MANONMANIAM SUNDARANAR UNIVERISTY, TIRUNELVELI-12
SYLLABUS
UG - COURSES – AFFILIATED COLLEGES
Course Structure for B. Sc. Zoology
(Choice Based Credit System)

(with effect from the academic year 2021-2022 onwards)

Part	Subject Status	Subject Title	Subject Code	Credit
III	Core	Evolution	CMZO61	4
III	Core	Animal Biotechnology	CMZO62	4
III	Core	Biostatistics, Computer Application and Bioinformatics	CMZO63	4
III	Core Elective I	1. **Sericulture** 2. Aquaculture 3. Dairy Production Technology	**CEZO61**/ CEZO62/ CEZO63	4
III	Core Elective II	1. **Apiculture** 2. Food and Food Processing Technology 3. Poultry Science	**CEZO64**/ CEZO65/ CEZO66	4
III	Core Practical VIII	Evolution & Animal Biotechnology	CMZOP8	2
III	Core Practical IX	Biostatistics, Computer Applications and Bioinformatics	CMZOP9	1
III	Core Elective Practical X	Corresponding Core Electives- I & II	CMZOPA	1

Nesamony Memorial Christian College, Marthandam

Total Marks: 100   Internal Exam: 25 marks + External Exam: 75 marks

A. **Scheme for internal Assessment**:
Maximum marks for written test: **20 marks**
 3 internal tests, each of **I hour** duration shall be conducted every semester.
To the average of the **best two** written examinations must be added the marks scored in. The **assignment** for 5 marks.

The break up for internal assessment shall be:
Written test- 20 marks; Assignment -5 marks   Total - 25 marks

B. **Scheme of External Examination**
3 hrs. examination at the end of the semester
A – Part : 1 mark question two - from each unit
B – Part : 5 marks question one - from each unit
C – Part : 8 marks question one - from each unit

➢ **Conversion of Marks into Grade Points and Letter Grades**

S.No	Marks	Letter Grade	Grade point (GP)	Performance
1	90-100	O	10	Outstanding
2	80-89	A+	9	Excellent
3	70-79	A	8	Very Good
4	60-69	B+	7	Good
5	50-59	B	6	Above Average
6	40-49	C	5	Pass
7	0-39	RA	-	Reappear
8	0	AA	-	Absent

➢ **Cumulative Grade Point Average (CGPA)**

$$CGPA = \frac{\Sigma\,(GP \times C)}{\Sigma C}$$

- **GP** = Grade point, **C** = Credit
- CGPA is calculated only for Part-III courses
- CGPA for a semester is awarded on cumulative basis

➢ **Classification**
a) First Class with Distinction   : CGPA $\geq$ 7.5**
b) First Class   : CGPA $\geq$ 6.0
c) Second Class   : CGPA $\geq$ 5.0 and $<$ 6.0
d) Third Class   :   CGPA$<$ 5.0

Nesamony Memorial Christian College, Marthandam

EVOLUTION

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- know the origin of life with various evidences.
- study various theories of Evolution.
- elucidate the various concepts in relation to evolution
- classify mimicry, protective colouration and adaptations in relation to evolution
- portray the different phases of evolution of horse, human beings and patterns of animal distribution.

COURSE OUTCOMES (COs)

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

CO1: understand the origin of life and evidences in favour of evolution

CO2: accept the modern concept of evolution

CO3: analyse the concept of evolution especially population genetics.

CO4: learn relationship between abiotic and biotic factors adaptation in the view of evolution

CO5: get thorough knowledge of the tree diagram of evolution of various animals and patterns of distribution

UNIT I

EVIDENCES OF EVOLUTION

Origin of life: Abiogenesis, Biogenesis, Cosmic theory, Biochemical origin of life, Urey-Miller experiment. Evidences of evolution: Morphological & Anatomical, Embryological, Physiological & Biochemical and Paleontological evidences.

UNIT II

THEORIES OF ORGANIC EVOLUTION

Lamarckism, Neo Lamarckism, Darwinism, Neo Darwinism, Mutation theory & New version of mutation theory. Modern Synthetic theory of evolution. Natural Selection. Convergent & Divergent evolution.

UNIT III

ADAPTATION & ISOLATION

Adaptation– Colouration and Mimicry -types and significance –Non- adaptive traits – Neotony & Significance. Isolation- Mechanism & Species concept -Speciation and Variation. Hardy -Weinberg Equilibrium - Genetic drift. Basic outlines of Molecular evolution.

UNIT IV
ANIMAL DISTRIBUTION
Zoogeographical regions – Palaearctic, Nearctic, Neotropical, Oriental, Australian and Ethiopian regions -their Climatic and faunal peculiarities. Wallace line- Discontinuous distribution - Continental Drift - Geological time scale (Up to periods for Paleozoic & Mesozoic era; Up to epoch for Cenozoic era).

UNIT V
EVOLUTION OF HIGHER FORMS
Evolutionary significance of Dipnoi– Origin of Amphibia – Golden age of Reptiles - Major types of Dinosaurs and reason for extinction, Affinities of Archaeopteryx, Outlines of evolution of Man.

Books for references
1. Verma PS & Agarwal VK Cell Biology, Genetics, Evolution and Ecology, S Chand Publishers, New Delhi.
2. Gupta PK, Cytology, Genetics & Evolution, Rastogi Publications, Meerut.
3. Arumugam N Organic Evolution, Saras Publication, Nagercoil.
4. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH, Evolution. Cold Spring, Harbour Laboratory Press.
5. Hall BK &Hallgrimsson B, Evolution, Jones and Bartlett Publishers.
6. M.P. Arora Evolution
7. Moody, Introduction To Evolution.
8. Dobzhansky, Th.: Genetics And The Origin Of Species 1951,Columbia Uty. Press.
9. Dodson, Evolution – Process and Product.

ANIMAL BIOTECHNOLOGY

LEARNING OBJECTIVES (LOs)
The objectives of the course are enabling the student to
- learn the fundamentals of modern Molecular techniques.
- understand the mechanism of Gene Expression and Regulation.
- give a nut shell idea of various protocols followed in Biotechnology in relation to animal science.

COURSE OUTCOMES (COs)
On successful completion of the course the student will be able to
CO1: relate the basic principles of recombinant DNA technology
CO2: explain various molecular techniques used in modern biotechnology.
CO3: categorise the cell and organ culture techniques.
CO4: make use of hybridoma technology for the production of monoclonal antibody.
CO5: compare the microbial enzyme and artificial enzymes
CO6: explain the general principles of generating genetically modified organisms and modern artificial methods in biotechnology.

UNIT I
RECOMBINANT DNA TECHNOLOGY

Scope of Biotechnology. Restriction Endonucleases. Modifying Enzymes (Reverse transcriptase, SI Nuclease, Tag DNA Polymerase, DNA Ligase). Cloning Vectors: pBR322, Lambda Phage & SV40. Gene Cloning: Integration of Desired Gene into the Vector. Introduction of Recombinant DNA into Host cells- Transformation, Transfection, Microinjection, Electroporation. Screening and Selection of Recombinants - Direct selection, Insertional inactivation, Blue-White selection, Colony Hybridization.

UNIT II
MOLECULAR TECHNIQUES

Blotting techniques -Southern, Northern and Western. Methods to isolate DNA – PCR Types, Principle & Applications. Electrophoresis – Types and Principle. DNA probes & diagnosis. Molecular Markers- RAPD – FISH- RFLP. DNA Library. DNA finger printing and its applications.

UNIT III
ANIMAL CELL AND TISSUE CULTURE

Primary culture - Applications. Steps involved in mammalian cell culture. He la &WI38 cell lines – Maintenance of cell lines. Hybridoma Technology - Monoclonal antibody Production. Organ culture - Techniques and Application. Animal cloning – Dolly.

UNIT IV
ENZYME BIOTECHNOLOGY

Microbial production- application of enzymes. Ribozymes. Artificial enzymes. Immobilization of enzymes - methods and its application. Biosensors. Commercial production of Insulin. Cryobiology – Methods of Cryopreservation.

UNIT V
APPLICATIONS

Genetically modified Animals -Transgenic Animals (Fish, Mice, Sheep & Cow) & its significance. Applications of r-DNA technology. Human Genome Project. Microarray, Biochips, Gene therapy, Super bug & bioremediation, Biofuels. Bioweapons, Solid and Liquid waste management. Biogas production. Biopesticides.

Books for reference
1. Brown TA. Gene cloning. London: Chapman & Hall; 1995.
2. Primrose SB, Twyman R. Principles of gene manipulation and genomics. John Wiley & Sons; 2013 May 28.
3. Robertis D. Cell and Molecular Biology. Lea &Febiger,U.S
4. Verma P.S & Agarwal V.K Genetic Engineering,S. Chand Publishers, New Delhi.
5. Prof.V. Kumaresan,"Animal Biotechnology", Saras Publication, A.R.P. Camp Road, Periavilai, Kottar P.O.,Nagercoil, K.K.Dist., - 629002.
6. Kumar H.D. A text book of Biotechnology, Affiliated East – West Press Ltd., NewDelhi
7. Animal Biotechnology,2006,R.Sasidhara, MJP Publishers, Chennai.
8. Dubey R.C "A text book of Biotechnology" S.Chand & Co., Ltd., NewDelhi.

CORE PRACTICALVIII- EVOLUTION & ANIMAL BIOTECHNOLOGY

LEARNING OBJECTIVES (LOs)
The objectives of the practical course are enabling the student to
- understand the gene frequency distribution in a population.
- elucidate the application of probability in genetics experiments.
- know the evolutionary importance and biotechnological applications of given models and specimens.
- understand the basic techniques of biotechnology from demonstrations

COURSE OUTCOMES (COs)
On successful completion of the practical course the student will be able to
CO1: evaluate the gene frequency in the light of Hardy- Weinberg law and Probability.
CO2: apply the known basic techniques for their projects and future studies.
CO3: relate the evolutionary significances of the known organisms.
CO4: understand and apply the biotechnological techniques for their higher studies.
CO5: describe and evaluate the significance of the tools in biotechnology.

CO6: develop a model prescribing the applications of biotechnology in day to day life.

PRACTICALS
EVOLUTION
1. Gene Frequency : Hardy -Weinberg law- Probability Experiment.
2. Museum Specimens, Slides, Models and Charts: Animals of evolutionary significance: Peripatus, Archaeopteryx, Limulus.
   Colouration and Mimicry: Lycodon and Krait; Stick insect, Leaf insect.
   Mutation: Peppered Moth, Ancon Sheep.
   Variations : Variation in finger prints.

ANIMAL BIOTECHNOLOGY
1. Isolation of genomic DNA –Demonstration.
2. Isolation of Plasmid –Demonstration
3. Protoplast preparation and fusion –Demonstration
4. Estimation of CO_2 in any three- effluent / sewage water samples –(Individual)
5. Isolation of Protein by PAGE –Demonstration.
6. **Models / Charts / Photos:**
PBR 322, Ti plasmid, Lambda Phage, SV40, Restriction enzyme, recombinant DNA, Gene cloning, Electroporation, Microinjection, Southern blotting, RFLP, RAPD, Monoclonal antibody, Stem cells, Dolly- Transgenesis, Organ culture, Anaerobic Digester, Fermentor.

BIOSTATISTICS, COMPUTER APPLICATIONS AND BIOINFORMATICS

LEARNING OBJECTIVES (LOs)
The objectives of the course are enabling the student to
- understand the mathematical principles of biological systems incorporating computer systems.
- explore the integration and application of statistics and bioinformatics in biology.
- acquire the skills and perspectives of statistics and bioinformatic tools in analysis and interpretation of data.
- gain an insight about the molecular databases.

COURSE OUTCOMES (COs):
On successful completion of the course the student will be able to
CO 1: attain an insight on statistical methods for analysis of biological data.

Nesamony Memorial Christian College, Marthandam

CO 2: undertake statistical operations in biology.

CO 3: gain basic understanding of computer hardware and software and use productive softwares effectively.

CO 4: acquire knowledge on the bioinformatic concepts for analyzing molecular data.

CO 5: analyse and use the bioinformatics tools for advanced sequence alignment, database searches, genome analysis and protein structure studies.

CO 6: understand and critically evaluate the data analysis procedures in publication of molecular biology research.

UNIT I
INTRODUCTION AND BASICS

Definition and Scope: Population and Samples – Types of variables. Collection and sources of data: Primary and secondary data – survey – census. Sampling methods & Sampling procedures. Classification and Presentation of data: Frequency distribution. Tabulation & Diagramatic representation of data: tables - parts- types; diagrams – line diagram – bar diagram – pie diagram- histogram – graphs. Measures of Central tendency – Calculation of Mean, Mode and Median (Grouped and Ungrouped Data).

UNIT II
MEASURES OF DISPERSION

Variance, Range, Standard Deviation and Standard Error, Coefficient of Variation. Chi – square test – Calculation and application, Student"s-t Test. Correlation: Introduction, Types, Perfect positive and negative, Linear and Non-Linear methods; Scatter diagram, Karl Pearson"s correlation coefficient; Interpretation of the Correlation coefficient.

UNIT III
INTRODUCTION TO COMPUTER

Components of Computer: Input devices and Output devices – CPU – Primary and Secondary, Memory operating system. Introduction to MS Office software- covering, word processing, spread sheet and presentation software. MS Word basics: Creating word document – File, Edit, Format, Save menus, adding bullets, numbering and symbols printing. MS Excel – entering and editing cell entries – adjusting row and column height – Pie- bar- line chart preparation. Uses of Internet – Email, Internet Browsing; e-learning tools & resources, World Wide Web (WWW), MS Power point.

UNIT IV
BIOINFORMATICS

Introduction: Definition of Bioinformatics – History – Scope and Application of Bioinformatics; Components of Bioinformatics - Bioinformatics in Life Science.

Biological Sequence Analysis: Sequence Alignment – Pair wise Sequence Comparison – Multiple Sequence Alignment.

UNIT V
MAJOR DATABASES IN BIOINFORMATICS

Nucleic acid sequence databases : NCBI, EMBL – Genbank; Protein sequence database – SWISS – PROT . Database similarity search Tools: BLAST, FASTA – Application of bioinformatics tools. Database Retrieval Tools: ENTREZ – Locus link – Pub Med (Publishers on Medicine); SRS - Protein structure visualizing tools – RasMol, Swiss PDB viewer.

Books for reference
BIOSTATISTICS
1. Arora and Mathan. Bio Statistics (5thEdition). Himalaya Publishing House, Ramdoot, Dr.BhaleraoMarg,Girgaon,Mumbai – 400004.
2. Daha, T.K. Biostatitics in Theory and Practics. EMKAY Publications, Post Box No.9410, B-19, East Akrishna Nagar, Swami Dayanand Marg, Delhi-110051.
3. Gurumani. N, An Introduction to Biostatistics (computer Application included) 2nd Edition M.J.P. Publishers, Tamilnadu Book House, 47 Nallathambi street, Triplicane- 600 005.
4. Jasra, P.K.and Gurdeef Raj. Biostatistics, Krishna Prakashan Media(P) Limited, 11, Shivahi Road, Meerut – 250001
5. Parihar and Parihar. Biostatistics and biometry, Student Edition, Agrobios(India) Behind NasraniCinema,Chopasani Road,Hodhpur-342002.
6. Pranab Kumar Banergee. Introduction to Biostatistics (2nd Edition). S. chand& Company Limited, 7361, Ram nager,New Delhi-110055
7. Prasad, S. Elementa of Biostatistics. Rastogi Publications, Gangotri, ShivajiRoad, Meerut 250002.
8. Satguru Prasad – Fundamentals of Biostatistics (Biometry). EMKAY Publication,Post Box No.9410 B-19, East Akrishna Nagar, Swami Dayanand Marg, Delhi-110051.
9. Pagano, M. and K. Gauvreau. Principles of Biostatistics. Thomas Learning,Alps Building,1st floor,56,Janpath,NewDelhi.
10. Satgurau Prasad, Elements of Biostatistics, Rastogi Publications Gangotri,Shivaji Road, Meerut 250002.

COMPUTER APPLICATIONS
1. Krishnamoorthy, R. Computer Programming andapplications.
2. Rajaram, V. Fundamentals of Computers.

BIOINFORMATICS

1. Bal, H.P. Bioinformatics principles and Applications, Tata Mc Graw Hill Publishing Company Limited, No. 444/1 Sri EkambaraNaicker Industrial Estate, Alkapakkam, Porur, Chennai – 600116
2. Dan, E. Krane and Michael L. Raymer.Fundamental concepts of Bioinformatics. Pearson Education (Singapore) PTE Limited, Indian Branch, 482 FIE Patparganj, Delhi-110 092.
3. Ignacimuthu, S. Basic Bioinformatics. Narosa Publishing House Private Limited,35- 36 Greams Road, Thousand Lights, Chennai-600006
4. Ranga, M.M. Bioinformatics, Agrobios (India) Behind Nasranicinema,Chopasani Road, Hodhpur – 342002.
5. C.S.V. Murthy Bioinformatics.

CORE PRACTICAL - IX BIOSTATISTICS, COMPUTER APPLICATIONS AND BIOINFORMATICS

LEARNING OBJECTIVES (LOs)

The objectives of the practical courses are enabling the student to
- find the mean, mode, SD,SE and CV using neem leaves.
- calculate the correlation using height and weight of the students.
- acquire the knowledge to use the computer applications.
- get awareness about the types and applications of bioinformatic tools.

COURSE OUTCOMES (COs)

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

CO1: remember the calculation and apply the formulae in their studies.

CO2: use the technology to analyze the results of the experiments.

CO3: understand and evaluate the data in the light of of bioinformatics tools.

CO4: design a biological study to apply the learnt technology.

1. Find out Mean, Median, Mode, Standard deviation, Standard error and Co-efficient of variance using serrations of neem leaves.
2. Calculation of correlation from height and weight of the students..
3. Bar diagram, Histogram, Pie diagram and Frequency curve and polygon - construction.
4. Models, Chart and Photos: Computer Mouse, CPU, Keyboard, Monitor.
5. Visit to a Computer centre to learn internet browsing and email sending – Compulsory for each student.
6. Take printout from NCBI, EMBL and PubMed and keep it for spot tests.
7. Write some of the file commands and keep for spot tests.

SERICULTURE

LEARNING OBJECTIVES (LOs)

The objectives of the courses are enabling the student to

- study the scope and importance of Sericulture for betterment of human welfare.
- introduce the concepts of sericulture and mulberry cultivation.
- get deep knowledge on diseases of silk worm and pests of mulberry plants.
- understand the methods of harvesting, and cocoon marketing.
- adopt sericulture as a vocation as it is a rural agro based cottage industry.

COURSE OUTCOMES (COs):

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

CO1: understand the scope sericulture and mulberry cultivation practices.

CO2: gain knowledge on diseases of silkworms and pests of mulberry.

CO3. understand the classification, life cycle and physiology of silkworm.

CO4. apply the rearing methods, harvesting of cocoon and cocoon marketing.

CO5: examine process of reeling, producing raw silk and marketing.

CO6: decide to start sericulture unit/reeling unit in the local area and become notable entrepreneur.

UNIT I

IMPORTANCE OF SERICULTURE

Sericulture industry in India: Sericulture as cottage industry, role of Central Silk Board, Moriculture: Morphology of Mulberry plant- High yielding varieties –methods of propagation- irrigation. Manuring: Biofertilizers – Green manuring – Triacontanol for increased mulberry productivity – Seriboost. Pruning- Harvesting and storing of mulberry leaves-Package of practices for mulberry cultivation.

UNIT II

DISEASES AND PESTS OF MULBERRY

Fungal diseases: fungal root, shoot and leaf diseases; Bacterial diseases: leaf blight disease, rot disease; Viral diseases: mulberry leaf mosaic disease, dawn disease; Dwarf disease, Nematode diseases: root knot disease; Deficiency diseases: nitrogen deficiency, phosphorus deficiency, potassium deficiency, magnesium deficiency and calcium deficiency diseases; Pests of mulberry: leaf eating insect pests and stem borer pests one example each.

UNIT III

BIOLOGY OF SILKWORM

Classification of Mulberry silkworm- habit and habitats; Voltinism- races of

silkworms; Life cycle- Structure of egg- larva- pupa and adult- Sexual dimorphism. Digestive system- circulatory system- excretory system- respiratory system, nervous system and reproductive system, endocrine and other glands of Silkworm.

UNIT IV
REARING OF SILKWORM COCOON MARKETING

Rearing house (CSB model) - Rearing appliances. Rearing operation: Disinfection – Brushing – Maintenance of optimum conditions, Feeding – Bed cleaning – Spacing. Methods of Rearing; Young age worms – Chawki rearing - Rearing of late age larva- Types: Shelf rearing. Floor rearing, Shoot rearing- Application of Sampoorna. Mounting: Mountages- Methods – Precautions. Cocoon marketing: Characteristics of cocoon- – defective cocoons – methods of harvesting. – Shell ratio and rate fixation.

UNIT V
DISEASES AND PESTS OF SILKWORM & REELING

Protozoan disease: Pebrine; Viral diseases: Flacherie, Gattine, Grasserie; Bacterial diseases: Flacherie, Septicemia, Sotto, Court; Fungal diseases : Muscardine; Pests: Uzy fly, Dermistid beetle of silkworm. Silk reeling: Cocoon stifling – types- storage of stifled cocoons- sorting- cocoon boiling and deflossing – brushing, Process of reeling: Different methods- silk waste and byproducts of silk reeling- Raw silk and marketing.

Books for reference
1. Ganga, G. and I. Sulochana Chetty, An introduction to Sericulture. Oxford & IBH Publishing Company Private Limited, S -155,Panchshila Park, New Delhi.
2. Ganga,G. Comprehensive Sericulture, Volume – 2 Silkworm Rearing and Silk Realing. Oxford & IBH Publishing Company Private Limited, S -155, Panchshila Park,New Delhi.
3. Dandin, S.B, Jayant Jayaswal and K. Giridhas, Hand Book of Sericultural Technologies, Central Silk Board, Madivala, Bangalore –68.
4. Kamile Afifa. S and Masoodi M. Amin, Principles of Temperate Sericulture,Kalyani Publishers, B – 1/1292,Rajinder Nagar, Ludhians.
5. Kesary, M and M.Johnson, Sericulture, Department of Zoology, N.M.. Christian College, Marthandam.

CORE ELECTIVE PRACTICAL- X SERICULTURE

LEARNING OBJECTIVES (LOs)

The objectives of the practical course are enabling the student to

- observe and analyse the features of silk gland, digestive and nervous system of silkworm.
- realize the importance selection of leaves for feeding.
- examine and analyse the stages development.
- assess the mulberry varieties, rearing and mounting appliances and marketing of cocoons.
- promote sericulture industry in rural area.

COURSE OUTCOMES (COs)

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

CO1: understand the biological importance systems of the silkworm.

CO2: appreciate the importance of feeding and rearing appliances

CO3: enhance the production by applying scientific knowledge and training.

CO4: decide to have a sericulture unit with less input.

PRACTICALS

1. Dissection of silk glands, digestive and nervous systems- Silk worm
2. Dissection of male and female reproductive system- Silk worm
3. Selection of mulberry leaves according to different stages of the larva.
4. Life history Silk worm – egg, larva, pupa and adult.
5. Sexual dimorphism in larva, pupa and adult- Silk worm
6. Mulberry varieties such as MR2, S30, S36, V2. (any four)
7. Chandrika and Netrika
8. Rearing tray and rearing stand.
9. Raw silk and silk waste
10. Cocoon- Bivoltine/ Multivoltine
11. Report on field visit to Sericulture farm/ unit. (Mandatory)

APICULTURE

LEARNING OBJECTIVES (LOs)

The objectives of the course are enabling the student to

- familiarize the organization of bee colony
- know the systematic planning of apiary unit.
- get knowledge about the value of honey and harvesting techniques.
- understand the disease and enemies and behaviour of honey bees.
- examine the scope for self employment opportunities. give self-employment opportunities after their graduation
- provide rural based and welfare oriented knowledge.

COURSE OUTCOMES (COS)

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

CO1: classify the honey bees and categorize its developmental stages and explain the principles of Apiculture and methods of Bee keeping.

CO2: construct modern hives and rear and recommeds apiary as a less expensive but profitable self employment.

CO3: make use of Honey bee products and marketing.

CO4: distinguish the enemies of bees and protect the bees from various diseases. and identify swarming, robbing and foraging behaviour of bees in an apiary.

CO5: trust the less expensive but profitable self employment.

CO6: gain confidence to establish an apiary after their graduation as a rural based and welfare oriented venture.

UNIT I

INTRODUCTION

Definition, Scope, Classification of bees: Rock bee, Indian bee, Little bee and Dammer bee- their identification and habits, choice of species in Apiculture. Bee colony: Distinctive features, Identification and Functions of queen, drones and workers, Structure and functions of legs, mouth parts and sting of worker bee. Development of Honey bee: egg, larva and pupa- time taken for the development of queen, drone and worker. Food of the bee: bee bread, honey and pollen- royal jelly-propolis. Artificial feeding.

UNIT II

PRINCIPLES OF APICULTURE

Arranging an Apiary: position- space- direction. Acquiring bees: care of newly captured colonies- handling the bees. Bee keeping: Primitive methods - their

advantages and disadvantages. Different types of Modern hives: Architecture - Parts of artificial hive and its advantages – other appliances used in apiary The bee comb and its architecture-Different kinds of cells-Burr comb.

UNIT III
HONEY BEE PRODUCTS

Honey: Collection and Extraction, Preservation and storage –Physical properties, Chemical composition, nutritive value, medicinal values- honey as daily food. Bee wax- Production - method of extraction- characteristics and uses. Bee venom- method of collection - composition of venom- its uses.

UNIT IV
ENEMIES AND DISEASES OF BEES

Enemies: Greater wax moth, lesser wax moth, ants, wasps, lice, beetles, birds and their management. Diseases of bees: adult and brood diseases- Bacterial, Fungal, Viral & Protozoan- Prevention and Control measures.

UNIT V
SWARMING AND OTHER BEHAVIOURS

Swarming- Prevention and control. Robbing and Fighting- Prevention and control. Uniting stocks- Different methods. Queen rearing. Supersedure. Foraging, inter-relationships of plants and bees. Behaviour of bees- bee dances.

Books for reference
1. Mishra,R.C. &R. Garg. Perspectives in Indian Apiculture. Agrobios (India)behind Nasrani Cinema, Chopasani Road, Jodhpur-342002.
2. Abrol,D.P. Bee Keeping in India. Kalyani Publishers, B-1/1292, Rajinder Nagar,Ludhiana-141 008.
3. Cherian, M.C. &Ramachandran. Bee Keeping in SouthIndia.
4. Philips, E.F. Bee Keeping,Agrobios (India) behind NasraniCinema,Chopasani Road,Jodhpur-342 002.
5. Sadar Singh, Bee Keeping in India Kar Delhi.
6. Sharma P.L and Singh, S.(controller) Hand Book of bee Keeping, printing and Stationery,Chandigarh.
7. Webb,A. Bee Keeping for profit and Pleasure, Agrobios (India), Behind Nasrani Cinema, Chopasani Road, Jodhpur-342002 .

CORE ELECTIVE PRACTICALS- X APICULTURE

LEARNING OBJECTIVES (LOs)
The objectives of the practical course are enabling the student to
- observe and mount legs, mouth parts and sting of workers to appreciate their diversified functions.
- compare the features of the colony members.
- relate the structural modifications with the functions
- practice the procedures for handling the bees and hygienic extraction of honey/
- motivate to start an apiary unit.

COURSE OUTCOMES (COs)
On successful completion of the practical course the student will be able to

CO1: identify and characterize the members of the colony.

CO2: describe the structure and management of the colony.

CO3: adopt suitable methods to handle the bees safely.

CO4: plan to develop a modern apiary and marketing honey with self involvement and interest.

PRACTICALS
1. Mountings of legs, mouth parts and sting of worker bees.
2. Specimen, Model, Slide and Appliances:
   Queen, Worker, Drone, Artificial hive (Newton hive), Queen excluder, smoker, honey extractor, honey, scraffing knife, Bee comb, Bee veil and Comb foundation sheet.
3. Report on field visit to Apiary farm/ unit. (Mandatory)