibody classes

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 Publsiher, pp-774.
2. Hainsworth , F.R. 1981. Animal Physilogy: Adaptation in function, Addison Wesley Longman Publishers, pp-669.
3. Mcfarland, D. 1999. Animal Behaviour: Psychobiology, Ethology and Evolution, Longman Publisher, pp-592.
4. Gorden, 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

CC -X – ZOOLOGY PRACTICAL – III Credit - 4
(GENETICS, EVOLUTION, ANIMAL PHYSIOLOGY AND IMMUNOLOGY)

The main objectives of this course are to:

- To understand Genetically importance and Evolutionary significance.
- To impart training on the techniques of physiological concepts in vertebrate animals.
- To understand molecular mechanisms involved in genetically and physiological mechanisms.
- To Understand Evolutionary trends, the process and patterns of social selection ofanimals.
- To have thorough understanding and Exposure about genetical deficiencies and its physiological changes and their evolutionary impact.

Genetics:

- Drosophila culture – Identifications of Normal, mutants and sexes.
- Blood groups ABO & Rh their genetic significance.
- Human karyotyping & Chromosomal abnormalities.
- Mendelian traits in Humans.

Evolution:
Spotters:

Connecting links, Living fossils, Protective coloration -Leaf insects, Stick insects, Chameleon, Hippocampus, Pepper moth. Mimicry: Monarch and Viceroy butterfly. Quantum evolution; Bat, Petrous.

Animal physiology:

1. O_2 consumption in aquatic animal (fish).
2. Salt loss,Salt Gain in aquatic animal (fish).
3. Differential Counts
4. Total RBC count
5. Estimation of blood glucose level in human (GOD kit).
6. Vaginal smear preparation in rat/mouse/cow to study the stages of oestrous cycle.

Spotters:

Slides **:**T.S of pineal gland, thyroid gland, parathyroid, thymus, adrenal and pancreas,T.S of Ovary, T.S of Testes, Muscles (striated, non-striated and cardiac), Nerve call.
Models: Structure of mammalian eye, organ of Corti,

Immunology :

1. Histology of lymphoid organs (primary and secondary) in chick-(Demonstration)
2. WIDAL test for typhoid detection.
3. Mancini's Single Radial immunodiffusion.
4. Ouchterlony's Double immunodiffusion.
5. Routes of immunization.

Spotters:

Lymph node, Lymphocytes, Vaccine, ELISA, RIA.

Course Outcomes:

CO1	Understand the theories and concepts of Genetics
CO2	Explain the process of evolution in animals
CO3	Compare and understand the events involved in physiology
CO4	Analyze the patterns of evolutionary changes in animals and the population dynamics
CO5	Interpret the genetical,physiological ,immunological and evolutionary interaction, adaptation of animals and its role in animal's habitat ecology

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

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

Course Objectives:		
The main objectives of this course are:		
1.	Students should know understand the basics of stem cells	
Course I	**:**	**Elective V (I/V)**
Course title	**:**	**Stem cell biology**
Credits	**:**	**3**
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, stem cell properties, Identification and Characterization, , 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; 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, potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells
IV	Stem cell and aging: aging theory; cell cycle; telomere and telomerase; 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;

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. Gardener 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

ELECTIVE- V (II/V) Credit - 3
APICULTURE AND SERICULTURE

Course Objectives:

1. The main aim is to give exposure about the culture of silkworm and bees.
2. It gives an idea for the self- employment opportunities to the students
3. It gives an idea aboutthe role of different research organizations and funding agencies to
   Promote Apiculture and Sericulture.

UNIT-I SILKWORM REARING

Types of Silkworm Mulberry Silkworms: Morphology and life cycle of silkworms. Management of egg of silkmouth. Silkworm rearing equipments (Rearing racks and trays, disinfectants, rearing appliances, black boxing) Chawki rearing, bed cleaning, mountages. Types of rearing house, harvesting of cocoons.

UNIT-II SILKWORM DISEASES AND MANAGEMENT

Bacterial Disease	: Flacherie, Septicemia and Sotto Disease
Fungal Disease	: Muscardine
Viral Disease	: Grasserie and InfectiousFlacherie,
Protozoan Disease	: Pebrine
Parasites	**:** Uzi fly, Dermestid beetles

Management – Enemies of silk moths. Selection of raw material for reeling, Storage and preservation of raw materials.Marketing and the role of Central Silk Board in the Development of sericulture.silk reeling techniques. Selection of raw material for reeling, Storage and preservation of raw materials.Marketing and the role of Central Silk Board in the Development of sericulture.

UNIT-III MORICULTURE

Mulberry Species – Classification, cultivation, irrigation and Common Indian mulberry plants and their morphology. Harvesting – various methods -leaf picking – shoot leaf harvesting- branch cutting. Chemical composition and nutritional values of Mulberry leaves.– mulberry planting methods sexual and asexual propagation –. Classification of disease of mulberry. Moriculture: Food and feeding habits of silkworm.

UNIT-IV APICULTURE METHODS

Natural bee colonies and their yield. Present status of apiculture in india. Types of bee hives - structure - location, care and management. Setting up an apiary: (brood and storage chambers, iron frames and comb sheets, drone excluder) rearing equipments, handling of bees-managing bees for honey production- managing bees for crop pollination. Bee foraging - polan and nector are yielding plants.

UNIT-V DISEASES OF APICULTURE

Bacterial Disease : American Foulbrood , European foulbrood.
Fungal Disease : Stone brood
Viral Disease :Dicistroviridae, Sacbrood, lake Sinai virus
Parasites : Varroa Mites, Acarine mites, Nosema Disease

Honey harvesting and extraction process; physicochemical analysis of honey. Uses of honey, bee venom and beeswax in Indian medicine.

Course out come

CO 1	Comprehend the structure, life cycle and various species of silkworm
CO 2	Understand the cultivation, harvest and preservation of mulberry leaves
CO 3	Analyze the genetics in the development of new strains
CO 4	Understand and analyze the different pests infecting silkworm and their control
CO 5	Analyze and Understand the silkworm rearing and silk thread reeling in developing silk farm

Mapping Course Outcomes with Programme Outcomes

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

REFERENCE BOOK

1. Venkatanarasaiah (2013). Sericulture, APH Publishing.

2. Amarder Singh and Ravinder Kumar, (2013). Hand book sericulture part – I.

3. Suresh K.Rao and SajanaRawat (2013). Economic importance of Apiculture, Campus Books international.

4. YoshimaroTanaka.Sericology, Central Silk Board, 99-B, Meghdoot, Marine Drive, Bombay-2

5. Kovaleve, P.A. Silkworm breeding Stocks, Central Silk Board, Marine Drive, Bombay.

6. Sharma P.L. and Singh, S.H**.** Book of Bee keeping.S.Chand publishers.

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Vermiculture	
Course I	**:**	**Skill Enhancement Course [SEC] - II**
Course title	**:**	**Dairy Farming (Online objective)**
Credits	**:**	**2**
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

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

1. https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html
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.	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 X**
Course title	**:**	**ENVIRONMENTAL BIOLOGY**
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 Ecology and organization of Ecosystems	K2
2.	Mechanisms of Ecological balance and its sustanance	K2 & K4
3.	Understand the fundamentals of climatic conditions and its impact on environment	K3 & K5
4.	Realizing the nature of pollution and the ways for its control/reduction	K3

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

Units	
I	Abiotic factors: Water, humidity, light. Biotic factors; Intra (Aggregation, colony formation, social organization) and inter specific associations (Neutralism, symbiosis and antagonism). Structure and function of an ecosystem: -Autotrophic and heterotrophic- producers, consumers - – primary and secondary productivity - methods of measurements -different trophic level - energy flow in an ecosystem - food chain - food web -. pyramids.
II	Nutrient cycles – Nitrogen, phosphorus, Carbon and sulphur – role of microbes in nutrient cycle .Biotic community – Concepts – Stratification – ecological niches – ecotone and ecological succession. Population ecology- definition, natility, mortality Population growth — Population fluctuation - Human population and urbanization.

III	Ecosystem:Structure and function; energy flow primary production and decomposition; structure and function of ecosystems: terrestrial (forest, dessert, grassland) and aquatic (fresh water, marine, eustarine).
IV	Air, Water,soil, thermal, oil, radiation and Marine pollution. Effects and control measures Acid rain, Ozone layer depletion, green house effect, global warming . Bio accumulation – Bio magnification,– Sewage and solid waste management - Natural resources – renewable and non renewable resources
V	Applied ecology:Environmental pollution; global environmental change; biodiversity-status, Conservation biology:Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Reading list

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.
5. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.
6. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.
7. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.
8. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.

Recommended texts

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.

10. Odum, E.P. 1893. Basic Ecology, Saunders & Co., Philadelphia, pp-383.
11. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.
12. 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	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

ZOOLOGY PRACTICAL IV-
ENVIRONMENTAL BIOLOGY **Credit - 5**

The main objectives of this course are to:

- ❖ Understand the nature of relationships among organisms that comprise functioning of Ecosystems.
- ❖ Provide the knowledge on interactions between organisms and their environments to drive the dynamics of populations andcommunities.
- ❖ Understand different habitat ecology, resource ecology and theirmanagement.

ECOLOGY

1. Animal Association: Parasitism, Symbiosis, Mutualism and Commensalism
2. Hydrological studies of water samples with special reference.
    - Chlorides,
    - silicates,
    - calcium,
    - total hardness,
    - phosphates and
    - nitrates
    - pH,
    - dissolved oxygen and
    - BOD,
    - CO_2,
    - Carbonates and Bicarbonates.
3. Quantitative and qualitative estimation of marine & freshwater plankton.
4. Quadrant survey of the given area of the grassland ecosystem(wthin college campus) and construct pyramids of number, biomass and pyramid of energy

SPOTTERS: Secchi Disc, Colorimeter, pH meter, Thermometer, Anemometer, lux meter, BOD Chamber,Environmental Chamber, Environmental shaker, BOD bottle, Green house, HPLC, GC, Atmospheric Gas analyser,Environmental mask.

Report on ecological collection representing different habitats and their adaptations – sandy, muddy, rocky shores fauna

Course Outcome

CO1	Understand the structure and functions of lymphoid organs, types of immunity, structure, types and properties of antigens and immunoglobulins and analyse antibody diversity.
CO2	Explain the process and mechanism of Humoral and Cell mediated immune response & Complements pathways
CO3	Understand the energy transformations across trophic levels and to understand how elements are cycling in the environment
CO4	Explain the concept of limiting factors and interactions of populations and communities in relation to dynamic environmental processes
CO5	Analyze the habitat ecology and to identify various types of natural resources and their management practice

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

*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 (I/II)**
Course title	**:**	**Aquaculture**
Credits	**:**	**3**
Pre-requisite:		
Students should know the fin fishes and shell fishes of commercially importantcandidate 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 anddevelops 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 Indian Aquaculture.Site selection - structure and construction design and layout of fish and shrimp pond - Water quality management for aquaculture. Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays – Fishing gears used in aqua farming.
II	Hatchery technology for Catlacatla, rohu, prawn. Artificial seed production –Induced breeding technique, larval rearing, packing and transportation. Classification of fish feed- Artificial feeds. Types, Feed - formulation - feeding methods. Live feed-, Artemia and their culture.
III	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

	(seabass). Edible and Pearl oyster culture - pearl production. Economic importance of Lobster, Types of Seaweed culture.
IV	Fish and Shrimp diseases and health management – infectious diseases - Bacterial, Fungal, Viral, Protozoan; Diseases diagnosis- ELISA, Western blotting, PCR test, prevention and control measures.
V	Types of ornamental fishes (freshwater and marine), their breeding behavior and biology. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations- CAS-MB, CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA, RGCA 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

Course Objectives:		
The main objectives of this course are:		
1.	Students should know basic concepts in Vermiculture.	
Course I	**:**	**ELECTIVE- VI (II/II)**
Course title	**:**	**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.. Vermitechnology- Definition, history, growth and development in India.
II	Vermiculture - definition, common species for culture; Environmental parmeters; culture methods –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, , , harvesting the compost, storage.
IV	Applications of Vermiculture -vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed.
V	Potentials and constraints for Vermiculture in India. Marketing the products of vermiculture - quality control, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing. Economic importance of Earthworms: In sustainable agriculture earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait and 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, KalyaniPublishers,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

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	**:**	**Animal behaviour**
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**

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 hobey 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 multicellularanimals; 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. HarjindraSingh, 1990. A TextBook of Animal Behaviour, AnomolPublication, 293pp.
3. HoshangS.Gundevia and Hare Goving 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 MillanCompany,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