

**Deccan Education Society's
FERGUSSON COLLEGE (AUTONOMOUS), PUNE – 411004.**

**Syllabus
for
S. Y. B. Sc. (Zoology)
[NEP - 2020]
(B.Sc. Zoology Semester-III and Semester-IV)**

**Deccan Education Society's
Fergusson College, (Autonomous), Pune - 411004.**

**Department of Zoology
Second Year Curriculum under NEP 2020**

Semester	Paper	Paper Code	Paper Title	Credit	Type
III	Major	ZOO-201	Functional Anatomy of Non – chordates	4	Theory
		ZOO-200	Zoology Practical (Major) - III	2	Practical
	Minor	ZOO-211	Bio-floc Technology	2	Theory
		ZOO-212	Zoology Minor Practical - III	2	Practical
	Open Elective O.E)	ZOO-220	Wonders of Animal World	2	Theory
	Vocational Skill Course (V.S.C.)	ZOO-230	Aquaculture Entrepreneurship	2	Theory
	Skill Enhancement Course (S.E.C.)	ZOO-240	Fundamentals of Animal Biotechnology	2	Theory
C.E.P.	ZOO-245	Community Engagement Programme (C.E.P.)	2	—	
IV	Major	ZOO-251	Applied Zoology	4	Theory
		ZOO-250	Zoology Practical (Major) - IV	2	Practical
	Minor	ZOO-261	Applied Entomology	2	Theory
		ZOO-262	Zoology Practical (Minor) - IV	2	Practical
	Open Elective O.E)	ZOO-270	Human Evolution	2	Theory
	Vocational Skill Course (V.S.C.)	ZOO-280	Biological Techniques	2	Theory
	Skill Enhancement Course (S.E.C.)	ZOO-290	Animal Tissue Culture	2	Theory
Field Project (F.P.)	ZOO-295	Field Project	2	—	

S.Y. B.Sc. Semester III
Subject- Zoology
(ZOO-201): Functional Anatomy of Non – chordates
(Major – Theory)

[Credits-4]

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	(ZOO-201): Functional Anatomy of Non – chordates	Number of Credits -4
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe habit and habitat, morphology of <i>Paramecium</i> , earthworm, liver fluke and sea star. State significance of protozoan parasites, mouth parts of insects, shell and foot modifications in molluscs. Define metamorphosis, metamerism, torsion, detorsion.	1
CO2	Illustrate various systems of <i>Paramecium</i> , earthworm, liver fluke and sea star. Explain larval forms of crustaceans, mouth parts and mimicry of insects, shell and foot modifications in mollusc, metamorphosis, metamerism, torsion, detorsion.	2, 4
CO3	Demonstrate and illustrate digestive system, circulatory system, respiratory system, excretory system of <i>Paramecium</i> , earthworm, liver fluke and sea star.	3
CO4	Compare larval forms of crustacean, sea star, mouth parts of insects, shell and foot of molluscs.	5
CO5	Prepare the chart of medically important insects, parasitic protozoans, mouth parts of insects,	6

Unit No.	Title and Contents	No. of Hours
I	Paramecium: systematic position, habit and habitat, external morphology, locomotion, nutrition and digestion, respiration, excretion and osmoregulation, reproduction.	07
II	Liver fluke: systematic position, habit and habitat, external morphology, digestive system, respiration, excretory system, reproductive system and life history. parasitic adaptations.	15
III	Earthworm: systematic position, habit and habitat, external morphology, locomotion, digestive system, circulatory system, excretory system, nervous system, sense organs and reproductive system.	13
IV	Sea star: : systematic position, habit and habitat, external morphology, digestive system, water vascular system, circulatory system, reproductive system and development.	10
V	General Topics- larval forms of crustacean, mouth parts of insects, metamorphosis in insects, mimicry in insect, bioluminescence in firefly.	15

S.Y. B.Sc. Semester III

Subject- Zoology
(Major – Practical)

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	(ZOO-200) Zoology Practical - III	Number of Credits -2
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Recall systematic position habit and habitat of Paramecium, Liver fluke, Earthworm and sea star.	1
CO2	Explain digestive system, reproductive system of earthworm.	2
CO3	Demonstrate external morphology, digestive system, water vascular system of sea star.	3
CO4	Identify larval forms of <i>Fasciola hepatica</i> , crustacean and sea star.	4
CO5	Evaluate mouth parts of insects, foot and shell in molluscs.	5
CO6	Study of shell and foot modification in molluscs.	6

Exp. No.	Title
1.	Study of culture and External morphology of Paramecium.
2.	Study of reproduction in Paramecium.
3.	Study of systematic position, habit and habitat, external morphology and digestive system of Earthworm.
4.	Mounting of septal nephridia and setae from Earthworm.
5.	Study of Male reproductive system of Earthworm.
6.	Study of female reproductive system of Earthworm and study of spermatheca.
7.	Study of larval forms of <i>Fasciola hepatica</i> .
8.	Study of systematic position, habit and habitat, external morphology and digestive system of sea star.
9.	Study of water vascular system of sea star.
10.	Study of reproductive system and larval forms of sea star.
11.	Study of mouth parts of insects.
12.	Study of shell and foot modification in molluscs.
13.	Study of crustacean larvae.
14.	Any other practical suggested by teacher.
15.	Visit to Biodiversity spot / vermiculture plant / coastal areas / research institute.

**** Use of virtual dissection software/ chart, models and slides.**

References:

1. Text Books of Zoology. Vol.11, Invertebrates, A. J. Marshall And W. D. Williams, ELBS and Macmillan, Hongkong.
2. Invertebrates Zoology, E.L. Jordan and P.S. Verma; S. Chand and Co. Ltd., New Delhi. 14th fully Revised Edition
3. Invertebrate Zoology, Ruppert and Barnes, 6th Edition. 4. An Introduction to Mollusca. H. S. Bhamrah, Kavita Juneja. Anmol Publications Pvt. Ltd. New Delhi- 110002 (India).
5. Life of Invertebrates, S. N. Prasad, Vikas Publishing Co. Sahaldabad.
6. The Invertebrates, Echinodermata Vol- IV, L.H. Hyman, International books and periodicals supply services Dehli.
7. An Introduction of Echinodermata. . H. S. Bhamrah, Kavita Juneja. Anmol Publications Pvt. Ltd. New Delhi- 110002 (India). 8. Invertebrate Zoology R. D. Barnes, Saunders College, Philadelphia.
9. Text Books of Zoology, Invertebrates Vol- II, T.J. Parker and W.A. Haswel, Edited by Marshall and Williams, CBS publications and distribution, New Dehli.
10. Animal Diversity 3rd edition, Cleveland P. Hickman, Jr Larry S Roberts and Allan Larson. Published by *McGraw Hill* company.
11. Invertebrate Zoology, Paul, A. Meglitch and Fedricks R. Schram, Oxford University Press, New York. 11. Modern Text Book of Zoology. Invertebrates. 6th Edition, R. L. Kotpal, Rastogi Publication, Meerut.
12. Biology of Invertebrates by Jan A, Pechenik Published by Mc Graw Hill Education (India) Private limited, Chennai.
13. Invertebrates 3rd Edition by Richard C Brusca, Wendy Moore, Stephen M. Shuster. Published by Sinauer Associates Inc. Publishers Sunderland and Massachusetts. USA.

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Minor: Bio-floc Technology ZOO211	Number of Credits -2 Number of hours-30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Outline importance of aquaculture and its basic types	1
CO2	Discuss aquaculture techniques with emphasis on Biofloc technology.	2, 4
CO3	Experimental method used in maintaining water parameters in Biofloc technology.	3
CO4	Analyse the optimum conditions necessary for Biofloc technology.	5
CO5	Determine the physical, chemical conditions in correlation with fishes used in Biofloc technology.	6

Unit No.	Title and Contents	No. of Hours
I	1.1 Introduction to Aquaculture 1.2 Aquaculture: Basic 1.3 Concept; Types of Aquaculture, 1.4 Culture of freshwater fish/ prawn, 1.5 Culture of marine fish/ prawn, 1.6 Pearl Culture, 1.7 Rearing ponds for aquaculture; 1.8 Composite Fish farming, 1.9 Breeding Ponds, Fish Seeds, Harvesting. 1.10 Introduction to Biofloc Culture Definition and Application of Biofloc Technology 1.11 Layout and Design of tanks 1.12 Composition and Nutritional Value of Biofloc Culture	15
II	2.1 Water Quality Parameters in Biofloc Technology 2.2 Dissolved oxygen (DO) Temperature, pH, Salinity, 2.3 TAN, Nitrite, Nitrate, Orthophosphate, Alkalinity, Setting Solids and Total Suspended Solids 2.4 Role of Microorganisms in Biofloc Technology 2.5 Benefits of Biofloc Culture 2.6 Species suitable for Biofloc Culture 2.7 Biofloc Technology- a tool for management of water quality in aquaculture	15

S.Y. B.Sc. Semester III
Subject- Zoology
(ZOO-212): Zoology Minor Practical - III
(Minor – Practical III)

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Zoology Practical Minor - III (ZOO-212)	Number of Credits -2
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Outline importance of aquaculture and its basic types	1
CO2	Discuss aquaculture techniques with emphasis on Biofloc technology.	2
CO3	Experimental method used in maintaining water parameters in Biofloc technology.	3
CO4	Analyze the optimum conditions necessary for Biofloc technology.	4
CO5	Determine the physical, chemical conditions in correlation with fishes used in Biofloc technology.	5

Exp. No.	Title
1.	Estimation of pH and alkalinity of the given water sample
2.	Determination of turbidity by using Secchi disc.
3.	Estimation of dissolved Oxygen of the given water sample
4.	Estimation of CO ₂ of the given water sample
5.	Estimation of nitrate of the given water sample
6.	Estimation of nitrite of the given water sample
7.	Estimation of total suspended solids of the given water sample
8.	Basic streaking methods for microbial culture by using water sample
9.	Identification of gut flora of locally available fish.
10.	Identification of local fish/ shrimp species used for aquaculture
11.	Layout and designing of bio floc tank and maintain it.
12.	Visit to aquaculture pond/ farm where bio floc is practiced and coastal area/Local waterbodies prepare a report.

References:

1. Biofloc Technology: An Overview and Its Application, Article *in* Research Today · January 2021.
2. RECENT TRENDS IN AQUACULTURE, BIOFLOC FISH CULTURE, National Fisheries Development Board, Department of Fisheries , Ministry of Fisheries, Animal Husbandry & Dairying, Government of India.
3. Training manual on Biofloc Technology for Nursery and Growout Aquaculture, CIBA TM Series 2019 No.15, ICAR - CENTRAL INSTITUTE OF BRACKISHWATER AQUACULTURE 75, Santhome High Road, R. A. Puram, Chennai – 600 028, Tamil Nadu, India
4. Biofloc Technology, A Practical Guide Book, Third Edition, Yoram Avinimelech
5. Biofloc Technology (BFT): An Effective Tool for Remediation of Environmental Issues and Cost Effective Novel Technology in Aquaculture, Das SK1* and Mandal A2, International Journal of Oceanography & Aquaculture, 2018.

S.Y.B.Sc. Semester III		
ZOO-220	Wonders of Animal World ZOO220 (Open Elective course)	Credits: 2 Hours: 30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's Cognitive Level
CO1	Describe animal diversity, behavioral peculiarities and parental care in different animals.	1
CO2	Articulate bioluminescence, regenerative activities, social organization, cannibalism nesting architecture, mimicry and camouflage in animals.	2
CO3	Illustrate importance of bioluminescence, mimicry, camouflage, echolocation in the survival of animals.	3
CO4	Explain modes of breeding and parental care in Pisces, Amphibians and Mammals, social organization and communication in honey bees.	4
CO5	Review migratory activities of birds, characters of non-chordates, chordates, unicellular and multicellular animals.	5
CO6	Generate curiosity about the fascinating world of animals which would enhance their interest and love for the subject of Zoology.	6

Unit	Contents	No. of hours
I	Introduction: Introduction to animal world, diversity of animals (brief idea of unicellular, multicellular, non-chordates and chordate animals).	03
II	Stunning behavior of animals: Bioluminescence in Animals: Noctiluca, Glow worm, Firefly, Angler fish (mechanism and use). Social organization of honey bees, mode of communication, its importance in pollination. Regeneration in animals: Hydra, Planaria, Starfish, Lizards. Cannibalism in Spider and scorpion. Nesting architecture: Termiteries of termites, Harvester ant, baya weaver Bird.	12
III	Fascinating world of Animals: Mimicry in insects and its significance: Great Eggfly, Common Crow, Common Palm fly and Plain Tiger. Lantern fly, stick insect and Phyllium leaf insect. Camouflage in Frogs and Chameleon. Pearl formation in Molluscs. Bird migration: Definition, types and factors inducing bird migration Brood parasitism in birds (Cuckoo), fishes and insects.	15

	<p>Echolocation in Bats, Dolphins and Whales.</p> <p>Breeding and Parental care:</p> <p>Pisces - Ovo-viviparous (Black Molly/Guppy), Mouth brooders (Tilapia), Brood pouches (Sea horse).</p> <p>Amphibia - Mouth brooders (Darwin's Frog), Egg carriers (Midwife Toad).</p> <p>Mammals - Egg-laying (Duck-billed Platypus), Marsupials (Kangaroo).</p>	
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References:

1. Vertebrate Zoology Volume I- Jordan E. L. and Verma P. S., S. Chand and Co.
2. Invertebrate Zoology Volume II- Jordan E. L. and Verma P. S., S. Chand and Co.
3. Chordate Zoology- P. S. Dhama and J. K. Dhama , R. Chand and Co.
4. Invertebrate Zoology- P. S. Dhama and J. K. Dhama , R. Chand and Co.
5. Modern Textbook of Zoology, Invertebrates, R. L. Kotpal. Rastogi Publication. 2009
6. Modern Textbook of Zoology, Vertebrates, R. L. Kotpal. Rastogi Publication. 2009
7. "Butterflies of India", Kehimiker Issac, BNHS Field guide, BNHS Publications, 2008.
8. KNOWLEDGE ENCYCLOPEDIA, Penguin Random House, 2017.
9. Biodiversity- S.V.S Rana- Prentice Hall Publications.
10. Invertebrate Zoology, Majupuriya T. C., S. Nagin & Co.
11. <https://webecoist.momtastic.com/2009/03/09/animal-natural-phenomenon-wonders/>
12. <https://www.amazon.in/Wonders-Animal-Kingdom-Robert-Huish/dp/1021083755>
13. <https://www.youtube.com/watch?v=GO0B-c9tLZ4>
14. <https://news.cgtn.com/news/2020-01-17/Natural-wonders-the-animal-kingdom-s-greatest-travel-rush--NjXp8adFCM/index.html>
15. <https://www.lannaantique.com/products/wonders-of-animal-life-j-a-hammerton>

S.Y. B.Sc. Semester III
Subject- Zoology
Vocational Skill Course (VSC)
Paper title: Aquaculture Entrepreneurship
(ZOO-230)

[Credits-2]

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Vocational Skill Course (VSC) ZOO-230 Aquaculture Entrepreneurship	Number of Credits - 2
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Understand the fundamental concepts of Aquatic Biomes Identify the components of composite fish culture. Memorize the different techniques involved in preservation .	1
CO2	Explain the different types composite cultures Describe the concept of prawn and pearl culture. Interpret the scope and importance of integrated fish farming.	2
CO3	Analyze the impact of agricultural, industrial, sewage, thermal and Oil spills, eutrophication on aquaculture. Apply the culture techniques for better production.	3
CO4	Differentiate fresh water and marine ecosystem. Analyze causes of pollution. Critically assess the role of camouflage and mimicry in the context of natural selection.	4
CO5	Evaluate the advantages and disadvantages of different culture techniques including cage culture and pen culture. Review Management of Aquatic Resources.	5
CO6	Synthesize information about by products from aquaculture industry and their preservation techniques to form a comprehensive entrepreneurial understanding. Write a report on management and conservation (legislations)	6

Unit No.	Title and Contents	No. of Hours
I	<p>Introduction to Aquaculture</p> <p>Aquatic Biomes Brief introduction of the aquatic biomes: Freshwater ecosystem -Inland -Riverine, Lacustrine, Cold water and Estuarine fisheries.</p> <p>Marine ecosystem - Stratification of marine habitat, Zone of marine habitat.</p> <p>Group of marine Fishery: Coastal/Inshore fisheries and Deep sea /Offshore fisheries.</p> <p>Techniques to start fish culture and preparation of farm. for entrepreneur, Breeding pond and its types. Hatchery / Hapa – Traditional and modern hatchery, Nursery pond, Rearing pond and Stocking pond</p> <p>Protocol to be followed for. Pearl Culture, Prawn culture -</p>	15
II	<p>Composite fish farming. - History, Principle, Salient features, scope and importance of integrated fish farming.</p> <p>Introduction to other important culture techniques: -</p> <p>Cage Culture–Shape, size and types of cages. Principle aim of cage culture. Advantages and disadvantages of cage culture.</p> <p>Pen Culture- History, Types of barriers in Pen Culture, merits and demerits of pen culture.</p> <p>By products from aquaculture industry.</p> <p>Preservation Technique – drying, salting, icing, smoking, eickling, canning etc.</p> <p>Management of Aquatic Resources</p> <p>Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations).</p> <p>Water quality assessment- BOD and COD.</p>	15

References: -

1. A Text Book of Marine Ecology by Nair M.B. and Thumpy D.H. – Tata MacGraw Hill Pub. – New Delhi.
2. An Introduction to Fishes by Khanna S.S. – Central Book Depot, Allahabad (1993).
3. Aquaculture, Principles and Practices by Pillay T.V.R. – Fishing News Books (1988).
Course Manual in Fishing Technology by Latha Shenoy, CIFE, Versova, Mumbai.
4. Crafts and Gear of India by Y. Shrikrishnan and Latha Shenoy – ICAR Pub.
5. Ecological Methods for Field and Laboratory Investigations by P. Michael. The Oceans By Svedrup H.V. – et.al. - Asian Pub. House.
6. Financial management by Prasanna Chandra- Seventh Edition.
7. Fish and Fisheries in India – by Jhingran V.G. – Hindustan Pub. Corporation – New Delhi.

8. Fisheries Biology, Assessment and Management by Michael King – Fishing News Publishers (1995)..
9. Fisheries Bioeconomics – Theory, Modelling and Management – FAO Fisheries Technical Paper 368 – FAO, 2001.13)
10. Goldman, C. (1994) Limnology (2nd edition).
11. Ananthakrishnan, T.N. (1989) Bioresources Ecology (3rd edition).
12. Pawlowski, L. (1980) Physicochemical Methods for water and Wastewater Treatment.
13. Wetzel, R. (2001) Limnology (3rd edition) Elsevier.
14. Trivedy, R.K. and Goyal, P.K. (1986) Chemical and biological methods for water pollution studies.
15. Welch, P.S. (2014) Limnology Vol. I-II. 17) Introductory Oceanography by Harold Thurman – Printis Hall Pub. London – 8th Edition.
16. Marine Ecology by Tait R.B. – Oxford Press.
17. Prawn and Prawn Fisheries by Kurian and Sebastian.25) Project Management by Prasanna Chandra.
18. Aquaculture law and policy : towards principled access and operations David L VanderZwaag; Gloria Chao London ; New York : Routledge 2012
19. Encyclopedia of aquaculture Robert R Stickney New York : Wiley 2000
20. Text Book of Fish Biology and Indian Fisheries by Dr. R. P. Parihar, Central Pub. House, Allahabad.
21. The Book of Indian Shells by Deepak Apte – Oxford Uni. Press.30) Wealth of India – Vol. IV – CSIR Pub.
22. FAO. 1997. Aquaculture Production Statistics 1987-1996.
23. FAO. 1999a. Fish and Fishery Products: World apparent consumption statistics based on food balance sheet. *FAO Fisheries Circular*, No. 821 (Rev. 5).
24. FAO. 1999b. *The State of World Fisheries and Aquaculture*. Rome: FAO.
25. FAO. 2000a. FishStat+ v.2.3. Available [Online]:
<http://www.fao.org/fi/statist/Fisoft/FishPlus>

Online readings

<https://oceanservice.noaa.gov/facts/aquaculture.html>

<https://asc-aqua.org/learn-about-seafood-farming/what-is-aquaculture/>

<https://www.conserve-energy-future.com/aquaculture-types-benefits-importance.php>

S.Y. B.Sc. Semester III

Subject- Zoology

Skill Enhancement Course (SEC)

Paper title: Fundamentals of Animal Biotechnology.

(ZOO-240)

[Credits-2]

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Skill Enhancement Course (SEC) ZOO-240 Fundamentals of Animal Biotechnology	Number of Credits -2
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the fundamental concepts of animal biotechnology, Recall the names restriction enzymes used in gene cloning. Outline the process of gene cloning..	1
CO2	Explain the application of animal biotechnology. Predict the result of gene cloning. Illustrate the concept of r DNA technology.	2
CO3	Interpret the result of gene cloning, Illustrate the principle of hybridoma technology. Demonstrate the methods of gene transfer.	3
CO4	Differentiate between the cloned vector and un-cloned vector, monoclonal and polyclonal antibody. Explain the concept of IVF.	4
CO5	Evaluate the method of gene transfer, conclude the result of cloning.	5
CO6	Hypothesize the problems of genetic engineering. Formulate the methods of transfection and hybrid selection. Write a report on application of cell culture in animal biotechnology.	6

Unit No.	Title and Contents	No. of Hours.
I	1.1 Introduction to animal biotechnology, definition, scope of animal biotechnology. basic concept of gene, genome proteomes. 1.2 Principle and application of rDNA technology and genetic engineering. – concept of gene cloning and enzymes used in gene cloning, plasmids, cosmids and vectors. 1.3 PCR and its application. Transfection techniques. - methods of gene transfer, microinjection, electroporation, lipofection and viral mediated gene transfer techniques 1.4 Screening strategies used in selection of clone - genes, antibiotic selection, blue- white screening, colony hybridization, Fluorescence in-situ hybridization (FISH) and immunological test. Animal Cell culture techniques and its application.	20
II	2.1 Application of Animal biotechnology- transgenic animals and its use- production of GH, hCG, 2.2 Application in medicine- monoclonal antibodies –hybridoma – technology, IVF, 2.3 Cloning of different animals, cloning for conservation endangered. 2.4 Concept of stem cells, types of stem cells and its application.	10

References: -

- R. C. Sobti , Suparna S Pachari Essential of Biotechnology.Ane books pvt. ltd.
- U Satya Narayana Biotechnology Books and allied (P) Ltd.
- Sandhya Mitra Genetic Engineering Principles and Practice Macmillan India ltd
- Gordon I. 2005. Reproductive Techniques in Farm Animals.CABI.
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- Lincoln PJ & Thomson J. 1998. Forensic DNA Profiling Protocols. Humana Press.
- .Portner R. 2007. Animal Cell Biotechnology. Humana Press.
- Spinger TA. 1985. Hybridoma Technology in Biosciences and Medicine. Plenum Press.
- Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific.

S.Y. B.Sc. Semester- IV

Subject- Zoology

Paper title: Applied Zoology

(ZOO 251):

Major

[Credits-4]

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Major-Applied Zoology ZOO 251	Number of Credits - 4
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe the concepts of apiculture, importance of bee keeping, traditional and modern bee keeping methods. Explain the role of Khadi Gramodyog and Village Development Corporation in development and spread of apiculture in India. Describe cultivation of mulberry plant for enhancement of silk production.	1
CO2	Discuss the medical properties of honey and its application in various fields, its nutrients and composition. Differentiate between different life stages of silkworm and explain their life cycle. Discuss control and prevention of pests and diseases.	2
CO3	Apply the knowledge of bee keeping in establishment and maintenance of bee colonies and for the use of various equipment to obtained bee products like honey, bee wax, royal jelly etc. Demonstrate the technique of handling the bees and processing of honey. Demonstrate and discuss the culture methods of <i>B.mori</i> Outline the silkworm rearing technology, types of montages used, spinning and harvesting techniques	3

CO4	<p>Explain the social organization and division of labour in the honeybees. Compare the indigenous and exotic species of honeybees and differentiate queen, workers and drone bees.</p> <p>Differentiate diseases of silk worms and different methods for control.</p> <p>Outline the important tools and equipment's used in sericulture</p>	4
CO5	<p>Appraise the importance of propagation of bee flora and its role in the agricultural crop pollination. Evaluate the impact of pesticides on honeybees. Compare and explain about different silks produced in India .Review employment generation through sericulture and role of women in sericulture.</p>	5
CO6	<p>Design the calendar for management of bee colonies. Prepare the proposal for financial assistance from banks for starting a bee keeping project.</p> <p>Write about judicious use of their by-products and moriculture.</p> <p>Evaluate, appreciate and specify the importance of embarking on self-employment through rearing of silkworms,</p>	6

Unit No.	Title and Contents	No. of Hrs
I	<p>Introduction to Apiculture- Indian history of bee keeping, Modern perspective and scope of beekeeping, . Origin, systematics and distribution of honey bee. Types of honey bees- indigenous, exotic, Species of honey bees. Morphology and anatomy of honey bee. Life cycle of honey bee, social organization of honey bee – queen, drone, worker. Division of labour in hive, Communication in bees. Diseases of bees, protozoan, bacterial, viral, fungal diseases and their diagnostic tests. Pest and Enemies of bees.</p>	15
II	<p>Selection of bee species for beekeeping, Bee keeping equipment's Artificial Bee Rearing- Modern Bee Keeping Equipment and Methods. Newton ISI Type Hives, Lang stroth hives, Honey Extractor, Smoker, Bee Veil, Gloves, Knife etc. Outline of Apiary industry. Seasonal management of bee keeping.</p> <p>Introduction to bee flora- Qualities of Good Bee Flora. Some Important Bee Flora and Their General Characters.-Migratory Bee Keeping - designing floral Calendar Improved Agricultural practices - crop pollination</p> <p>Bee products</p> <ul style="list-style-type: none"> i) Honey –composition, quality and uses. ii) Bee wax-composition and its uses. iii) Propolis--composition, quality and uses. iv) Royal jelly –composition, quality and uses. v) Bee venom. –composition, quality and uses. vi) Pollen and its uses. <p>Economic of Bee keeping- Funding agencies for beekeeping in India. Steps involved in starting a beekeeping project, Marketing of honey and honey products</p>	15
III	<p>Silkworm distribution and races The silkworms. Its morphological characteristics. Types of silkworms. Distribution and types of races. Exotic and indigenous races of silkworm. Introduction to Sericulture: Definition, history and present status; Silk route World silk production. World map and silk road, spread of Sericulture to Europe, South Korea, Japan, India and other countries.</p>	15

	<p>Biology of silkworm and Moriculture</p> <p>Biology of silkworm. Life cycle of silkworm. Study of different classifications</p> <p>Selection of mulberry variety and establishment of mulberry garden, Rearing house and rearing appliances. Types of mountages, Spinning, harvesting and storage of cocoons</p> <p>Silkworm rearing technology: Early age and Late age rearing .</p> <p>Cultivation of mulberry: a) Varieties for cultivation b) Rainfed and irrigated mulberry cultivation- Fertilize schedule, Prunning methods and leaf yield</p> <p>Harvesting of mulberry: a) Leaf plucking b) Branch cutting</p> <p>c) Whole shoot cutti Silk worm rearing: a) Varieties for rearing b) Rearing house c) Rearing techniques</p>	
IV	<p>Diseases of silk worm and prevention and control</p> <p>Diseases of silkworm. Disinfectants: Formalin, bleaching powder RKO.</p> <p>Introduction and classification of silkworm diseases. Protozoan disease: symptomatology due to Nosema bombycis infection, source, mode of infection and transmission, cross infectivity, prevention and control.</p> <p>Bacterial, Viral, Fungal diseases: causative agents, symptoms, transmission prevention and control.</p> <p>Prospects of Sericulture in India</p> <p>Types of silk produced in India; Importance of mulberry silk.</p> <p>Silk industry in different states, employment, potential in mulberry and non-mulberry sericulture.</p> <p>Employment generation in sericulture: Role of women in sericulture.</p> <p>Sericulture organization in India; role of state departments of Sericulture, Central Silk Board, Universities and NGOs in Sericulture development</p>	15

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Major Practical zoology-IV ZOO 250	Number of Credits -2
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Describe colony organization, life cycle, Morphology of bee. Recall various instrument used in apiculture. Describe different diseased silkworms based on external symptoms.	1
CO2	Differentiate between caste of honeybee, species of honeybee, Illustrate labour distribution between queen, worker and drone. Differentiate between different instruments used in sericulture	2
CO3	Classify bees on the basis of morphology. Explain various bee products and its uses.	3
CO4	Describe the life cycle of silk worm. Analysis soil pH to study the suitability for moriculture	4
CO5	Assess the quality of Honey. Assess the quality of soil and interpret its suitability for moriculture.	5
CO6	Prepare report on bee keeping. Prepare report on Sericulture Organization set up in India sericulture maps indicating mulberry and non –mulberry belts in India.	6

Exp. No.	Title
1.	Study of morphology, lifecycle of honey bee.
2.	Study of mouth parts, wings hamulli, pollen basket, sting apparatus.
3.	Study of bee keeping equipment's and bee products.
4.	Study of bee pests and bee enemies.
5.	Quality analysis of honey –by water test, burn test, vinegar test. OR Quality analysis of honey by using CBRTI honey testing kit.
6.	Study of adulterants in honey by specific gravity test, moisture test, total reducing sugar.
7.	Study visit to any apiary industry or CBRTI Pune.
8.	Study of life cycle of Bombyxmori.
9.	Study of any five equipments in Sericulture.
10.	Sericulture maps: Indicating mulberry and non –mulberry belts in India.
11.	Preparation of pie charts: A) Different types of silk production in India. B)World Silk Production
12.	Submit a report on role of women in sericulture
13.	Soil analysis for pH to study the suitability for moriculture.
14.	Visit to sericulture unit.
15.	Report on Sericulture Organization set up in India :- a) Govt. of India b) Five traditional states viz., Karnataka, Andhra Pradesh, Tamilnadu, West Bengal and Jammu & Kashmi
16.	Identification of different diseased silkworms based on external symptoms (grasserie, flacherie, muscardine and pebrine).

References: -

1. Prospective in Indian Apiculture - R.C. Mishra
2. Rearing queen bees in India - M.C. Suryanarayana et. al.
3. Bee Keeping in India - G. K. Ghosh
4. Technology and value addition of Honey - Dr. D. M. Wakhle and K. D. Kamble.
5. ABC & XYZ of Bee culture - A. I. Root
6. Indian Bee Journal - All India Bee Keeping Association
7. Asian Bee Journal.
- 8) Honey Farming – R.O.B Manley
- 9) . Honey by The Ton – Oliver Field .
- 10 . Beekeeping at Buck fast Abbey
11. Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
12. Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
13. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan1972.
14. Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
15. Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
16. A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore
17. Manual on sericulture (1976). Rome : Food and Agriculture Organization of the United Nations, Agricultural Services Division.
18. Ullal, S.R. and . Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore
19. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
20. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
21. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) Fuzi Pub. Co. Ltd., Tokyo, Japan.
22. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production;, CSB, Bangalore.
23. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore. 1989.
24. Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

S.Y.B.Sc. Semester IV		
ZOO-261	Applied Entomology (Minor-Theory) ZOO261	Credits: 2 Hours: 30

Course Outcomes (COs)	
CO1	Define the term related to insect pests and their control. Describe the damage caused and management of insect pests. Describe the insects used as food and in the field of Forensic science.
CO2	Discuss the new avenues in Applied entomology. Discuss the external features. Damaged caused and control measures of insect pests .Explain the methods of insect pest management.
CO3	Illustrate the method of pest control.
CO4	Explain the damage caused and control measures of insect pest. Explain the concept of Integrated Pest Management (IPM).
CO5	Recommend the proper pest control method for given insects.
CO6	Propose cost effective pest control method for suggested insect pest.

Unit	Contents	No. of Hours 30
I	Avenues in Applied Entomology. a) Introduction – Definition and scope of Applied Entomology. b) Insects and their products as a food- Grasshoppers, locusts, termites, lepidopteran larvae, bee bread and honey c) Insects and their products as a medicine- Maggot therapy, Api-therapy, honey, royal jelly, propolis .	06
II	Pests of field crops, stored grains and their management. a) Pests of sorghum (Jowar)- sorghum shootfly: <i>Atherigona soccata</i> , Stem borer: <i>Chilo partellus</i> , b) Pests of paddy(Rice)- Thrips: <i>Stenchaetothrips biformis</i> , Green leafhopper: <i>Nephotettix spp.</i> , c) Pests of cotton - Leafhopper: <i>Amrasca devastans</i> , Cotton aphid: <i>Aphis gossypii</i> d) Pests of stored grains – Grain weevils , Pulse beetle	12
III	Common pests of livestock and their management Bird louse, poultry flea, cow fly (Gomashi)	06

IV	Methods of Pest Management: a) Manual control b) Mechanical control c) Chemical control d) Biological control e) Integrated Pest Management	06
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S.Y.B.Sc. Semester I		
ZOO-262	Applied Entomology Practical (Minor). Minor Zoology Practical-IV ZOO262	Number of Credits: 02 Hours : 30
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Identify, sketch and label the mouth parts of insects. Identify and describe the insect pest.	
CO2	Explain the identification marks and external characters of insects. Explain morphological features of larvae and pupae of insects	
CO3	Illustrate the damage caused and control measures of given insect pest. .	
CO4	Identify and explain the life cycle of insects. Identify and explain the structure and use of type of crop field equipment's.	
CO5	Evaluate the occurrence of the seasonal insect pest of crops in nearby field. Recommend a proper control measure and submit a report	
CO6	Make a temporary preparation of different body parts of insects. Make a formulation of insecticide .	

Sr. No.	Title of Experiment/ Practical
1	Observation of permanent slides of mouthparts of Insects (Honeybee, Bed bug, Grasshopper, Aphid, Scale insect)
2	Study of external features, damage caused and control measures of - Grasshopper, plant bug, caterpillar, leaf hopper, rice weevil, bird louse (specimens or photographs of insects and damaged crop plant parts)
3.	Temporary mounting of mouth parts, legs and sting of honey bee.(E)
4	Study of adulteration in honey (water test, flame test, blot test and vinegar test)
5	Temporary mounting of mouth parts of male and female mosquito .(E)
6	Calculations of doses/ concentrations of different insecticides. (dust, granules, sprayers, emulsible powders) (E)
7	Study of different crop field equipment's - sprayers, dusters insect attractants and traps.
8	Study of external features and life cycle of flesh flies (any one from Diptera and Coleoptera) (E)
9	Study of larvae and pupae in insects (specimens or photographs)
10	Temporary mounting of mouth parts, cornea and spiracles in cockroach (E)
11	Activity and Field Report: Visit the nearby field crop, collect any 5 insect pest and submit collected insects and a report. OR Submit a report on common veterinary pests in your area. OR Visit a nearby grainary/ godown/flour mill, collect any five insect pests and submit collected insect pests and a report.

Any 10 experiments: 08 compulsory + 1 Activity (Equivalent to Two Practical)

References:

1. Applied Entomology, 2nd edition, P G Fenemore, Alka Prakash, Publisher: New Age International.
2. General and Applied Entomology, 2nd edition, B. V. David and T. N. Ananthkrishnan (2006), Publisher: Tata McGraw Hill
3. Text Book of Applied Entomology, K. P. Shrivastava (1996), Publisher: Kalyani Publishers
4. Introduction to General and Applied Entomology, 2nd edition, V. B. Awasthi (2007), Publisher: Scietific Publishers India Jodhapur.
5. Biological control by natural enemies, Bebach P. and David R. (1991), Publisher: Cambridge University Press.
6. Textbook of Entomology – Ross – John Wiley publication
7. General and Applied Applied Entomology – Alka Prakash and Fennemore, New Age Publishers
8. Applied Agricultural Entomology – Lalit Kumar Jha New Central Book Agency
9. Entomology – Novel approaches – P.C. Jain and M. C. Bhargava, New India Publishing House
10. Integrated Pest Management – Concepts and Approaches Dhaliwal GS & Arora R. 2003. . Kalyani Publ., New Delhi.

S.Y.B.Sc. Semester IV		
ZOO-270	Open elective (OE) Human Evolution ZOO-270	Credits: 2 Hours: 30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's Cognitive Level
CO1	Define term evolution describe natural selection, outline time scale of evolution..	1
CO2	Articulate theories of evolution, discuss stages in human evolution. Explain Man Java Man, Pithecanthropus (Sinanthropus) Pekinensis - Peking Man, Homo Habilis-Transitional Man, Homo Heidelbergensis-Heidelberg Man, Homo Neanderthalensis - Neanderthal	2
CO3	Illustrate. Modern human diversity: distribution morphological variation and races of human being.	3
CO4	Explain Time, Origin of Primate and Man, Place of Origin of Man, Special Features of Primate, Evolution and Adaptive Radiation in Primates, Impact of descent from trees on Primate Organization	4
CO5	Review about: Pithecanthropus Erectus- Java Man, Pithecanthropus (Sinanthropus) Pekinensis - Peking Man, Homo Habilis- Transitional Man, Homo Heidelbergensis-Heidelberg Man, Homo Neanderthalensis - Neanderthal Man	5
CO6	Generate curiosity about the human evolution.	6

Unit	Contents	No. of hours
I	Introduction to Evolution- Origin of Life on Earth- Geological Time Scale (Azoic Era, Archaeologic Era, Proterozoic Era, Paleozoic Era, Mesozoic Era, Cainozoic Era). Time, Origin of Primate and Man, Place of Origin of Man, Special Features of Primate, Evolution and Adaptive Radiation in Primates, Impact of descent from trees on Primate Organization	15

II	<p>Evidences of Hominid Evolution from Apes, Darwin's 'Natural selection Theory'. Common Ancestor of Apes and Man in Oligocene and Miocene, Origin of Modern <i>Homo sapiens</i>: Morphology and Genetic Evidence- Concept of Gene and Gene Pool, "Variation in the population is a raw material' for evolution.</p> <p>Brief introduction to Human Osteology- About: Pithecanthropus Erectus- Java Man, Pithecanthropus (Sinanthropus) Pekinensis - Peking Man, Homo Habilis-Transitional Man, Homo Heidelbergensis-Heidelberg Man, Homo Neanderthalensis - Neanderthal Man</p> <p>Cultural Evolution of Human and Modern Human Diversity: Distribution, Morphological Variation and "Races"</p>	15
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References:

1. The Origin of Species, Charles Darwin, Om Book International
2. Organic Evolution, Veer Bala Rastogi, 2020, Third Edition.
3. Almost Human, Lee Berger and John Hawks
4. Organic Evolution, B. L. Chaudhary, Scientific Publishers

S.Y. B.Sc. Semester IV
Subject- Zoology
Vocational Skill Course(VSC)
Paper title: Biological Techniques
(ZOO-280)

[Credits-2]

S.Y B.Sc. (Zoology)		
Title of the Course and Course Code	Biological Techniques. ZOO-280	Number of Credits -2 Number of hours; 30
Course Outcomes (COs) On completion of the course, the students will be able to:		Bloom's cognitive level
CO1	Define concepts of microscopy Identify the components of compound microscope.	1
CO2	Classify the different types of microscopes. Explain the concept centrifugation.	1,2
CO3	Illustrate Principles of Sedimentation and Svedberg co-efficient Interpret, differential and density gradient centrifugation.	3
CO4	Differentiate Types of Microtomes, Explain Paraffin Method of Sectioning and Frozen Method of Sectioning.	4
CO5	Review the basic Principle of electrophoresis techniques. Compare type of Electrophoresis.	5

Unit No.	Title and Contents	No. of Hours
I	<p>MICROSCOPY- Introduction, Basic principle of Microscopy.</p> <p>Resolving power of microscope, Types of microscope -simple and compound (Light) microscope, component parts of a simple microscope, Phase contrast microscope, Electron microscope.</p>	5
II	<p>CENTRIFUGATION- Introduction Principle of Centrifugation, Centrifugal force, Principles of Sedimentation Svedberg coefficient Basic component of a centrifuge machine.</p> <p>Types of centrifuges and their uses.</p> <p>Differential centrifugation,</p> <p>Density Gradient centrifugation.</p> <p>Sub-cellular Fractionation.</p>	5
III	<p>HISTOLOGY AND MICROTOMY-</p> <p>Introduction Microtome- Types of Microtomes (Rocking microtome, Rotary Microtome, Sledge Microtome, Sliding Microtome and Freezing Microtome)Microtome Knives.</p> <p>Paraffin Method of Sectioning</p> <p>Frozen Method of Sectioning.</p>	10
IV	<p>SEPARATION TECHNIQUES-Principle of Chromatography and its applications. Introduction, Basic Principle of electrophoresis, Instrumentation Setup of Electrophoresis, Supporting Medium,</p> <p>Types of Electrophoresis -Boundary electrophoresis, Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis, Disc electrophoresis, SDS-PAGE , Gradient Gels or Pore Gradient Isoelectric Focusing.</p>	10

References:-

1. Biological Tools and Techniques- Ananta Swargiary Kalyani Publishers, New Delhi.
2. Biochemical Techniques and Instrumentation - Felix, S & F Parthiban, Daya Publishing House.
3. Biological Instrumentation and Methodology by P K Bajpai, S Chand Publication.
4. Basic Techniques in Biochemistry and Molecular Biology - RK Sharma and SPS Sangha, Wiley India
5. Fundamentals and Techniques of Biophysics and Molecular Biology by Pranav Kumar , Pathfinder Academy.
6. Wilson and Walkers Principles And Techniques Of Biochemistry And Molecular Biology - Hofmann A , Cambridge University Press.
7. Basic Research Techniques in Biology: Research Techniques in Biology- Raja VNR Vukanti, Notion Press.
8. Biological Techniques by PR Yadav-Discovery Publishing Pvt.Ltd.
9. E.book- **Biological Techniques** [Print Replica] Kindle Edition
by Dr. Kishore R. Pawar (Author), Dr. Ashok E. Desai (Author) Format: Kindle Edition

S.Y. B.Sc. Semester IV		
Title of the Course and Course Code	Skill Enhancement Course (SEC) Animal Tissue Culture ZOO-290	Number of Credits : 02 Number of hours-30
Course Outcomes (COs) On completion of the course, the students will be able to:		
CO1	Describe the different aspects for successful animal cell culture	1
CO2	Understand the rationale behind different media compositions and techniques used in ATC	2
CO3	Consider different factors that establish a cell line in vitro and describe variations in cell culture	3
CO4	Illustrate the problems associated with cryopreservation and outline the different techniques for successful outcome	4
CO5	Assess different methods of cell characterization	5
CO6	Design different methods of cell culture and describe the application	6

Unit No.	Title of Unit and Contents	No. of Lectures
I	Animal Tissue culture: Introduction; comparison with bacterial culture; maintenance of aseptic conditions. Contamination; type and detection methods. In vivo vs. in vitro growth conditions for cells of multicellular organisms. Overview of concept of monolayer, suspension, organ culture.	08
II	Equipment and infrastructure: Laboratory design, Instruments and equipment used in ATC Laminar Air Flow, CO ₂ -incubators, inverted microscope, specialised tissue culture equipment. Nutrition & Physiology: Media and rationale behind medium formulation. balanced salt solutions. Advantages and disadvantages of serum and serum free media.	07
III	Primary cell culture: Source selection, different methods of establishing primary cell culture. Special reference to fibroblast culture and lymphocyte culture.	06

IV	<p>Cell lines: Evolution of cell line, Subculture Finite and transformed cell lines, Mammalian and insect cell line growth conditions,</p> <p>Characterization of cell lines: Need for characterization. Methods of Characterization; Karyotyping, biochemical & genetic characterization of cell lines.</p> <p>Cell storage and distribution: a. Cryopreservation b. Cell repositories</p> <p>Application of Animal cell cultures.</p>	09
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References:

1. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. 6th ed. Wiley & Sons, Inc., USA, 2010.
2. Sudha Gangal, Principles and Practice of Animal Tissue Culture, 2nd ed. University Press, India, 2010.

E-Resources:

- <https://www.abcam.com/protocols/counting-cells-using-a-haemocytometer>
- <http://home.sandiego.edu/~josephprovost/Hemocytometer%20Cell%20Counting%20Protocol.pdf>
- <https://www.sigmaaldrich.com/technical-documents/protocols/biology/cell-quantification.html>
- <https://www.biologydiscussion.com/essay/animal-tissue-culture-in-india-laboratory-andfacilities/542913>
- <https://www.vanderbilt.edu/viibre/CellCultureBasicsEU.pdf>