

**Manonmaniam Sundaranar University,
Tirunelveli – 627 012**



**Programme: M. Sc. Zoology
for affiliated Colleges**

**Course structure under Choice based credit system (CBCS)
Learning Outcome Based Curriculum Framework (LOCF)
(for the students admitted from the academic year 2021-22 onwards).**

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Vision

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

Mission

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

Introduction

Outcome based education is incorporated in the curriculum as per the recommendations of UGC and NAAC quality mandate 2018. The emphasis has been laid on the curriculum reforms through learning outcome based approach. The learning outcomes-based curriculum framework (LOCF) is intended to allow flexibility and innovation in programme design and syllabi development, teaching-learning process, and assessment of student learning levels. LOCF implementation process establish Mission statements, Program Educational Objectives (PEOs), Program outcomes (POs) and Program specific outcomes (PSOs) with Bloom's Taxonomy and mapping the cognitive levels with PO and PSOs.

Preamble

Zoology is the branch of Biology that studies animal Kingdom, including classification, distribution, structure, Biochemistry, Physiology etc. and their interactions with the ecosystem. This is a vast subject that advances workers in the field and tends to specialize in one or more of the subdivisions in which they can hope to become very proficient. The mandatory areas devised with great diligence and expertise by the State Board of Studies of the Tamil Nadu State Council for Higher Education (TANSICHE) are incorporated in the curriculum. Zoology is a complex subject having an immense number of avenues to open up new challenges like the control of COVID-19 pandemic, other epidemic outbreak and categorizing crisis management. Also it motivates the learners to crack the global opportunities in research and finally gain expertise in their field of interest to become Zoology faculty and Scientists.

Programme Educational Objectives (PEOs)

The M.Sc., Programme will enable the students

PEO1:To acquire knowledge on recent development in Science and its applications in various fields.

PEO2:To prepare the post-graduate aspirants to qualify competitive examinations, and subsequent placements.

PEO3:To gain knowledge on agro-based industries related to applied Science leading to self-employment and entrepreneurship.

PEO4:To inculcate scientific literature in Science and promote students with research aptitude to participate in the society oriented research.

PEO5:To upgrade the academic performance of students in par with the national and international levels.

PEO6:To create the holistic development in students and facilitate them to become a responsible Indian citizen.

Programme Outcomes (POs)

Upon completion of M.Sc., programme the students will be able to

PO1: Gain knowledge and skill in the fundamentals of both classic and applied aspects.

PO2: Analyse the interactions among the diverse animals and their relationship with the environment.

PO3: Understand the various genetic principles and their importance to animal and human health.

PO4: Acquire knowledge on applied and agro-based industries such as sericulture, aquaculture, poultry farming, vermicomposting etc.

PO5: Make use of the principles and professional ethics while delivering their duties in relevant fields.

PO6: Apply the knowledge and understanding for utilization of renewable energy for sustainable development and creating a clean and healthy environment.

PO7: Contribute their education and experience to the development of our country.

Programme Specific Outcomes (PSOs)

Upon completion of M.Sc., Zoology programme, the student will be able to

PSO1: Apply various concepts of Zoology in genetic engineering, soil fertility, food industry, clinical laboratory, health and hygiene etc.

PSO2: Utilize academic proficiency, effective communication and practical skills in dissemination of knowledge.

PSO3: Make use of the knowledge and skills to face pandemic, epidemic and other health issues.

PSO4: Critically evaluate various ecological issues and resolve the complex environmental problems.

PSO5: Design research project to collect, present, use statistical packages for analysis and interpret the biological data

PSO6: Practice moral standards and ethical principles in biological research leading to social and clinical values.

PSO7: Participate in competitive examinations and become professionals at various field of animal sciences including research and teaching.

PSO8: Develop empathy and love towards the wild animals, their environment and conservation practices.

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Programme - M. Sc. Zoology

Course structure under Choice based credit system (CBCS) for affiliated Colleges

Learning Outcome Based Curriculum Framework (LOCF)

(For the students admitted from the academic year 2021-22 onwards)

SEMESTER I									
Course	Course code	Name of the Course	Hrs/W		Credit	Exam hrs	Marks		
			L	P			CIA	EA	Total
Core I		1.1 Structure and function of Invertebrates	4+		4	3	25	75	100
Core II		1.2 Comparative Anatomy of Chordates	4+		4	3	25	75	100
Core III		1.3 Environmental Biology	4+		4	3	25	75	100
Core IV		1.4 Biochemistry	4+		4	3	25	75	100
Core Practical I		Practical I (1.1 & 1.2)		4	2	3	50	50	100
Core Practical II		Practical II (1.3 & 1.4)		4	2	3	50	50	100
		Total	22	8	20				
SEMESTER II									
Course	Course code	Name of the Course	Hrs/W		Credit	Exam hrs	Marks		
			L	P			CIA	EA	Total
Core V		2.1 Cell and Molecular Biology	4+		4	3	25	75	100
Core VI		2.2 Developmental Biology	4+		4	3	25	75	100
Core VII		2.3 Genetics	4+		4	3	25	75	100
Core VIII		2.4 Evolution	4+		4	3	25	75	100
Core Practical III		Practical III (2.1 & 2.2)		4	2	3	50	50	100
Core Practical IV		Practical IV (2.3 & 2.4)		4	2	3	50	50	100
Field work		Field work in any core subject		4	3				
		Total	18	12	23				

SEMESTER III									
Course	Course code	Name of the Course	Hrs/W		Credit	Exam hrs	Marks		
			L	P			CIA	EA	Total
Core IX		3.1 Comparative Animal Physiology	4+		4	3	25	75	100
Core X		3.2 Animal Biotechnology	4+		4	3	25	75	100
Core XI		3.3 Research Methodology	4+		4	3	25	75	100
Core XII		3.4 Microbiology	4+		4	3	25	75	100
Core Practical V		Practical V (3.1 & 3.2)		4	2	3	50	50	100
Core Practical VI		Practical VI (3.3 & 3.4)		4	2	3	50	50	100
		Total	22	8	20				
SEMESTER IV									
Course	Course code	Name of the Course	Hrs/W		Credit	Exam hrs	Marks		
			L	P			CIA	EA	Total
Core XIII		4.1 Biostatistics and Bioinformatics	4		4	3	25	75	100
Core XIV		4.2 Immunology	4		4	3	25	75	100
Core XV		4.3 Entomology	4		4	3	25	75	100
Elective XVI		4.4 Aquaculture / Sericulture	3+		4	3	25	75	100
Core Practical VII		Practical VII (4.1 & 4.2)		4	2	3	50	50	100
Core Practical VIII		Practical VIII (4.3 & 4.4)		4	2	3	50	50	100
		Project (Compulsory)		6+	8		50	50	100
		Total	15	14	27				

Course components:

Course division	No. of courses	Total credits	Total marks
Core Courses	15	60	1500
Elective	01	03	100
Practical	08	16	800
Field work	01	03	100
Project work	01	08	100
Total	26	90	2600

Duration of the course: Two years (Four semesters)

Date of Effect: For the students admitted during the academic year 2021-22 and onwards.

Eligibility condition:

Those who have passed B.Sc. Zoology, B. Sc. Advanced Zoology, B.Sc. Applied Zoology, B.Sc. Animal Science and Biotechnology, B.Sc. Advanced Zoology and Biotechnology, B.Sc. Life Science and B.Sc. Biology (Hon.) from recognized university.

Theory Examination:

The M.Sc. Zoology Core Theory Examination having the following marks.

Internal Marks – 25		External Marks - 75	
CIA Test	= 15 marks	Section A: 10x 1 =	10 marks (Q.No. 1 to 10)
Assignment	= 05 marks	Section B: 05 x 5 =	25 marks (Q.No. 11 to 15)
Seminar	= 05 marks	Section C: 05 x 8 =	40 marks (Q.No. 16 to 20)
Total	= 25 marks	Total	= 75 marks

Practical Examination:

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

Internal - 50		External – 50	
Major Practical	= 15 marks	Major Practical	= 15 marks
Minor Practical	= 10 marks	Minor Practical	= 10 marks
Spotters (ABC&D) 4x5	= 20 marks	Spotters (ABC&D) 4x4	= 20 marks
Observation Note book	= 05 marks	Observation Notebook	= 05 marks
Total = 50 marks		Total = 50 marks	

Passing minimum of 50% for external and overall components.

CORE PAPER I: 1.1 STRUCTURE AND FUNCTION OF INVERTEBRATES

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- ❖ insist the importance of nomenclature and taxonomic classification of invertebrates and fundamental concepts.
- ❖ acquire knowledge on the similarities and differences of structural organization between organisms and functional relations among invertebrates.
- ❖ understand the structure of different organ systems and their special functional adaptations.
- ❖ emphasize the role of functional aspects in the light of evolutionary significance.
- ❖ importance of larval forms and minor phyla to understand the phylogeny.

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: develop critical understanding of fundamental concepts in taxonomic procedure and identification of invertebrates at species level using bioinformatics tools.

CO2: examine the pattern of locomotion and nutrition of invertebrates on the basis of their morphological characteristics and structures.

CO3: apply the knowledge of respiration, circulation and excretion and analyses how do the variations are established among invertebrate animals.

CO4: analyses the progressive complexity of nervous system among invertebrates and compare the complexity of neural evolution with other taxa.

CO5: interpret and conclude how the morphological changes occur in invertebrate due to changes in environment and help to drive evolution over a long period of time.

CO6: The course makes a detailed comparison of the anatomy of invertebrates and also highlights how the taxonomic hierarchy relates their complexity of structure and function. The course thus gives an overview of the intricate life processes and adaptive radiations in invertebrates.

Unit: I Principle of Animal taxonomy

Basic concept of Biosystematics and its significance. Species concept; International code of Zoological Nomenclature - New trends in taxonomy – Taxonomic procedures-Animal collection, handling and preservation – process of identification of species-Organization of coelom – Acoelomates – Pseudocoelomates - Coelomates: Protostomia and Deuterostomia.

Unit: II Locomotion and Nutrition

Locomotion: Pseudopodia - Flagella and ciliary movement in Protozoa - Hydrostatic movement in Coelenterates, Annelida and Echinodermata. Nutrition and Digestion - Patterns of feeding and digestion in lower Metazoan - Filter feeding in Polychaeta, Feeding mechanism in Arthropoda, Mollusca and Echinodermata.

Unit: III Respiration, Circulation and Excretion

Organs of respiration: gills, lungs and trachea - Respiratory pigments - Mechanism of respiration. Haemolymph-tubular and neurogenic heart - blood vessels- Circulation pattern. Excretion - Organs of excretion: coelom, coelomoducts, nephridia and Malpighian tubules - Mechanisms of excretion and osmoregulation.

Unit: IV Nervous system

Primitive nervous system: Coelenterata and Echinodermata - Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda) - Trends in neural evolution.

Unit: V Invertebrate larval forms and Minor Phyla

Larval forms of free-living Invertebrates - Larval forms of parasites - Strategies and evolutionary significance of larval forms (Crustaceans and Echinoderm larva). Minor Phyla (Structural features and affinities) - Concept and significance - Organization and general characters.

Suggested Reading Material

1. Hyman, L.H. The Invertebrates. Vol.1 Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function. Thomas Nelson and Sons Ltd., London.
3. Bullock, T. H. (1977) Introduction to nervous systems, San Francisco: W. H. Freeman.
4. Hyman, L.H. The Invertebrates. Vol.2-8. McGraw Hill Co., New York and London.
5. Barnes, R.D. Invertebrate Zoology, III edition. W.B. Saunders Co., Philadelphia.
6. Russel-Hunter, W.D. A Biology of Higher Invertebrates, the Macmillan Co. Ltd., London
7. Hyman, L.H. The Invertebrate smaller coelomate groups, Vol.V. McGraw Hill Co., New York.
8. Sedgwick, A. A student text book of Zoology. Vol.I, II and III. Central Book Depot, Allahabad.
9. Parker, T.J., Haswell, W.A. Text Book of Zoology, Macmillan Co., London.

10. EkambaranathaIyer, M and Anantha Krishnan, N.A Manual of Zoology. Vol I&II.S. Viswanatan(Printers and Publishers) Pvt. Ltd., Chennai.
11. Jordan, E.L. and Verma, P.S. Invertebrate Zoology. (14th edition) S. Chand and Company Limited, 7361 Ram Nagar, QutabRoad, New Delhi- 110055.
12. Kotpal, R. L. Modern Text book of Zoology, Invertebrates(9th edition) RatogiPublications, GangtriShivaji Road, Meerut.
13. Kotpal, R.L. Minor Phyla, Ratogi Publications, GangtriShivaji Road, Meerut.
14. Verma, A. Invertebrates: Protozoa to Echinodermata. Naris Publishing House, Private Limited. 35-36, Greams Road, Thousand Light. Chennai.

LAB ON STRUCTURE AND FUNCTION OF INVERTEBRATES

1. Collection, Identification and submission of the following
 - A. Insects (10 nos.) B. Campus fauna (5 nos.)
2. Mounting of appendages of prawn
3. Mounting of mouth parts of cockroach or mosquito or silk worm larvae.
4. Mounting of trachea of cockroach or any insect.
5. Dissection of Digestive system, Nervous system and Reproductive system
Cockroach or grasshopper
6. Using CD/ virtual software/Animation-Observation and Comparison of anatomy of Circulatory system and Nervous system of Invertebrates.
7. Museum specimen/ Slides/Models/Charts
Amoeba, Paramecium, Euglena, Ctenophora, Sagitta, Sycon sponge, Madrepora, Chaetopterus, Amphitrite, Freshwater mussel, Sepia, Octopus, Sea Star, and Sea cucumber,
Larval forms:Miracidium larva, Redia larva, Cercaria larva, Rhabditiform larva, Nauplius larva, Zoea larva, Mysis larva, Bipinnaria larva, Brachiolaria, Ophiopleutus larva.

Cos cognitive level and mapping with POs and PSOs:

CORE COURSE 1.1: STRUCTURE AND FUNCTION OF INVERTEBRATES																	
CO	CONGNITIVE LEVEL	PO							PSO								
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER II: 1. 2 COMPARATIVE ANATOMY OF CHORDATES

4Hrs/ Week

Credits 4

LEARNING OBJECTIVES (LOs)

The objectives of the courses are enabling the student to

- ❖ understand the origin, evolution and classification of Chordates.
- ❖ explore the vertebrate morphology and anatomy with the aim to understand the physiological functions and adaptation.
- ❖ explain and describe the physiological adaptations in chordates.
- ❖ compare and evaluate the anatomical structures with functions in the diverse group of chordates.

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: develop understanding of the evolution of vertebrates by integrating the structure, function and development.

CO2: relate the evolutionary concepts including homology and analogy and able to discuss the details of major organ systems.

CO3: analyze and appreciate the basic structural organization of endoskeletal system in diverse groups of chordates and its evolutionary importance.

CO4: compare the similarities and dissimilarities of respiratory, circulatory and nervous system of vertebrates.

CO5: apply the knowledge of progressive changes in the development of urinogenital system and sense organs in relation to their mode of life.

CO6: integrate the morphology of vertebrates with their ecology, behaviour and physiological adaptation in diverse habitats.

CO7: design and construct a teaching module to elucidate/explain the comparative anatomy of chordate.

Unit I Origin of Chordata and Classification

Concept of Protochordata- The nature of Vertebrate morphology - Definition, Diagnostic characters and relation to other disciplines - Importance of the study of vertebrate morphology. Classification of Vertebrates.

Unit II Integumentary system

Skin and its derivatives - Development, general structure and functions of skin and its soft and horny derivatives - Glands, scales, horns, claws, nail, hoofs, feathers and hairs.

Unit III Endoskeletal system and Digestive system

Form and function, Body size and skeletal elements of the body- Comparative account of skull and Vertebral column- Limbs and girdles (Appendicular and axial skeleton). Comparative account of buccal cavity and alimentary canal in Vertebrates.

Unit IV Circulatory, Respiratory and Nervous system

General plan of circulation in various groups. Blood - Evolution of heart - Evolution of aortic arches and portal systems. Respiratory system –Types and Characters of breathing organs in various groups. Nervous system- Comparative anatomy of the brain and spinal cord in relation to the functions- Nerves- cranial and spinal- Peripheral and Autonomous nervous system

Unit V Urinogenital system and Sense organs

Evolution of urinogenital system in Vertebrate series - Simple receptors - Organs of olfaction, taste and hearing and vision - Lateral line system - Electroreception.

Suggested Reading Material

1. Alexander, R.M. The Chordata. Cambridge University Press, London.
2. Barrington, E.J.W. The Biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh.
3. Harish. C. Nigam. Biology of Chordates published by S. L. Jain, Arihant Press, M-5, Industrial Area, Jullundhur City-144004.
4. EkambaranathaIyer M and Ananthakrishnan, T. N.A Manual of Zoology, Chordata N. Viswanatan , S. (Printers and Publishers)Pivate Ltd., Chennai.
5. Jordan, E.L and Verma, P. S. Chordate Zoology., (11th edition). S. Chand, & company Ltd, 7361, Ram Nagar, Wutab Road, New Delhi- 110 055.
6. Bournr, G.H. The structure and function of nervous tissue. Acadamic Press, New York
7. Carter, G.S. Structure and habit in vertebrate evolution –Sedgwick and Jackson, London.
8. Eccles, J. C. The understanding of the brain. McGram Hill Co., NewYork and London.
9. Kingsley, J.S. Outlines of Comparative Anatomy of Vertebrates. Central Book Depot, Allahabad.
10. Kent, C.G. Comparative anatomy of vertebrates. ,
11. MilltonHilderbrand. Analysis of vertebrate structure. IV. Ed. John Wiley and Sons Inc., New York.
12. Monielli, A.R. The Chordates. Cambridge University Press, London
13. Smith, H.S. Evolution of chordate structure. Hold Rinehart and Winstoin Inc., NewYork
14. Sedgwick, A. A Students Text Book of Zoology, Vol.II
15. Tansley, K. Vision in vertebrate. Chapman and Hall Ltd., London
16. Torrey, T.W. Morphogenesis of vertebrates, John Wiley and Sons Inc.,New York and London
17. Walters, H.E. and Sayles, L.D. Biology of vertebrates. Macmillan & Co., New York.

18. Wolstenholmf, E.W and Knight, J. (Ed.).Taste and Smell in vertebrates, J&A Churchill, London.
19. Romer, A.S. Vertebrate body, IIIrd Ed. W.B. Saunders Co., Philadelphia.
20. Young, J.Z. Life of vertebrates. The Oxford University Press, London.
21. Colbert, E.H. Evolution of the vertebrates, John Wiley and Sons Inc., New York.
22. Romer, A.S. Vertebrate Paleontology, 3rd Edn. University of Chicago Press, Chicago.
23. Clark, W.E. History of the Primates IV Edn. University of Chicago Press, Chicago.
24. Young, J.Z. Life of mammals. The Oxford University Press, London.
25. Weichert, C.K. and Presch, W. Elements of chordate anatomy, 4th Edn. McGraw Hall Books Co., New York.
26. Montagna, W. Comparative anatomy. John Wiley and Sons Inc.
27. de Deer, S.G. Embryos and Ancestors. Clarendon Press, Oxford.
28. Andrews, S.M. Problems in vertebrate evolution. Academic Press, New York.
29. Waterman, A.J. Chordata and function.
30. Joysey, K.A. and T.S. Kemp. Vertebrate evolution .Oliver and Boyd, Edinburgh.
31. Lovtrup, S. The phylogeny of vertebrate, John Wiley and Sons, London.
32. Barbiur, T. Reptiles and Amphibians: Their habits and adaptation. HongtonMiffin Co., New York.
33. Kingsely Nobel, G. The biology of the Amphibia. Dover Publications, New York.
34. Smyth. Amphibia and their ways. The McMillan Co., New York.
35. Andrevos, S.M., Miles, R.S. and Walkar, A.D. Problems in vertebrate evolution. Academic Press, New York.

LAB ON COMPARATIVE ANATOMY OF THE CHORDATES

1. Collection, Identification and submission of the following
 - A. Fishes (5 nos.)
 - B. Campus fauna
2. Mounting of scales from shark skin and from a bony fish.
3. Observation of gills and fins of fishes
4. Using CD/ virtual software/Animation-Observation and Comparison of anatomy of Circulatory system and Nervous system of Vertebrates.
5. Museum specimen/ slides/models/charts
Amphioxus, Ascidian, Salpa, Balanoglossus, Petromyzon, Scoliodon, Anabas, Carp, Sardinella, Anguilla, Rana, Salamander, Feathers, beak and claws of birds, Horn and hoof of mammal.
6. Osteology- Skull, Atlas, Axis, typical cervical vertebrae, fore limb, hind limb, pectoral and pelvic girdle of frog / mammal.
7. Vertebrate respiratory organs, alimentary canal, heart, V. S. of heart, brain-dorsal and ventral view and urinogenital system- specimen / models / charts.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: I																
CORE COURSE : 1.2COMPARATIVE ANATOMY OF CHORDATES																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K-4 Analyze	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER III: 1.3 ENVIRONMENTAL BIOLOGY

4Hrs/ Week

Credits 4

Learning Objectives (LOs):

- To provide fundamental environmental concepts that provides an in-depth understanding of our environment.
- The scientific basis for understanding how environmental systems interfere with population and interactions, community ecology and succession, types of ecosystems, pollution effects and conservation.

Course Outcomes (Cos):

The Course will provide an overview of know the concepts of environment, populations ecology and its interactions, community ecology and ecological succession, ecosystems and biography and pollution and conservation.

CO1: Understand the concepts of environment

CO2: Identify the characteristics of population and its interactions

CO3: Understand community ecology and ecological succession

CO4: Appreciate how elements are cycling in the environment

CO5: Understand the productivity and functions of Indian ecosystems

CO6: Understand the types, sources, effects and control of pollution and importance of green-house effect, acid rain and ozone depletion

CO7: Recognise the need of conservation strategies.

Unit I: Environment & Concepts

Environment: Abiotic and biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept and types of habitat and niche; fundamental and realized niche; resource partitioning; character displacement.

Unit II: Population ecology and Species interactions

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Unit III: Community Ecology and Ecological Succession

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Unit IV: Ecosystem and Biogeography

Ecosystem: Structure and functions; energy flow and mineral cycling (C,N,S, and P); primary and secondary production ; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

Unit V: Pollution and Conservation

Environmental pollution: Air, water, soil and radioactive- Sources, effects and control; Biodiversity: status, types and threats; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management, Wildlife Management- Sanctuaries and National parks; Biodiversity hot spots - Remote sensing - Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). Environmental Impact Assessment.

Suggested Reading Materials:

1. Eugene P. Odum and Gary W. Barrett. 2004 Fundamentals of Ecology. Brooks / Cole Publisher.
2. Eugene P. Odum. 1983. Basic Ecology: Fundamentals of Ecology. Holt-Saunders Publishers, Japan.
3. Turk J. and Turk A: Environmental Science. 1988. Saunders College Publishers.
4. Primark, R.B.: A Primer of Conservation Biology. 4th edition. 2008. Sinauer Associates Publishers.
5. Sharma, P. D. Ecology and Environment 13th edition. 2017. Rastogi Publications
6. Kanagasabai, C.S. 2005.Environmental Studies. Rasee publishers. Madurai.
7. Yogendra, N. and Srivastava, N. 1998. Environmental Pollution, Ashish Publishing House. New Delhi.
8. Sapru R.K.2001. Environment Management in India, Vol. I & Vol. II Ashish Publishershouse, New Delhi.
9. Verma, P.S. and Agarwal, V.K. (2007) Environmental Biology: Principles of Ecology. 11th Reprinted Edition. S. Chand & Co. Ltd., India.
10. Kormondy E. Concepts of Ecology. 1995. 4th edition. Pearson Publishers.
11. Dash M. and Dash S. 2009. Fundamentals of Ecology. McGraw Hill Educations.
12. Raman, N. S., Gajbhiye, A. R. and Khandeshwar, S. R. 2019. Environmental Impact Assessment. Dreamtech Press.
13. Lehman, C. Loberg, S. and Clark, 2019. A. Quantitative Ecology: A New Unified Approach. University of Minnesota Libraries Publishing.

LAB ON ENVIRONMENTAL BIOLOGY

1. Estimation of pH in different water samples.
2. Estimation of Total Dissolved Solids (TDS) in different water samples
3. Estimation of Dissolved oxygen
4. Estimation of Dissolved Carbon dioxide (CO₂) in the given water samples.
5. Estimation of Total alkalinity
6. Observation of commensalism and mutualism

7. Observation of host-parasite relationship
8. Observation of prey-predator relationship
9. Food chain and food web in a nearby ecosystem
10. Visit and field study report on a pond, forest or marine ecosystem (any one).

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: I CORE COURSE: 1.3 ENVIRONMENTAL BIOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K-4 Analyze	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER IV: 1.4 BIOCHEMISTRY

4Hrs/ Week

Credits 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- Illustrate the structure of atoms and molecules and their biological importance
- Relate the structure and biological functions of carbohydrates, proteins, lipids, nucleic acids, and vitamins
- Explain the synthesis of carbohydrates, proteins, lipids, and nucleic acids and their role in metabolic pathways
- Analyse the mechanism of action of enzymes, enzyme kinetics and the role of coenzymes, iso enzyme and ribozyme
- Compare the metabolic disorders of carbohydrates, proteins, lipids, and nucleic acids

COURSE OUTCOMES (COs):

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

CO1: Explain the structures and functions of biomolecules

CO2: Classify the biomolecules

CO3: Identify biomolecules structural differences and its properties

CO4: Apply biochemical calculation for enzyme kinetics.

CO5: Analyse the properties of bio molecules

CO6: Interpret the metabolic disorders of biomolecules

CO7: Solve the problems in biochemistry

Unit I

Structure of atoms and molecules. Bonds – covalent, electrovalent, Vander Waal's and hydrogen bond. Water – Biological importance, pH, Buffers – biological importance. Unique solvent properties – electrolytic dissociation into cations and anions, Henderson Hassel Balch equation

Unit II

Carbohydrates – classification, structure, properties, biological importance and functions. Metabolism – Metabolism – glycolysis, TCA cycle, glycogenesis, gluconeogenesis, glycogenolysis, HMP shunt pathway Metabolic disorder: diabetes and their biomedical significance.

Unit III

Protein- classification, structure, properties, biological importance and functions of amino acid -Ramachandran plot. Protein metabolism – deamination and transamination, urea cycle. Metabolic disorders – phenylketonuria, alkaptonuria, albinism Enzyme - classification, co- enzyme, isoenzyme, ribozyme. Enzyme kinetics

Unit IV

Lipid – Classification of lipids- simple, compound and derived lipids. Biological importance of lipids. Beta oxidation of fatty acids, ketosis, biosynthesis of fatty acids and triglycerides. Metabolic disorders – Hypercholesterolemia, Hyperlipoproteinemia and Atherosclerosis. Role of liver in fat metabolism

Unit V

Vitamins – Structure of water soluble and fat-soluble vitamins and deficiency symptoms. Nucleic acids- synthesis and degradation of purines and pyrimidines (De novo and Salvage pathways). Syndromes associated with nucleic acid metabolism- Lesch -Nybansyndrome, gout.

Suggested reading materials:

- 1 Murray, R. K., Granner, D. K., Mayes, P. A., Rodwell, V. W. (2017) Harper's Biochemistry. Prentice Hall International Inc.
- 2 Lehninger, A. L., Nelson, D. K., and Cox, M. M. (2015) Principles of Biochemistry. CBS Publishers and distributors, New Delhi.
- 3 Stryer, L. (2016) Biochemistry. W. H. Freeman and Company, New York.
- 4 Voet, D. Judith, G. Voet, Charlotte W. Pratt. (2014) Fundamentals of Biochemistry, John Wiley & Sons Inc. New York.
- 5 Satyanarayanan, U (2015). Essentials of Biochemistry, Uppala Author – Publisher Interlinks, Vijayawada.
6. Eric E. Conn, Paul K. Stump, F. George Bruening, Roy H. Doi. 2007. Outlines of Biochemistry. (5th edn.) John Wiley & Sons, Inc
7. Elliott, W.H. & C. Elliot. 2003. Biochemistry & Molecular Biology. Oxford University Press, UK
8. Horton, H.R., Morson, L.A., Scrimgeour, K.G., Perry, M.D and J.D. Rawn. 2006. Principles of Biochemistry. Pearson Education, International, New Delhi.
9. Jermy M. Berg, John L Tymoczko, Lubert Stryer, 2012, Biochemistry. W.H. Freeman
10. Keith Wilson and John Walker. 2008. Principles and Techniques of Biochemistry and Molecular biology (6th edn). Cambridge University Press, UK.

LAB ON BIOCHEMISTRY

1. Salivary amylase activity in relation to temperature
2. Salivary amylase activity in relation to pH
3. Salivary amylase activity in relation to substrate concentration
4. Salivary amylase activity in relation to enzyme concentration
5. Chromatographic separation of amino acid
6. Qualitative analysis of nitrogenous waste products
7. Qualitative analysis of carbohydrate, protein and fat
8. Preparation of standard graph for carbohydrate
9. Preparation of standard graph for Protein
10. Quantitative estimation of muscle protein

COs cognitive level and mapping with POs and PSOs:

SEMESTER I																
CORE COURSE:1.4 BIOCHEMISTRY																
CO	COGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-2 Understand	3	2	3	2	2	1	-	2	1	2	1	-	-	-	-
CO2	K-3 Apply	3	3	3	2	2	1	-	2	2	2	1	-	-	-	-
CO3	K-3 Analyse	3	2	3	3	3	3	-	3	3	3	1	1	-	-	-
CO4	K-4 Analyse	3	3	3	3	3	3	2	3	3	3	2	1	-	-	-
CO5	K-4 Analyse	3	3	3	3	3	3	2	3	3	3	2	1	1	1	-
CO6	K-5 Evaluate	3	3	3	3	3	3	2	3	3	3	3	2	1	1	1
CO7	K-6 Creativity	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER V: 2.1 CELL AND MOLECULAR BIOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- ❖ To equip the students on the structure and function of cells
- ❖ To understand importance of molecular structure of chromosome, nucleic acid etc.
- ❖ To emphasize the role of recombinant DNA technology and gene expression.

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: understand the structural and functional differentiation of prokaryotes and eukaryotes.

CO2: Acquire knowledge on structure and function of cell organelles.

CO3: Imbibe the knowledge on cell cycle and related diseases

CO4: Enable to understand the bio-chemical nature of DNA

CO5: Understand DNA repairing mechanism and protein synthesis

CO6: Learn regulation of gene expression in prokaryotes and eukaryotes.

Unit I Microscopy and Cell organelles

Cell theory; Ultrastructure of plant and animal cells. Cytoplasm - Structure and function of organelles - Nucleus, endoplasmic reticulum, Golgi complex, mitochondria, ribosomes, lysosomes, cytoskeletal structures - Cell types –epithelial cells, endothelial cells, Organization of cells into tissues.

Unit II Cell structure

The cell membrane & its properties; Fluid mosaic model of Plasma membrane; Integral & peripheral membrane proteins. Cell junctions- gap junctions, tight junctions & anchoring junctions - Transport of molecules across the membrane- diffusion & facilitated diffusion & active transport (Sodium, Potassium ATPase pumps). Intracellular Vesicular Trafficking Structural organization of Eukaryotic Chromosome; giant chromosomes.

Unit III Cell communication, Cell cycle and oncogenesis

Cell signalling- signal molecules-Surface membrane and cytoplasmic receptors; Cell-cell Communication, Intracellular signalling.Cell cycle stages G₀ – G₁– Check points -Cell cycle and cancer. Spindle organization – Regulation and synchronization of cell division–Oncogenesis - Molecular and biochemical characteristics of cancer cells Cell ageing, Cell death and its regulation

Unit IV Nucleic acids

Experimental evidence for DNA as genetic material- Griffith experiment, Hershey and Chase experiment - DNA- structure and forms of DNA - Genetic Code-Characteristics.Replication (both prokaryotes and eukaryotes) types. - RNA – structure, types and function DNA damage & repair mechanisms - Plasmids – types and function

Unit V Protein synthesis

Transcription of mRNA prokaryotes and eukaryotes & post transcriptional modification. Translation in prokaryotes and eukaryotes & Post translational modifications. Bacterial Genetics- Regulation of gene expression - prokaryotes: lac and trp operon - Mechanisms of Gene transfer in bacteria - transformation, conjugation and transduction.

Suggested Reading materials:

1. Power, C.B. 2009. Cell Biology. Himalayan Publishing House, New Delhi.
2. Paul, A. 2009. Cell and Molecular Biology. Books and Allied (P) ltd, India.
3. Prakash S.L. 2007.Cell and Molecular Biology. M.J.P. publishers,Chennai
4. Gupta, P.K. 2004. Cell and molecular Biology. Rastogi Publications, Meerut.
5. Frifelder, D. 2000. Molecular Biology 2nd edition. Narosa Publishing House, NewDelhi.
6. Alberts, B. et al., 1994. Molecular Biology of the Cell (3rd edition). Garland Publishing, Inc., New York
7. Cooper, GM and Hawman RE. 2013. Cell a Molecular Approach (6th Edition). Sinauer Associates, Inc
8. De Roberties E.D.P and E.M.F.DeRoberties. 2011. Cell and Molecular Biology. 8th edition. B.I. PublicatonsPvt. Ltd., India
9. Karp G. 2013. Cell and Molecular Biology Concepts and Experiments. John Wiley & Sons, Inc
10. Cooper, GM and Hawman RE. 2013. Cell a Molecular Approach (6th Edition). Sinauer Associates,Inc.

11. Wolfe, L.S., 1993. Molecular and Cellular Biology, Wadsworth publishing company.
12. Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. 2011 Lewin's Genes X, Jones and Bartlett publishers Inc, London UK
13. Watson, J.D., Basker, T. A., Bell, S.P., Gann, A., Levine, M. and Losick, R. 2004. Molecular Biology of the Gene. Pearson Education (Singapore) Pvt., Ltd.
14. Harvey Lodish, 2000. Molecular Cell Biology 4th Edition, W.H Freeman and Company, New York
15. Company, New York
16. Allison LA. 2007. Fundamental Molecular Biology. Blackwell Publishing Ltd., USA.

LAB IN CELL AND MOLECULAR BIOLOGY

1. Observation of Barrbody
2. Observation of the stages of mitosis
3. Observation of the stages of meiosis
4. Quantitative estimation of nucleic acids
5. Cytological techniques- Micrometry.
6. Human buccal smear and blood smear.
7. Histological techniques- demonstration
8. Mounting of polytene chromosomes

Models/Spotters/Slides:

Observation of different types of tissues - Nucleic acids models - Griffith experiment - Bacterial transformation - Conjugation experiment - Karyotype of man.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: II																
CORE COURSE : 2.1 CELL AND MOLECULAR BIOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K-4 Analyze	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER VI: 2.2 DEVELOPMENTAL BIOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- ❖ To understand the basic concepts of development
- ❖ To comprehend the process of production of gametes
- ❖ To emphasize the importance of morphogenesis and organogenesis

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: Understand the concept of differentiation and transgenics of development.

CO2: Acquire knowledge on gametogenesis, fertilization and early development

CO3: Comprehend cell surface molecules in sperm-egg recognition

CO4: Enable to know the environmental regulation of embryonic development

CO5: Understand the concept of regenerative capacity in the animal

CO6: Learn infertility and various assisted reproductive technology

Unit: I

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Unit: II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis of frog, establishment of symmetry.

Unit: III

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis – vulva formation in *Caenorhabditiselegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Unit: IV

Neoteny: Occurrence and significance – Regeneration: Regenerative capacity in the Animal Kingdom – Factors influencing regeneration – Stimulation and Suppression – Polarity and Gradients – Development of immune system in vertebrates.

Unit: V

Asexual reproduction - Assisted Reproductive Technology (ART) – Male infertility – Sperm abnormalities – Superovulation – IVF, ICSI, GIFT – Screening of genetic disorders.

Suggested Reading Material

1. Belinsky. B. I. An Introduction to Embryology 5th edition 2012, Cengage India publishers.
2. Grant, Philip. 1979. Biology of Developing Systems. Holt, Rinehart & Winston of Canada Ltd.
3. Austin, C.R. and Short, R.V., Reproduction in Mammals. 1982. Cambridge University Press, London.
4. Schatten, H. and Schatten, G. 2012. The Molecular Biology of Fertilization. Academic Press.
5. Longo. F.J. 1997. Fertilization, 1st edition, Garland Science Publishers.
6. R.G. Edwards and S. A. Brody. 1995 Principles and practice of Assisted Human Reproduction. Saunders publishers.
7. Shumway Waldo, Introduction to Vertebrate Embryology, 2001. Biotech Books publishers.
8. Subhasmita Panda, Fundamentals of Genetics and Embryology, 2017. Kunal Books Publishers.
9. Sabita Mishra, 2019 Langman's Medical Embryology, South Asia Edition, Wolters Kluwer India Pvt Ltd
10. Pawar B. A., Kakade V. B. and Shaikh, M. A. J. General Embryology, 2015. Success Publications

LAB ON DEVELOPMENTAL BIOLOGY

1. Dissection – Mylabris insect reproductive system
2. Temporary mounting of chick blastoderm
3. Spermatogenesis and Oogenesis (vertebrate) – chart
4. Study of different types of eggs – Amphibia, frog, chick, man – models / chart
5. Frog early development – two-celled stage, four-celled stage, blastula, gastrula with yolk plug stage – slide / model
6. Observation of insect / frog metamorphosis
7. Larval forms of Invertebrata- Redia, Cercaria, Zoa, Mysis, Veliger, Bipinnaria

8. Observations of whole mounts of chick embryos – 24, 48, 72 & 96 h - slides / chart
9. Observation different types of placenta: Diffuse placenta of pig, Cotyledonary placenta of calf, zonary placenta of dog, monodiscoidal placenta of man and bidiscoidal placenta of monkey.
10. Slides showing the uterine cycle in a mammal.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: II																
CORE COURSE : 2.2 DEVELOPMENTAL BIOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO4	K-4 Analyze	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER VII: 2.3 GENETICS

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- ❖ To understand the basic concepts of heredity and scope of genetics
- ❖ To comprehend the gene and gene mapping in prokaryotes and eukaryotes
- ❖ To emphasize the chromosomal aberrations, chromosome anomalies and genetic diseases

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: Evaluate the deviations from Mendelian Inheritance

CO2: Acquire knowledge on concepts of Linkage, recombination and crossing over

CO3: Comprehend and contrast X-linked and Y-linked inheritance in man

CO4: Enable to know the concepts of Eugenics and Euthenics.

CO5: Understand the concept of genetic structure of populations and changes in gene frequency

CO6: Evaluate mutation, mutagenesis, mutagens, and mutants and its evolutionary significance

Unit I: Mendelian genetics

Definition and scope of Genetics- Mono hybrid Cross & laws of Dominance and segregation. Dihybrid cross & law of Independent Assortment. Deviations from Mendelian Inheritance: Incomplete Dominance, Co-Dominance-Multiple Allelic Inheritance - Gene interaction, epistasis, pleiotropy. Non –Mendelian Inheritance- polygenic Inheritance, Cytoplasmic Inheritance

Unit II: Linkage and crossing over

Concepts of Linkage, recombination & crossing over, Autosomal linkage - cytological basis of crossing over. gene mapping in prokaryotes and eukaryotes - two-point test cross; Determination of gene order- Three-point test cross in *Drosophila*. gene mapping in humans by linkage analysis in pedigrees – Tetrad analysis in *Neurospora*- Sex determination in humans and *Drosophila*. Sex-linked inheritance- Conceptual basis - X- Linked Inheritance in Humans- Hemophilia, Colour blindness; Y -linkage - hairy pinna in males.

Unit III: Cytogenetics

Chromosomes-structure and function of chromatin – Euchromatic and heterochromatin – Polytene and Lamp brush –Chromosomal aberrations- Numerical aberrations- Chromosomal non-disjunction, Euploidy & Aneuploidy; Down syndrome, Turner syndrome, Edward Syndrome, Klinefelter Syndrome. Structural aberrations- Inversion, Translocation, Deletion, Duplication. Pedigree analysis - Chromosome anomalies and diseases: Prenatal diagnostics: Amniocentesis, Chorionic Villus sampling. Karyotyping Concepts of Eugenics & Euthenics.

Unit IV: Population genetics.

Genetic structure of populations –Gene pool, Genotype Frequency, Allelic frequency, kinds of selection, Fisher's theorem, genetic variability, genetic load. Gene Frequency and Genetic Equilibrium – Hardy Weinberg Law, conservation of gene frequency co-dominance and dominance in natural populations. Changes in gene frequency - genetic drift, migration, selection, heterozygous advantage, inbreeding depression.

Unit V Mutation

Terminology-Mutagenesis, Mutagens, Mutants; Types of mutagens- Base analogues, Chemical mutagens, Intercalating genes, mutator genes. Types of mutation- spontaneous and induced mutation, point mutation, frame shift mutation, sickle-cell anaemia, site directed mutagenesis, forward and reverse mutation, transposable elements and transposition, and evolutionary significance. Inborn errors of metabolism.

Suggested reading materials:

1. Verma, P.S and Agarwal, V.K. 2012. Genetics, S.Chand & Co publishers, New Delhi, India
2. Gupta, P.K. 2011. Genetics, Rastogi Publications, New Delhi, India
3. Sinnott E.W. 1995. Principles of Genetics, 5th Edition, Tata - McGraw Hill Publishers. New Delhi, India
4. Peter J. Russell. 2010. Genetics: A Molecular Approach, 3rd Ed., Pearson Publications, New York. USA
5. Peter Snustad, D. and Michael J. Simmons, 2015. Principles of Genetics, 7th Edition, John Wiley & Sons, Inc., New York, USA
6. Pierce Benjamin A. 2020. Genetics: A Conceptual Approach, 7th Edition. W.H. Freeman and Company Publishers. USA.
7. Gardner Eldon J., D. Peter Snustad 2006, Principles of Genetics 8th Ed. John Wiley & Sons, New York, U.S.A.
8. Strickberger, M.W. 1996. Genetics (3rd Edn.), Prentice Hall, India Ltd., New Delhi.

9. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R. C. and W.M. Gelbart. 2000. An Introduction to Genetic Analysis (7th Edn.). W.H. Freeman & Co.
10. Hartl, D.L. and E.W. Jones. 2001. Genetics: Analysis of Genes and Genomes (5th Edn.), Jones and Bartlett Publishers, Sudbury, Massachusetts.
11. Snustad, D.P. and M.J. Simmons. 2008. Principles of Genetics (5th Edn.). John Wiley & Sons Ltd. New York.

Lab in Genetics

1. Identification of Colour blindness among the students using Ishihara's colour chart.
2. Survey of simple Mendelian traits among the students.
3. Study of polygenetic inheritance among the students using fingerprint.
4. Study of Hardy-Weinberg Equilibrium using two different colour beads.
5. Action of Natural Selection in population using colour beads.
6. Genetic drift in a small population using colour beads.
7. Human pedigree construction for a family data.

Demonstration/Models/Spotters:

Monohybrid and Dihybrid crosses – Down Syndromes – Turners yndrome - EdwardSyndromes - KlinefelterSyndromes - Sickle cell anaemia - Isolation of mutant colonies by Gradient plate method Isolation of mutant colonies by Replica platemethod.Karyotype– pedigree chart – sex-linked inheritance and x linked inheritance.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: II																
CORE COURSE : 2.3 GENETICS																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyze	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	K-5 Evaluate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER VIII: 2.4 EVOLUTION

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- ❖ To understand the basic concepts of emergence of evolutionary theories
- ❖ To comprehend the major trends in the origin of higher categories
- ❖ To monitor natural populations and conservation of genetic resources

COURSE OUTCOMES (COs)

Upon the successful completion of the course, the student will be able to

CO1: Interpret the evolutionary time scale and stages of primate evolution

CO2: Acquire knowledge on molecular Evolution and role of gene in evolution

CO3: Comprehend molecular phylogenetics and construction of phylogenetic tree

CO4: Evaluate the protein and nucleic acid sequences with phylogeny

CO5: Justify the concept of extinction of small populations

frequency

CO6: Assess the development of artificial evolution *in vitro*

Unit: I

Emergence of evolutionary theories: Lamarck – Darwin – Concepts – evolutionary synthesis – evolutionary time scale – eras – periods – epoch. Human evolution: Stages of primate evolution including *Homo*. Behavioral Evolution: Altruism and evolution – Group selection and kin selection.

Unit: II

Molecular Evolution: Role of gene in evolution - Evolution of gene families, Molecular drive - Assessment of molecular variation Origin of higher categories Phylogenetic gradualism and punctuated equilibrium - Major trends in the origin of higher categories - Micro- and Macro-evolution – speciation.

Unit: III

Molecular phylogenetics: How to construct phylogenetic trees? - Phylogenetic inference –Distance methods, parsimony methods, maximum likelihood method - Immunological techniques.

Unit: IV

Protein and Nucleic acid sequences: Amino acid sequences and phylogeny - Nucleic acid phylogeny-DNA-DNA hybridizations, Restriction Enzyme sites, Nucleotide sequence - comparisons and homologies - Molecular clocks.

Unit: V

Population genetics and Ecology: Metapopulations - Monitoring natural populations - Why small populations become extinct? - Loss of genetic variations - Conservation of genetic resources in diverse taxa – Artificial evolution (*in vitro*).

Suggested Reading Materials

1. Dobzhansky, Th. Genetic and Origin of Species. Columbia University Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbins and J.M Valentine. Evolution. Surjeet Publication, Delhi
3. Futuyama, D.J. Evolution Biology, Suinuaer Associates, INC Publishers, Dunderland.
4. Hartl, D.L. A Primer of Population Genetics. Sinauer Associates. Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution –The role of chromosomal change.The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston, Inc.
8. Smith, J.M. Evolutionary Genetics. Oxford University Press, New York.
9. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London.

LAB ON EVOLUTION

1. Morphological evidences – fore limbs and hind limbs of vertebrates, Mouth parts of insects,
2. Serial homology in prawn appendages
3. Homology and Analogy inlimbs and in wings.
4. Fossil evidences – Ammonites, Nautilus, Belemnites and fossil wood.
5. Tracing the voyage of the H. M. S. beagle on a world map, with dates and important discoveries.
6. Adaptive radiation – breaks on various birds.
7. Museum specimens for adaptive colouration – cryptic and warning.
8. Mimicry – Monarch and viceroy butterfly.
9. Demonstration of natural selection with coloured beads.
- 10.Demonstration of genetic drift with coloured beads.
- 11.Variations – Fingerprints of the students of the classes.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER: II																
CORE COURSE : 2.4 EVOLUTION																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyze	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	K-5 Evaluate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	K-6 Create	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER IX: 3.1 COMPARATIVE ANIMAL PHYSIOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- To understand the principles and facts of animal physiology.
- To emphasize on mammalian physiology and other vertebrate taxa.
- To deal with the diverse functions of the living organisms encompassing various physiological systems.

COURSE OUTCOMES (COs):

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

- CO1:** assess the levels of adaptations, its mechanism, and physiological adaptations of different environments.
- CO2:** compare the physiological adaptations to stress, exercise, meditation, yoga and their effects.
- CO3:** evaluate the respiratory physiology in air, and water and its neural and chemical regulations.
- CO4:** Analyse the mechanism of excretion and their excretory products and the role of endocrine glands in various functions.
- CO5:** Compare the neural and muscular physiology and analyse the mechanism of muscular contraction.

Unit: I

Adaptation - Levels of adaptation - Mechanism of adaptation - Significance of body size - Adaptation, acclimation and acclimatization - Concepts of homeostasis. Physiological adaptations of different environments – Marine - Shores and Estuaries – Freshwater - Extreme aquatic environments - Terrestrial life - Extreme terrestrial environments - Parasitic habitats. Stress Physiology - Basic concept of environmental stress and strain; concept of elastic and plastic strain; stress resistance, stress avoidance and stress tolerance.

Unit: II

Endothermy and physiological mechanism of regulation of body temperature - Physiological adaptation to osmotic and ionic stress; mechanism of cell volume regulation - Osmoregulation in aquatic and terrestrial environments - Physiological response to oxygen deficient stress - Physiological response to body exercise - Meditation, Yoga and their effects.

Unit: III

Respiratory physiology - Respiration in air and water. Structure and function of the respiratory Structures - Respiratory pigments – Transport of respiratory gases between the lungs and tissues - Dissociation curves – Neural and chemical regulation of respiration.

Unit: IV

Excretory physiology – Excretory organs – mechanism of excretion – physiology – adaptations of excretion to environment – Excretory products: synthesis and elimination. Endocrine glands – Feedback regulation – Pituitary – gonadal axis – Role of reproductive hormones – gamete formation; fertilization; embryonic development; parturition; lactation; neuroendocrine regulation.

Unit: V

Neural and muscular physiology – Neurons – action potential – nerve impulse transmission – neurotransmitters – mechanism of neural transmission – neurodegenerative diseases. Muscle contraction – theories – molecular mechanism of muscle contraction.

Suggested Reading Materials:

1. Eckert, R. Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
2. Hochachka, P.W. and Somero, G. N. Biochemical Adaptation. Princeton, New York.
3. Hoar, W.S. General and Comparative Animal Physiology, Prentice Hall of India.
4. Schiemdt Nielsen. Animal Physiology: Adaptation and Environment. Cambridge.
5. Strand, F.L. Physiology: A regulation System Approach. Macmillan Publishing Co., New York.
6. Pummer, L. Practical Biochemistry, Tata McGraw-Hill
7. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.

8. Wilson K. and Walker. J. Practical Biochemistry.
9. William S. Hoar. General and Comparative Physiology
10. E. L. Jordan and P. S. Verma, Chordate Zoology. S. Chand and Co., New Delhi.
11. C. D. Prosser and F. A. Brown Comparative Animal Physiology.
12. R. Nagabhushanam, M. S. Kodarkar and R. Sarojini. Textbook of Animal Physiology.
13. Kunt Schmidt – Nicolsen Animal Physiology – Adaptation and Environment, Cambridge University Press.
14. Gayton, A. C. and Hall, J. E., A Textbook of Medical Physiology, 9th Edn.,
15. Harcourt Brace and Company Asia Pvt. Ltd., W. B. Saunders Company.

LAB ON COMPARATIVE ANIMAL PHYSIOLOGY

1. Estimation of haemoglobin – Any method.
2. Determination of ESR – Demonstration
3. Detection of haemin crystals in blood.
4. Estimation of salt loss in fish.
5. Estimation of salt gain in fish.
6. Opercular activity of fish in relation to salinity
7. Opercular activity of fish in relation to temperature.
8. Qualitative analysis of excretory products in ammoniotelic, ureotelic and uricotelic animals.
9. ECG, EEG, Conditional reflex – Chart.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER III																
CORE COURSE 3.1 COMPARATIVE ANIMAL PHYSIOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER X: 3.2 ANIMAL BIOTECHNOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- ❖ facilitate the method of conversion of natural raw materials into useful products by the application of living organism in the industrial process.
- ❖ conservation of resources via the recycling of waste material and the recovery of more valuable products.
- ❖ Diagnose diseases and apply therapeutics using biotechnology tools
- ❖ Deal with environmental pollution remedies using recombinant strains and bioethics of biotechnological products.

COURSE OUTCOMES (COs):

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

- CO1:** Discuss the basic steps in gene cloning, hybridization and DNA sequencing techniques.
- CO2:** Evaluate human genome project, DNA sequencing, synthesis of oligonucleotides and gene transfer technology
- CO3:** Examine cell culture, organ culture, embryo culture and *in vitro* fertilization and embryo transfer.
- CO4:** Analyse fermentation, microbial products, protein engineering, and enzyme biotechnology.
- CO5:** Evaluate the microbial biomass production and genetically engineered microorganisms.

UNIT I: Genetic engineering

Gene cloning - basic steps of gene cloning, restriction and modifying enzymes, types of restriction enzymes, ligases - linkers and adaptors, C DNA, selection of recombinants. Hybridization techniques, chemical synthesis of oligonucleotides, PCR and DNA sequencing techniques.

UNIT II: Gene cloning

Cloning and expression vectors, construction of chimeric DNA, nucleic acid probes, DNA libraries, polymerase chain reaction, molecular markers, DNA sequencing, synthesis of oligonucleotides. Human Genome Project. Gene transfer technology- Particle bombardment, micro injection techniques, electrophoresis, liposome fusion.

UNIT III: Microbial Biotechnology

Fermentation: Bioreactor. Microbial products: primary and secondary metabolites. Protein engineering. Bioremediation of hydrocarbons, industrial wastes and heavy metals. Single cell protein, biopolymers, bio pesticides and bio fertilizers. Xenobiotics, bio-leaching, bio-mining and bio-fuel. Enzyme biotechnology: Isolation and purification of enzymes, uses of enzymes in industries, immobilization of enzymes and their uses, Biosensors. Terminator and traitor technology. Intellectual Property Rights.

UNIT IV: Medical Biotechnology

Drug development: production of pharmaceuticals by genetically engineered cells (hormones, interferons), microbial transformation for production of important pharmaceutical (steroids and semi-synthetic antibiotics), drug design and targeting. Diagnostic kit development for micro analysis. Applications of biotechnology in medicine, Vaccines, diagnostics and forensics. Gene therapy – Pharmacogenomics.

Unit V: Industrial and Environmental Biotechnology:

Production of metabolites - Downstream processing and *in situ* recovery of products, microbial biotransformation, microbial biomass production (SCP). Bioremediation and phytoremediation - Genetically engineered microorganisms (GEMs) - treating oil spills, detection of pesticide in soil and their degradation, sequestering heavy metals. Biomining and Biofuels.

Suggested reading materials:

1. Gupta P.K. (2009). Elements of Biotechnology. Meerut: Rastogi Publications.
2. Singh B.D. (2003). Biotechnology - Expanding Horizons. Chennai: Kalyani Publishers.
3. Satyanarayana V. (2004). Biotechnology. Kolkata: Books and Allied (P) Ltd.
4. Dubey R.C. (2006). A Text Book of Biotechnology, 4th Ed. New Delhi: S. Chand and Co. Ltd.,
5. Rema L.P. (2006). Applied Biotechnology. Chennai: MJP publishers.
6. Prakash S. Lohar, (2012). Biotechnology. Chennai: MJP publishers.
7. Satyanarayana, U.2007. Biotechnology. Uppala author-publisher interlinks, Vijayawada, Andhra Pradesh, India.
8. Old, R.W and Primrose, S.B.1993. Principles of Gene manipulation: An introduction to Genetic Engineering. Blackwell Science Publication.
9. Ignacimuthu, S.2008. Biotechnology: An introduction, Narosa Publishing house, New Delhi.
10. Purohit, S.S.2008. Biotechnology. Student Edition, Jodhpur.

LAB ON BIOTECHNOLOGY

1. Estimation of citric acid in citrus fruits
2. Preparation of wine - Demonstration
3. Preparation of bread - Demonstration
4. Preparation of yoghurt - Demonstration
5. Diagnosis of diseases using ELISA - Demonstration
6. Preparation of Vermicompost - Demonstration
7. Extraction of genomic DNA from bacteria - Demonstration
8. Southern and Northern blotting techniques –charts
9. Flow Charts - Bioreactor - Antibiotics production
10. Spotters: pBR322, Lambda phage, Dolly, RAPD, Gene cloning, Stem cells

Cos cognitive level and mapping with POs and PSOs:

SEMESTER III																
CORE PAPER X: 3.2 ANIMAL BIOTECHNOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER XI: 3.3 RESEARCH METHODOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (Los):

The objectives of the course are enabling the student to

- ❖ understand the working principles, construction and applications of the instruments used in research related to Zoology.
- ❖ Know the general laboratory procedures and maintenance of research equipment.
- ❖ appreciate the importance, concept of research and learn the art of thesis, paper writing and publication.
- ❖ overview the concept of preparation of research proposal & funding agencies,

COURSE OUTCOMES (COs):

Upon the successful completion of the course, the student will be able to

COs 1: Understand the objectives, types and importance of research. Formulate the parts of dissertation and develop report writing.

COs 2: Plan the methods of writing scientific paper and components of research paper.

Realise the need of publication and know the importance of impact factor & citation index.

COs 3: Analyse the working principles of microscopy, pH meter and preparation of different buffers. Measure the pH of soil and different water samples

COs 4: Realise the need of centrifuges and their uses in research and can separate amino. Realise the principle and applications of gas liquid chromatography. acids and sugars using paper & thin layer chromatography

COs 5: Learn the principles and applications of electrophoresis, flame photometer, and bomb calorimeter. Estimate amino acids and sugars using spectroscopic techniques

Unit I: Research and Project writing Methods

Research- Definition, objectives, types and importance- Research process- Literature survey- sources- scientific databases- Research report writing- Parts of Thesis and Dissertation-Title, certificate, declaration, acknowledgements, contents- List of tables, figures, plates & abbreviations, Introduction, Review of literature, Materials and methods- Results- Presentation of data -Tables, figures, maps, graphs, Photographs - Discussion-Summary, Bibliography/References and Appendix.

Unit II: Article Publication and Presentation

Writing scientific paper- Organization of scientific paper- Importance of title- abstract- key words, Introduction, Materials and Methods, Results, Discussion, Acknowledgements and References-Publication in research journals-Standards of Research journals- Peer- review- impact factor- citation index- plagiarism - Preparation of manuscript- Proof correction- proof correction marks- Method of correcting proof- Presentation in seminars and conferences- Writing chapters in books- Preparation of Research proposal and funding agencies – Research fellowships.

Unit III: Microscopy, pH and Buffer

Microscopy- General principles- Light, Phase contrast, Fluorescent, Electron, (SEM & TEM) and Confocal Microscope - Cytotechniques. pH basic principles and construction of pH meter- pH electrodes- Principles and application of buffers- Mechanism of buffer action and preparation of common buffers- Citrate, acetate, tris and phosphate- Application of buffers- pH measurements of soil and water.

Unit IV: Isolation, Fractionation and Separation

Isolation, fractionation and separation of cellular constituents- Isolation of mitochondria, and nucleic acids- Homogenization- Manual, mechanical and sonication - Centrifugation techniques- Basic principles, Different types of Centrifuges- Analytical and preparative- Chromatography- Paper, thin layer - separation of amino acids and sugars- Gas liquid chromatography - HPLC. Nuclear magnetic resonance (NMR) spectroscopy – X-ray fluorescence spectroscopy (XRF), Fourier Transform Infrared (FTIR) spectroscopy – characterization of nanoparticle.

Unit V: Electrophoresis, Colorimetry and Calorimeter

Electrophoresis- General Principles - Horizontal & Vertical gel electrophoresis, Iso electric focusing, 2D, pulse field and immune electrophoresis - Electrophoresis of proteins and nucleic acids- Spectroscopic techniques - Flame photometer, Bomb calorimeter - Principle and applications.

References:

1. N. Gurumani 2016 Research Methodology for Biological Sciences. MJP Publishers, Chennai.
2. BijuDharmapalan 2012 Scientific Research Methodology. NarosaPublishing House, New Delhi.
3. S.Palanichamy and M. Shunmugavelu 2009. Research methods in biological sciences. Palani paramount publications, Palani.

4. K. Kannan 2003 Hand book of Laboratory culture media, reagents, stains and buffers Panima publishing corporation, New Delhi.
5. Keith Wilson and John Walker 2002 practical biochemistry – Principles and techniques. Fifth edition. Cambridge Univ. Press.
6. P. Asokan 2002. Analytical biochemistry – Biochemical techniques. First edition – Chinnaa publications, Melvisharam, Vellore
7. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pte. Ltd, Indian Branch, Delhi, India.
8. Rodney Boyer, 2001. Modern Experimental Biochemistry. III Ed. Addison Wesley Longman Pvt. Ltd, Indian Branch, Delhi, India.
9. J. Jeyaraman 1981. Laboratory Manual in Biochemistry. New Age International publishers, New Delhi.

LAB ON RESEARCH METHODOLOGY

1. Centrifuge – techniques, types.
2. Phase contrast microscope – principle
3. Micrometry – measurement of cells.
4. Colorimeter – Verification of Beer Lambert’s law
5. Microtome techniques – staining procedure
6. Chromatography principle – paper, thin layer, column and gas chromatography
7. Electrophoresis (demonstration only) separation of nucleic acid and protein.
8. Separation of amino acids and sugars using paper chromatography
9. Separation of amino acids and sugars using thin layer chromatography
10. Estimation of Protein using VIS/ UV-VIS Spectrophotometer / colorimeter.
11. Estimation of sodium, potassium, calcium and magnesium using Flame photometer.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER III																
COREXI: 3.3 RESEARCH METHODOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER XII: 3.4 MICROBIOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- ❖ Promote interest in the basic and applied areas of Microbiology
- ❖ Deal with the classification of bacteria, algae, fungi, protozoa and viruses.
- ❖ Impart knowledge of role of microorganisms in industrial, food, medical and agricultural sectors.
- ❖ Emphasize the primary and secondary screening of microbes linked to fermentation industry.
- ❖ Focus on the medically important microbes, causative agents of diseases, symptoms and control measures

COURSE OUTCOMES (COs):

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

CO1: Assess the classification of microorganisms, general properties and their structure and cultivation methods.

CO2: Analyse the bacterial morphology, nutritional requirements and culture techniques.

CO3: Evaluate the role of microbes in fermentation and microbial production of antibiotics, bio-fertilizers, insecticides etc.

CO4: Apply the microbial analysis of water purity, role of microbes in sewage treatment and biogas production and mining.

CO5: Examine various microbial pathogenesis and problems related to antibiotic resistance in man.

Unit I:

Evolution of Microorganisms & Microbiology: Members of the microbial world, Microbial evolution, Microbiology & its origin and microbiology today -Scope, history & development of Microbiology –Characterization, Classification(Haeckel, Whittaker and Carl Woese) and Identification of Microorganisms –Comparison of bacteria, archaea&eukarya – Introduction to taxonomy : phenotypic classification, phylogenetic classification, genotypic classification, taxonomic ranks –Techniques for determining microbial taxonomy & phylogeny: Classical & molecular characteristics - Genetic relationship - DNA homology -16S r RNA sequencing -Phylogenetic tree - Bergey's manual of systematic bacteriology.

UNIT II:

Cultivation of microorganisms - Culture media: chemical and physical, functional types: supportive media (Transport), enriched media, selective media and differential media. Isolation of pure cultures: streak, spread and pour plate methods - Methods of preservation and maintenance of cultures – principle and applications of lyophilizer. Extracellular components: Capsule, slime layer, sheath, flagella and pili – Structure & Functions. Cell wall & Cell membrane: Archae bacteria, Gram positive & Gram negative – Structure & Functions. Intracellular membranes – Structure & functions. Growth curve, Auxenic, synchronous, asynchronous culture. Batch culture, fed batch & continuous culture: chemostat and turbidostat. Bacterial growth: Binary fission, Growth curve. Factors affecting growth: Physical, chemical and biological. Spore: endo and exospores. Endospore: structure, factors influencing sporulation,

UNIT III:

Etiology, transmission, pathogenesis, clinical manifestation, lab diagnosis, chemotherapy and prophylaxis of respiratory tract infections: upper respiratory tract infections (*Streptococcus pharyngitis*, *Corynebacterium diphtheriae*) and lower respiratory tract infections. (*Mycobacterium tuberculosis* and *Streptococcus pneumoniae*) – Urinary tract infections – Sexually transmitted infections. (*Treponema pallidum*, *Neisseria gonorrhoeae*) – Gastro intestinal infections (Bacteria- *Escherichia coli*, *Salmonella* sp., *Shigella* sp., *Vibrio* sp., Protozoan - *Entamoeba histolytica* – Viral-Rotaviruses). Studies on central nervous system infections (Bacterial: meningitis and tetanus) – Skin infections (Bacterial: Pyogenic Staphylococcal and Streptococcal) – Mycobacterial disease (leprosy) – Vector borne infections (Rickettsial infections) – Protozoa infections (Malaria) – Fungal infections (Dermatophytosis, Candidiasis) – Viral infections (Rabies, Poliomyelitis, Oncogenic viruses).

UNIT IV:

Rhizosphere effects – R/S ratio – Rhizoplane – Biofertilizers and role in agriculture – Bacteria (*Rhizobium*, *Azotobacter*, *Azospirillum* and *Phosphobacteria*). Algae (Blue green Algae) – and Fungi (VAM). Concept and scope of food microbiology – Food composition – Types and microorganisms in food materials. (Bacteria, Mold, and Yeasts) – Factors influencing microbial growth in food. Extrinsic and intrinsic factors. (Nutrient content, p^H , buffering capacity, redox potential, relative humidity). Contamination and its sources. Spoilage of foods and its classification Principles of food preservation. (Temperature – Dehydration – Osmotic pressure – Chemicals – Radiation). Contamination, spoilage and preservation of Vegetables – Fruits – Seafood's – Meat – Milk and poultry products. Production of antibiotics (Penicillin, streptomycin). Vitamins (B_{12}). Beverages (Beer, wine). Yeast (Baker's, brewer and food and feed yeast production). Immobilization: principle, types, significance and applications

Unit: V:

Biorecovery – Recovery of metals from ores – oxidation of minerals – testing for biodegradability – Biomagnifications – Removal of heavy metals and radionuclides from effluents – Preparation of metal sulfides. Bioremediation – Case histories – Constraints and priorities – Types of bioremediation – in situ bioremediation, ex situ bioremediation – Bioaugmentation – Bioreactors for bioremediation process – Biopackages for biodegradation. Biodegradation of xenobiotic compounds: organic contaminants Hydrocarbon, halogenated organic solvents, herbicides, pesticides – Treatment of solid and liquid wastes – Vermicomposting – Aiming for eco-friendly biodegradable products – Bioplastics Production of antibiotics (Penicillin, streptomycin). Vitamins (B₁₂). Beverages (Beer, wine). Yeast (Baker's, brewer and food and feed yeast production). Immobilization: principle, types, significance and applications

LABORATORY MANUALS RECOMMENDED:

1. Cappuccino, J.C. and Sherman, N. (1996). Microbiology – Laboratory Manual. Benjamin Cummings, New York
2. Kannan, N. (1996). Laboratory manual in General Microbiology. Palan Paramount Publication, Palani.
3. Gunasekharan, P. (1996). Laboratory manual in Microbiology, New Age International Ltd., Publishers, New Delhi.
4. Sundararaj, T. (2005). Microbiology – laboratory manual. (1st edition). Pubinj. Sunciararaj, T, Chennai
5. Jayaraman, J. (1985). Laboratory manual in Biochemistry. Wiley Eastern Ltd, New Delhi.
6. Plummer, D.T. (1998). An Introduction to practical Biochemistry. Tata McGraw Hill, New Delhi.
7. Palanivelu P. (2001). Analytical Biochemistry and Separation techniques – A Laboratory Manual.
8. Benson (2002). Microbiological applications – Laboratory Manual in General Microbiology. International edition. McGraw Hill Higher education.
9. Collins, C.R. and Lyne P.M. (1976). Microbiological methods (4th edition). Butterworths, London.
10. Dubey, R.C. and Maheshwari, O.K., (2002). Practical Microbiology. S. Chand and Co Ltd., New Delhi.
11. Baron, E.J. and Finegold, S.M. (1995). Diagnostic Microbiology. Blackwell Scientific Press.
12. Davis, L., Dipner, M.O and Battey, J.F. (1986). Basic methods in Molecular Biology. Elsevier, Amsterdam
13. S.Rajan. (2012): Experimental Procedures in Life Sciences. Anjanaa Book House, Chennai 600107.

LAB ON MICROBIOLOGY

1. Laboratory precautions
2. Washing and cleaning of glassware
3. Hanging drop technique
4. Sterilization - principles and methods
 - a. Moist heat
 - b. Dry heat
 - c. Filtration
 - d. Fumigation
- 5.. Counting cells/Spores of Microorganism
 - a) Haemocytometer
 - b) Ocular micrometer
 - c) counting chamber
 - d) Serial dilution technique. Plating techniques – pour plate and spread plate
 - e) spectrophotometer method
6. Simple staining
7. Negative staining
- 8 Gram's staining
- 9 Spore staining (Schaffer-Fulton method)
10. Capsule staining
11. Preparation of liquid, solid and semi-solid media
12. Preparation of agar deeps, agar slants and agar plates
13. Preparation of basal, enriched, selective and enrichment media
14. Cultural characteristics of microorganisms
15. Techniques of isolation of pure cultures – Streak plate method
16. Fungal slide culture techniques
17. Microbiological examination of milk*.
 - i) Methylene blue reduction test
 - ii) Rezaurintest
2. Whole cell Immobilization*.
3. Fermentative production of ethyl alcohol by yeast*.
4. Wine production – (DEMO)*.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER III																
CORE XII: 3.4 MICROBIOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER XIII: 4.1 BIOSTATISTICS AND BIOINFORMATICS

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- ❖ Impart knowledge on data collection, classification tabulation and graphic presentation.
- ❖ Learn important statistical methods such as measure of central tendency, correlation and regression.
- ❖ Gain knowledge on concept of probability, distributions and tests of significance.
- ❖ Comprehend the chi-square test – goodness of fit and one-way two-way analysis of variance
- ❖ Understand the role of information technology in Biology and application of Bioinformatics.

COURSE OUTCOMES (COs):

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

- CO1:** Assess the methods of collection data, sampling, classification, tabulation and presentation of data.
- CO2:** Analyse the measure of central tendency, dispersion, skewness and kurtosis.
- CO3:** Evaluate the types of correlation, correlation coefficient, regression analysis and regression equation.
- CO4:** Examine the theoretical Distribution, Binomial distribution, Poisson distribution and Normal distribution in Biological sciences.
- CO5:** Apply the concepts of Bioinformatics, bioinformatics tools and Polygenetic analysis tools.

Unit 1: Collection of Data:

Primary and Secondary data –Methods of collecting primary data –sources of secondary data. Sampling and Sample Designs: Essentials of sampling –Methods of sampling –Random sampling methods –Non random sampling methods –Merits and Limitations of sampling. Classification and tabulation of data –Diagrammatic and graphic presentation of data.

Unit II: Measures of Central Tendency:

Mean- Arithmetic mean –Weighted arithmetic mean – Median – Mode. Measures of Dispersion: Quartile deviation – Mean deviation – Standard deviation – Lorenz curve. Skewness Moments and Kurtosis: Measure of skewness –Absolute measure of skewness -Relative measure of skewness -Karl Pearson's coefficient of skewness- Bowley's coefficient of skewness. Moments. Measures of kurtosis.

Correlation analysis: Types of Correlation –Methods of studying correlation Karl Pearson's coefficient of correlation –Regression Analysis –Regression line, Regression equations.

Unit III: Probability and Expected Value:

Concepts of probability –Types of events - Theorems of probability - conditional probability –Bayes' Theorem. Theoretical Distribution: Binomial distribution -Poisson distribution - Normal distribution. Statistical Inference: Test of hypothesis -procedure of testing hypothesis. Estimation: Test of significance for large sample - Test of significance for small samples –Student's t- distribution.

Unit IV: Chi square test and a Goodness of fit

Yates correction F-Test and Analysis of Variance – one-way classification and two-way classification. Experimental design – Randomized block design –Latin squares – The Sign Test – A rank sum test (The Mann-Whitney U Test).

Unit V: Bioinformatics:

Information Technology in Biology - Types of sequences used in bioinformatics – Application of Bioinformatics. Biological Database: Objectives – Properties of Database –database retrieval system –Symbols used in data base – Nomenclature of DNA sequences Nomenclature of protein sequences –NCBI. SWISS-PROT. Data Base Similarity Search Tools: BLAST –FASTA –Application of bioinformatics tools –Homology search tools –Protein functional analysis tools – Sequences analysis tools –Structural analysis tools - Molecular modelling and visualizing tools –Polygenetic analysis tools.

Suggested reading materials:

1. Gupta S.P. 2008 Statistical methods Sultan Chand &Co. New Delhi.
2. Khanum. A& I.A. Khan 2004 Fundamental of Biostatistics, Ukazz Publication. Hyderabad.
3. C.S.V.Murthy 2008 Bioinformatics Himalaya Publishing House Pvt Ltd . New Delhi.
4. Sundararajan and Balaji 2007 Introduction to Bioinformatics Himalaya Publishing House Pvt Ltd. Mumbai.
5. Banergi,P.K. 2004Introduction to Biostatistics S Chand & company Ltd .NewDelhi.
6. Gurumani,N. 2004Introduction to Biostatistics .MJP Publishers Chennai
7. Misra ,B.N.and Misra ,B.K.1998 Introductory Practical Biostatistics. Naya Prakash, Calcutta.
8. Pillai, RSN.and Bhavathi ,V.1989 Statistics S Chand & company Ltd .New Delhi
9. Scheffler W.C.1980. Statistics for biological sciences Addison –Wesley Publishing Company, NewYork.
10. Sokal,R.R.and Rohif ,F.J. 1987 Introduction to Biostatistics .W.H.Freeman and Company New York.

11. Sundar Rao,P.S.S and Righard ,J.2002 An Introduction to Biostatistics .III edn Prentice Hall of India
12. N.J.Chikhale and V.S. Gomare 2007 Bioinformatics Theory and Practice Himalya Publishing House Pvt Ltd .Hyderabad.
13. Attwood T.K. Parry smith D.J. 2006 Introduction to biostatistics, Dorling Kindersley (India) Pvt Ltd South Asia.

LAB ON BIOSTATISTICS AND BIOINFORMATICS

1. Calculation of mean, median, mode, standard deviation, standard error, variance and coefficient of variation - individual observation and continuous series.
2. Calculation of correlation coefficient – length and width of leaves.
3. Calculation of correlation coefficient – height and weight of students in the class.
4. Calculation of regression co-efficient using length and width of leaves.
5. Probability experiment with coin tossing (one coin, two coins). using chi square test
6. Test of significance for small samples – student’s t test.
7. PubMed, NCBI, EMBL, SWISS-PROT – printout.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER IV																
CORE XIII: 4.1 BIOSTATISTICS AND BIOINFORMATICS																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER XIV: 4.2 IMMUNOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (Los):

The objectives of the course are enabling the student to

- ❖ Understand the concepts and molecular events underlying Immunology.
- ❖ Identify the cells and organs of immune system and antigen-antibody interactions.
- ❖ Appreciate the MHC, immune-regulation, immune-tolerance and complement system.
- ❖ Know the Immunological tolerance, hypersensitivity, immunological reactions and immune response.

COURSE OUTCOMES (COs):

Upon the successful completion of the course, the student will be able to

COs 1: Explain the organization and structure of lymphoid organs Cells of the immune system and their differentiation.

COs 2: Analyse antigens, Antigenicity, immunogenicity, factors influencing immunogenicity and structure and functions of Antibodies

COs 3: Analyse the Complement system, Major Histocompatibility Complex and HLA system in man

COs 4: Evaluate generation, activation and differentiation of T-cells and B-Cells.

COs 5: Assess the immunological reactions and immune response to tumor evasion of the immune system – cancer immunotherapy

UNIT –I: OVERVIEW OF THE IMMUNE SYSTEM

Historical perspective – innate (nonspecific) immunity – acquired (specific) immunity.-EXPERIMENTAL SYSTEMS -Experimental animal models – cell-culture systems – recombinant DNA technology – analysis of DNA regulatory sequences – gene transfer into mammalian cells-CELLS AND ORGANS OF THE IMMUNE SYSTEM-Cells of the immune system – organs of the immune system – leukocyte recirculation –ANTIGENS-Immunologic properties of antigens - factors that influence immunogenicity - epitopes -IMMUNOGLOBULINS: STRUCTURE AND FUNCTION-Basic structure of immunoglobulin's-Immunoglobulin sequencing studies – immunoglobulin fine structure – immunoglobulin receptor complex – antigenic determinants on immunoglobulins – immunoglobulin isotypes – the immunoglobulin super family-HISTOCHEMICAL AND IMMUNOTECHNIQUES :-Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and

immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

UNIT –II: ANTIGEN-ANTIBODY INTERACTIONS

Strength of antigen-antibody interactions – cross-reactivity – agglutination reactions – radioimmunoassay – enzyme-linked immunosorbent assay – western blotting – immunofluorescence – immune electron microscopy-HYBRIDOMAS AND MONOCLONAL ANTIBODY=Formation and selection of hybrid cells – production of monoclonal antibodies – uses for monoclonal antibodies – engineered monoclonal antibodies – t-cell hybridoma-ORGANIZATION AND EXPRESSION OF IMMUNOGLOBULIN GENES-Genetic model compatible with immunoglobulin structure – multigene organization of immunoglobulin genes – variable-region gene rearrangements – regulation of immunoglobulin-gene transcription – generation of antibody diversity – class switching among constant region genes – expression of immunoglobulin genes – b-cell developmental stages-MAJOR HISTOCOMPATIBILITY COMPLEX-General organization and inheritance of the MHC – class I MHC molecules and genes – class II MHC molecules and genes – polymorphism of class I and class II MHC molecules – class III MHC molecules – mapping of the MHC – expression of MHC molecules – probing MHC structure and function – MHC and immune responsiveness – MHC and susceptibility to infectious diseases- ANTIGEN PROCESSING AND PRESENTATION-Self-MHC restriction of T cells – role of antigen-presenting cells – antigen processing – antigen presentation – clinical applications

UNIT –III:T-CELL RECEPTOR

T-cell receptors Organization and rearrangement of TCR genes – T-cell receptor complex: TCR-CD3 -- T-cell accessory membrane molecules -- TCR-antigen-MHC interaction alloreactivity of T cells-T-CELL ACTIVATION, MATURATION, AND DIFFERENTIATION-t-cell maturation – T_h-cell activation – mature peripheral t-cell populations-CYTOKINES-General properties of cytokines – discovery and purification of cytokines – structure of cytokines – function of cytokines – cytokine receptors – cytokine antagonists – cytokine secretion and biological activity of T_h1 and T_h2 subsets – role of cytokines in the inflammatory response – cytokines and disease-GENERATION OF THE HUMORAL IMMUNE RESPONSE-Kinetics of the humoral response – experimental systems – identification of cells required for induction of humoral immunity – use of hapten-carrier conjugates study cellular interactions – steps in B-cell activation, proliferation, and differentiation – induction of the humoral response in vivo.

UNIT –IV:CELL – MEDIATED IMMUNITY

Direct cytotoxic response – delayed-type hypersensitivity response -IMMUNE REGULATION AND TOLERANCE-Regulation of immune responsiveness – tolerance-THE COMPLEMENT SYSTEM-The complement components – initial steps in complement activation – formation of membrane-attack complex- regulation

of the complement system – complement-binding receptors – biological consequences of complement activation – complement deficiencies-HYPERSENSITIVWE REACTIONS-Cell and coombs classification – I_GE-mediated (type I) – hypersensitivity – antibody-mediated cytotoxic (type II) hypersensitivity – immune complex-mediated (type III) hypersensitivity – T_{DTH}-mediated (type IV) hypersensitivity-AUTOIMMUNITY-Autoimmune disease in humans – animal models for autoimmune disease – role of the CD4+ tcell, MHC, and tcell receptor in autoimmunity – proposed mechanisms for induction of autoimmunity – treatment of autoimmune diseases-VACCINES-Active and passive immunization – designing vaccines for active immunization – whole-organism vaccines – purified macromolecules as vaccines – recombinant antigen vaccines – recombinant vector vaccines – synthetic peptide vaccines – multivalent subunit vaccines – anti-idiotypic vaccines

UNIT –V: IMMUNE RESPONSE TO INFECTIOUS DISEASES

Viral infections – bacterial infections – protozoan diseases – diseases caused by parasitic worms (helminthes)-IMMUNODEFICIENCY DISEASES-Classification of immune deficiencies – phagocytic deficiencies – humoral deficiencies – cell-mediated deficiencies – combined humoral and cell-mediated deficiencies-THE IMMUNE SYSTEM IN AIDS-Discovery of AIDS and its causative agent- HIV structure and infectious process – clinical diagnosis of AIDS – HIV destruction of CD4+ tcells – immunologic abnormalities in AIDS – serologic profile of HIV infection – screening tests for HIV infection – development of an AIDS vaccine-TRANSPLANTATION IMMUNOLOGY-The immunologic basis of graft rejection – clinical manifestations of graft rejection – tissue typing – general immunosuppressive therapy – specific immunosuppressive therapy – clinical transplantation-CANCER AND THE IMMUNE SYSTEM-Cancer: organ and terminology – malignant transformation of cells – oncogenes and cancer induction – tumors of the immune system – tumor antigens – immune response to tumors – immune surveillance theory – tumor evasion of the immune system – cancer immunotherapy.

Text books:

1. C.V.Rao, An Introduction to Immunology NarosaPublishing House, 35, Greams Road, Thousand light, Chennai -600006.
2. Immunology, 2007. I.Kannan. MJP Publishers, Chennai.
3. Immunology N.Arumugam – Saras publication

Reference books:

1. Blaine T. Smith. (2008). Concepts in Immunology and Immuno-therapeutics, (4th ed.): American Societyof Health-System Pharmacists.
2. Chapel, H., Haeney, M., Misbah, S., & Snowden, N. (2014). *Essentials of Clinical Immunology*, (6thed.): Willey Blackwell Publishing.Kannan, I. (2013). *Immunology*: MJP Publication.
3. Male, D., Brostoff, J., Roth, B, D &Roit, I. (2012). *Immunology*, (8th ed.): Elsevier.
4. Owen, J., Jenni Punt, Sharon Stranford. (2013). *Kuby Immunology*, (7th ed.): W. H. Freeman.

5. Thomas J. Kind., Richard A. Goldsby., Barbara A. Osborne., Kubi, J. (2000). *Kuby Immunology*. New York: W.H. Freeman.
6. Vaman Rao., (2016). *Immunology*. New Delhi: Narosa Publishing House Pvt, Ltd.
7. Janis Kuby, Immunology W.H.Freeman and Company, New York.
8. Klans.D.Elgert, Immunology Wiley –Liss Pub. Co. U.S.A.
9. R.M.Coleman, M.F.Lomb and R.E.S.Cord Fundamental Immunology 2nd Edn. W.C.Brown Publishers U.S.A.
10. I.M.Roitt, Essential Immunology E.L.B.S.
11. Donald M.Weir and John Shewart Immunology Churchill Livingstone 9th Edn.
12. GerogePinchuk 2004.Schum’s Outlines Immunology Tata McGraw –Hill.
13. Aruna Bhatia Manual of Practical Immunity Vikas Pub. House Ltd., New Delhi.
14. Talwar .G.P. A hand book practical immunology - Third edition ,Backwell scientific publication-ISBN 0-632-01491

LAB ON IMMUNOLOGY

1. ABO blood group identification.
2. Study of lymphoid organs.
3. Haemagglutination assay.
4. Study of antibody titer values.
5. Immunodiffusion – Single /Double and Radial
6. Immuno-electrophoresis. ELISA and Western Blot
7. Lymphoid organs in Rat – Dissection
8. Lymphoid organs – Histology slides
9. Cells – Differential count of blood cells – Staining with Giemsa
10. Lymphocyte separation – Gradient methods
11. Antigen – Antibody reactions – Kits
 - a) Determination of blood groups
 - b) Diagnostic test for typhoid
 - c) Quantitative precipitin assay teaching kit
 - d) Test for HBS Ag.
 - e) Estimation of serum proteins

Cos cognitive level and mapping with POs and PSOs:

SEMESTER IV																
CORE XIV: 4.2 IMMUNOLOGY																
CO	CONGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

CORE PAPER XV: 4.3 ENTOMOLOGY

4Hrs/Week

Credits: 4

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- Demonstrate insect identification, structure, and function
- Examine insects deeply within a biological level of analysis
- Impart knowledge on basic aspects of anatomy of different insects
- Identify the potential impact of different insect species on agriculture,
- Understand the principles and methods of managing pest insect populations

COURSE OUTCOMES (COs):

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

CO1: Classify insects using taxonomic keys.

CO2: Demonstrate the external morphology of the insect body and their appendages and functions

CO3: Identify, collect, and manage different insects of household, man and animals

CO4: Apply appropriate indirect and direct measures to prevent or reduce pest attack

CO5: Analyse the main pest species of crops based on the symptoms of the attack and morphological traits

CO6: Develop strategies to manage the vectors population

CO7: Plan and implement crop protection according to the Integrated Pest Management Principles.

Unit I

Introduction – principles of classification – Taxonomist A. D. Imms' classification down to orders with their diagnostic characters of any ten significant orders– methods of collection, killing and preservation of insects.

Unit II

External morphology of insects – types of mouthparts, antennae, wings, legs, thorax and abdomen. Life cycle of insects- types of metamorphosis.

Unit III

Structure, morphology and functions of integument. Alimentary canal and associated glands. Organization, structure and types of tracheal system. Hemolymph-composition and function. Hemocytes – types and function. Reproductive system – male and female

Unit IV

Any four important pests of Paddy, Sugarcane and Coconut. Pests of stored products – internal feeders and external feeders. Insects associated with human beings- vectors - mosquitoes and house fly – beneficial insects.

Unit V

Methods of pest control - natural, cultural, mechanical, legal, biological and chemical organic and inorganic compounds – synthetic pyrethroids). Recent trends in pest control- Biointensive integrated pest management, hormones, pheromones, anti-feedants. Sterile insect technique – insect virus. Modern trends in pest control - integrated pest management.

Suggested reading materials:

1. David BV and TN. Ananthkrishnan.2004. General and Applied Entomology, McGraw Hill Education, Bangalore.
2. R.F. Chapman, 1998 The Insects: Structure and Function. Cambridge University Press.
3. Saxena R. C. and R.C. Srivastava 2007. Entomology, Agrotech Publishing Academy, Udaipur
4. Tembhare. D.B. 2017. Modern Entomology, Himalaya Publishing House, New Delhi,
5. Sandhya Agrawal 2009, Applied Entomology Oxford Book Company, Jaipur, India.
6. Ravindran K.R. 2013. A Text Book of Economic Zoology, Wisdom Press, New Delhi
7. Nalina Sundari, M.S. and R. Shanthi 2006. Entomology MJP Publishers, Chennai
8. Vasanthraj David B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology. Brillion Publication, New Delhi.
9. Sanjay Mardal A.2004 Handbook of Insect Neuro Endocrinology, Emkey Publication, Delhi- 51
10. Kumar A, and Nigam P.M. 2004. Economic and Applied Entomology, Emkey Publication, Delhi – 51

LAB ON ENTOMOLOGY

1. Identification and classification of common local insects.
2. Mounting– Honey bee (Mouth parts, Sting and pollen basket),
3. Mounting of mouth parts of mosquito
4. Museum specimens: Any three insect pests and their damages – paddy, coconut, sugarcane.
5. Life history of House fly
6. Life history of Mosquito
7. Submission of insect box with minimum 20 insects.

COs cognitive level and mapping with POs and PSOs:

SEMESTER IV																
CORE COURSE: XV 4.3 ENTOMOLOGY																
CO	COGNITIVE LEVEL	PO							PSO							
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8
CO1	K-2 Understand	3	3	3	3	2	1	-	2	2	1	1	-	-	-	-
CO2	K-3 Apply	3	3	3	2	2	1	-	2	2	1	1	-	-	-	-
CO3	K-3 Analyse	3	3	3	3	2	2	-	2	2	2	1	1	-	-	-
CO4	K-4 Analyse	3	3	3	3	3	3	1	2	2	2	2	1	-	-	-
CO5	K-4 Analyse	3	3	3	3	3	3	2	3	2	2	2	2	2	1	-
CO6	K-5 Evaluate	3	3	3	3	3	3	2	3	3	3	2	2	2	2	1
CO7	K-6 Creativity	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

ELECTIVE PAPER I: AQUACULTURE

3Hrs/Week

Credits: 2

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- ❖ Creating awareness on the scope & importance, fishery resources of India in general and Tamil Nadu in particular.
- ❖ Support different types of Fish culture, fresh water and marine prawn culture and its prospects in India
- ❖ Promote, facilitate and influence the best possible standards of fisheries management.
- ❖ Provide the technical and general knowledge necessary for competent fisheries management.
- ❖ Inform the recent advancement and role of biotechnology in conservation of fishes.

COURSE OUTCOMES (COs):

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

CO1: Assess the biotic and abiotic factor of water necessary for fish life and ecological characteristics of lakes, rivers and marine environment.

CO2: Analyse culture of mussels, clams, oysters and pearl culture, sewage fed fish culture, paddy cum fish culture, frog culture, and sea weed culture.

CO3: Evaluate the fish breeding in natural conditions, hypophysation, stripping, transgenic fishes, hybridization and polyploidy.

CO4: Construction of different types of fish ponds, setting and management of fresh water aquarium.

CO5: Examine common fish diseases such as bacterial, viral, fungal and nutritional deficiency diseases.

Unit I

Aquaculture: history, definition, scope & importance, fishery resources of India in general & Tamil Nadu in particular, abiotic and biotic factor of water necessary for fish life, ecological characteristics of lakes & rivers, general ecological characteristics of reservoirs of India.

Unit II

Fish culture: mono, poly, mixed & composite fish culture, fresh water and marine prawn culture and its prospects in India, culture of mussels, clams, oysters and pearl

culture, sewage fed fish culture, paddy cum fish culture, frog culture, sea weed culture.

Unit III

Fish breeding in natural conditions, bundh breeding, hypophysation & stripping, transport of live fish and seed, different types of crafts and gears used for fish catching, plankton – its definition, culture & identification, common weeds of fish ponds & methods of their eradication, production of mono sex and sterile fishes, transgenic fishes, hybridization, polyploidy, role of bio technology in conservation of fishes.

Unit IV

Fresh water fish farm: selection of site, construction of fish farm and soil chemistry, designing layout and construction of different types of fish ponds, setting and management of fresh water aquarium, preservation and processing of fish, fish by products industry and their utility.

Unit V

Water pollution, its effects on fisheries and methods of its abatement, common fish diseases (bacterial, viral, fungal and nutritional deficiency diseases), biochemical composition and nutritional value of fish, fisheries economics and marketing, fisheries managements and extension.

Suggested reading materials:

1. Pillay T.V.R. & Dill, W. A. 1979. Advances in Aquaculture. Fishing News Books Ltd.
2. Agarwal, S.C. 2008. A Handbook of Fish Farming. Narendra Publishing House.
3. Rath, R. K. 2011. Fresh water Aquaculture. 3rd edition. Scientific Publishers, CIFA.
4. Hall, C. B. 2000. Ponds & Fish Culture. Agro-Botanica Publishers.
5. Chhapgar, B. F. 2008. Fishes of India. 2nd edition. Oxford University press.
6. Jhingaran, V. G. 1997. Fish and Fisheries of India. Hindustan Publishing Corporation.
7. Khanna, S.S. 2019. An Introduction to Fishes. Surjeet Publications.

8. Kumar, H.D.2005. Sustainability and Management of Aquaculture & Fisheries, Daya Publishing House.
9. Sanatam, R. Sukumaran, N. and Natarajan, P. 1990. A manual of Freshwater aquaculture India Book House Pvt Ltd.
10. Gupta, S. K. and Gupta, P. C. 2006. General and applied ichthyology. Fish and Fisheries. S. Chand & Co.

LAB ON AQUACULTURE

1. Morphometry of a pond
2. Estimation of fish population using mark and recapture method
3. Estimation of primary productivity of macrophyte
4. Analysis of dissolved oxygen, salinity and alkalinity of any two water samples
5. Study of fish pathology
6. Taxonomic description of cultivable fishes (Indian major carps, 3 exotic carps)
7. Morphological feature of penaeid and non-penaeid prawn
8. Determination of age of fishes.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER IV																	
ELECTIVE PAPER I: AQUACULTURE																	
CO	CONGNITIVE LEVEL	PO							PSO								
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)

ELECTIVE PAPER II: SERICULTURE

3Hrs/Week

Credits: 2

LEARNING OBJECTIVES (LOs)

The objectives of the course are to

- ❖ Creating awareness on the scope, importance, Sericulture resources of national and international level.
- ❖ Promote the various techniques involved in the rearing of mulberry silkworm.
- ❖ Support practices for mulberry cultivation and propagation. Methods of propagation, manuring, irrigation, pruning and harvesting of leaves.
- ❖ Provide knowledge on physical characters for commercial purposes and Cocoon marketing.
- ❖ Inform the recent trends in silk production and marketing and sericulture an entrepreneurship for youth and women.

COURSE OUTCOMES (COs):

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

CO1: Assess the Silk producing organisms, Non-mulberry silkworms: Eri, Tasar&Muga, their food plants and life history.

CO2: Analyze mulberry varieties, cultivation, propagation, manuring, irrigation, pruning and harvesting of leaves.

CO3: Evaluate the biology of *B. mori*, voltinism and races suitable for rearing.

CO4: Rearing methods like Chawki rearing and rearing of late age and mature larvae-mounting practices and cocoon marketing.

CO5: Examine diseases of Silkworm like Fungal, Viral, Bacterial diseases and Pest of silkworm and causative agent, symptoms, prevention and control measures.

UNIT I Sericulture - India and World Scenario

Introduction, History, Scope & Importance – Silk production in the world – Sericulture in India – CSB, Central Silk Board and Research Institutes – CSR & TI, NSSP (National Silkworms seed project). Silk producing organisms, Non-mulberry silkworms: Eri, Tasar&Muga- food plants and life history

UNIT II Moriculture

Taxonomy and Mulberry varieties and diversity of mulberry, Package of practices for mulberry cultivation and propagation – Plantation system – Methods of propagation, manuring, irrigation and pruning - Harvesting of leaves. Genetics of mulberry: Spontaneous and induced mutation, Diseases of mulberry: Factors, symptoms and control measures – Fungal, Bacterial, Viral, Nematode and deficiency diseases. Pest of Mulberry: Life cycle, nature of damage and control – Bihar hairy caterpillar, mealy bugs, thrips and stem borer.

UNIT III Biology of *Bombyx mori*

Biology of *B.mori* – races and voltinism. Structure of egg, larva, pupa and adult. Sexual dimorphism- larva, pupa and adult. Anatomy: Digestive system, circulatory, respiratory, Excretory, male and female reproductive system. Silk gland – Structure and Significance-Silk protein. Neuroendocrine system, neuro secretory cells, Corpora allata, Corpora cardiaca, ecdysial gland. Hormonal control of moulting and metamorphosis. Exocrine glands and pheromones.

UNIT IV Grainage and Rearing operation

Grainage technology: Breeding Stations - methods of industrial egg production, mother moth examination, diapausing and non-diapausing eggs. Incubation and transport of eggs. Silk worm - Rearing: Rearing House (CSB- model)and Rearing appliances. Rearing operation- Disinfection, brushing, maintenance of optimum conditions, feeding, bed cleaning, spacing, care during moulting, mounting, and Harvesting. Rearing methods: Chawki rearing and rearing of late age and mature larvae- Mountingpractices.

UNIT V Silk reeling operation and disease management

Cocoon marketing- physical characters for commercial purposes- shell ratio – defective and malformed cocoons -Stifling, Storage- Sorting–deflossing- riddling- blending - cooking, brushing. Reeling operation: reeling appliances- types - raw silk – raw silk testing – silk wastes, preparation of compost using sericultural wastes and by products of sericulture. Diseases of Silkworm:Fungal, Viral, Bacterial diseases; Pest of silkworm – Uzi fly and Dermestid beetles - causative agent, symptoms, prevention and control measures.

Suggested Reading materials:

1. Damdrin, S.B. Jayant Jayaswal K., Giridhar 2000. Hand book of sericulture technologies. Central Silk board, Bangalore, India
2. Ganga,G and I.SulochanaChetty 2008;Second Edition. An Introduction to Sericulture. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. G.Rangaswamy etal.,Mulberry cultivation – Central Sericultural Research and Training Institute . Mysore (1972).
4. Ullal, S.R. and Narasimhanna, M.N. (1987), Handbook of Practical Sericulture, Central Silk Board Publication, Bangalore.
5. HisaoAruga.Principles of Sericulture.Oxford& IBH Pub. Co. Pvt. Ltd., New Delhi.
6. Madan Mohan Rao, M. 1998. A book of sericulture B.S. Publications, 4-3-309. 2nd floor, Sultan Bazar, Hyderabad.
7. Choudhary, S.N.1982. MugaSilk Industry. Directorate of Sericulture, Government of Assam, Assam.

8. Nanavaty, M.N., 1990. Silk Production, Processing and Marketing. South Asia Books.
9. M.S. Jolly, (1982) Economics of Sericulture under Irrigated and Rainfed Conditions CSR & TI Mysore.
10. Sarkar, D.D. (1998), Silkworm Biology, Genetics and Breeding: Vikas Publication, New Delhi.
11. Silkworm Diseases (1988): FAO Pub. by Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi.
12. Joly, M.S., Sen, S.K. and Absan, M.M. (1974), Tasar Culture, CSTRI, Ranchi.

LAB ON SERICULTURE

1. Any three local varieties of mulberry (MR2, K2, V1).
2. Pests of mulberry.
3. Dissections: Digestive system, silk gland, nervous system – larva,
4. Mounting of mouth parts of larva.
5. Life cycle of *Bombyxmori*
6. Sexing of Larva, pupa and adults
7. Characteristics of defective cocoons.
8. Physical characters of commercial cocoons.
9. Spotters: Rearing tray, rearing stand, chandrika, cocoon, raw silk, Open Pan cooking unit. Three pan cooking unit, Jettebout, country charkha, Netrika.
10. Diseases of Silkworm – (bacterial, and fungal).
11. Diseases of mulberry (fungal and nematode)
12. Field visit to sericulture station.

Cos cognitive level and mapping with POs and PSOs:

SEMESTER IV																	
ELECTIVE PAPER II SERICULTURE																	
CO	CONGNITIVE LEVEL	PO							PSO								
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	
CO1	K-1 Remember	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K-2 Understand	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K-3 Apply	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K-4 Analyse	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO5	K-5 Evaluate	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO6	K-6 Create	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Strongly Correlated (3); Moderately Correlated (2); Weakly Correlated (1)