



SYLLABUS for Affiliated Colleges

**M Sc. ZOOLOGY (Structure, Physiology,
Development and Classification of animals)**

CBCSS - OBE (Outcome Based Education) System

(KU CBCSS OBE -PG-2023)

2023 admission onwards

PART-2

(III & IV Semester)

Kannur University

Thavakkara, Civil Station P.O. Kannur District.

Kerala 670 002, India.

The revised SCHEME AND CREDIT DISTRIBUTION CHART OF COURSES IN THE M Sc. ZOOLOGY (Structure, Physiology, Development and Classification of animals) PROGRAMME

Semester	Course Code	Title of Course	Marks			Credits	Hrs/Wk
			Internal	External	Total		
1	MSZNG01C01	Biochemistry	15	60	75	4	4
	MSZNG01C02	Biophysics & Biostatistics	15	60	75	4	4
	MSZNG01C03	Cell Biology & Genetics	15	60	75	4	4
	MSZNG01C04	Systematics, Evolutionary Biology & Behavioural Science	15	60	75	4	4
	MSZNG01C05	Biochemistry, Physiology, Endocrinology and Immunology - Practical					3
	MSZNG01C06	Cell Biology, Genetics, Molecular Biology, Bioinformatics and Biophysics - Practical					3
	MSZNG01C07	Systematics, Evolutionary Biology, Environmental Biology Biostatistics and Behavioural Science - Practical					3
	Total Credits For semester I			60	240	300	16
2	MSZNG02C08	Animal Physiology & Endocrinology	15	60	75	4	4
	MSZNG02C09	Molecular Biology and Bioinformatics	15	60	75	4	4
	MSZNG02C10	Environmental Biology	15	60	75	4	4
	MSZNG02C11	Immunology	15	60	75	4	4
	MSZNG01&02C05	Biochemistry, Physiology, Endocrinology and Immunology - Practical	15	60	75	3	3
	MSZNG01&02C06	Cell Biology, Genetics, Molecular Biology, Bioinformatics and Biophysics - Practical	15	60	75	3	3
	MSZNG01&02C07	Systematics, Evolutionary Biology, Environmental Biology Biostatistics and Behavioural Science - Practical	15	60	75	3	3
	MSZNG02C12	Viva Voce	5	20	25	1	
	Total Credits For Semester II			110	440	550	26
3	MSZNG03C13	Developmental Biology & Animal Ethics	15	60	75	4	4
	MSZNG03 O01	Open Elective (Multi-Disciplinary)	15	60	75	4	4
	MSZNG03 E01	Elective I	15	60	75	4	4
	MSZNG03 C14	Microbiology and Biotechnology - Practical					3
	MSZNG03 C15	Histology and Developmental Biology- Practical					3
	MSZNG03 E04	Elective - Practical					3

	MSZNG03 C16	Project (with presentation)					4
	Total Credits For Semester III		45	180	225	12	26
4	MSZNG04C17	Microbiology & Biotechnology	15	60	75	4	4
	MSZNG04 E02	Elective II	15	60	75	4	4
	MSZNG04 E03	Elective III	15	60	75	4	4
	MSZNG03&04 C14	Microbiology and Biotechnology- Practical	15	60	75	3	3
	MSZNG03&04 C15	Histology and Developmental Biology- Practical	15	60	75	3	3
	MSZNG03&04 E04	Elective - Practical	15	60	75	3	3
	MSZNG03&04C16	Project (with presentation)	15	60	75	3	4
	MSZNG04C18	Viva Voce	5	20	25	1	
	MSZNG04C19	Personal Collection and field study report	5	20	25	1	
	Total Credits For semester IV		115	460	575	26	24
Total Marks & Credits for Semesters I, II, III and IV			330	1320	1650	80	

SEMESTER III

MSZNG03C13; DEVELOPMENTAL BIOLOGY AND ANIMAL ETHICS

(72 hours, 4 Credits)

Course Objectives

CO1. Understand the basic principles of animal development (K2).

CO2. Analyse the findings from experimental embryology (K4).

CO3 Remember principles of animal ethics (K1).

CO4 Understand involvement of genetic mechanism in development (K2).

Module 1. Basic Concepts in Developmental Biology (18 hrs)

Unit .1.1. Specifying identity: (8 hrs)

1.1.1. The primary germ layers and early organs (brief account only)

1.1.2. Cell differentiation

1.1.3. Levels of commitment: specification & determination

1.1.4. Types of specification: autonomous, conditional & syncytial

1.1.5. Induction & competence: Types of induction.

1.1.6. Imprinting

1.1.7. Genomic equivalence

UNIT.1.2. Stem cells: (2hrs)

1.2.1. Stem cell concept

1.2.2. Potency

1.2.3. Stem cell niches

1.2.4. Medical applications of stem cells.

Unit. 1.3. Gametogenesis, fertilization & sex determination: (8hrs)

1.3.1. Gametogenesis in mammals-spermatogenesis and oogenesis

1.3.2. Fertilization and prevention of polyspermy in sea urchin

1.3.3. Mammalian pattern of sex determination- primary sex determination and secondary sex determination

1.3.4. Environmental influence on sex determination.

Module 2. Early Development in Animals (18 hrs)

Unit.2.1. Drosophila development: (8hrs)

2. 1.1. Fertilization, cleavage, MBT, gastrulation

2.1.2. Axis formation- Anterior-posterior, dorsal-ventral, extremity

2.1.3. Segmentation genes: gap genes, pair-rule genes & segment polarity genes

2.1.4. Homeotic selector genes

Unit. 2.2. Amphibian development: (6hrs)

2.2.1. Fertilization, cortical rotation, cleavage, MBT

2.2.2 Gastrulation

2.2.3. Specification of germ layers

2.2.4. Formation and function of amphibian organizer.

Unit 2.3. Chick development: (4hrs)

2.3.1. Cleavage

2.3.2. Gastrulation, Primitive streak

2.3.3. Anterior-posterior and left-right axis formation

Module 3. Organogenesis & Post-embryonic Development (18hrs)**Unit 3.1. Organogenesis: (8hrs)**

3.1.1. Differentiation of neurons.

3.1.2. Vulval induction in *Caenorhabditis elegans*

3.1.3. Tetrapod limb development

3.1.4. Vertebrate eye development

Unit 3.2. Metamorphosis and Regeneration: (8hrs)

3.2.1. Metamorphosis:

3.2.1.1. Insect metamorphosis

3.2.1.2. Amphibian metamorphosis

3.2.2. Regeneration:

3.2.2.1. Types of regeneration- stem cell-mediated, epimorphosis, morphallaxis, and compensatory regeneration. (Brief account)

3.2.2.2. Regeneration in Hydra

3.2.2.3. Vertebrate limb regeneration

Unit 3.3. Histological techniques (2hrs)

3.3.1. Steps for histological preparations

3.3.2. Embedding and sectioning

3.3.3. Staining techniques used in histology

Module 4. Development in wider contexts: (18hrs)**Unit 4.1. Experimental Embryology (4hrs)**

4.1.1. Work of Hans Spemann & Hilde Mangold: constriction & transplantation experiments

4.1.2. Gradient experiments in sea urchin

4.1.3. Mutants & transgenics in the analysis of development

4.1.4. Transgenic DNA chimeras

Unit 4. 2. Development and environment (4hrs)

4.2.1. Environmental influence on normal development.

4.2.2. Teratogenesis: Influence of Alcohol, retinoic acid, DES and BPA

Unit 4.3. Animal ethics (10hrs)

4.3.1. Humans in research:

4.3.1.1. General Principles

4.3.1.2. Clinical trials of drugs and other interventions: General guidelines

4.3.1.3. Principles of research among vulnerable populations & Additional safeguards

4.3.2. Animals in research

4.3.2.1. Advantages and disadvantages of animal experimentation.

4.3.2.2. Impact of experimentation on animals.

4.3.2.3. Principle of the 4 R's: replacement, reduction, refinement and rehabilitation.

4.3.2.4. Humane Science-The Science of alternatives: In chemico, In silico, In vitro- (cultures, microphysiological systems, organoids, computer models, etc.), Volunteer studies, etc.

4.3.2.5. Legislation in animal experimentation:

4.3.2.5.1. Prevention of Cruelty to Animals Act 1960 (PCA)

4.3.2.5.2. The Breeding of and Experimentation on Animals (Control and Supervision) Rules, 1988,

4.3.2.5.3. The Committee for Control and Supervision of Experiments on Animals (CCSEA):

4.3.2.5.3.1. Ethical principles.

4.3.2.5.3.2. Function of CCSEA

4.3.2.5.3.3. CCSEA Guidelines on specific aspects regarding the use of animals in scientific experiments.

4.3.2.5.3.4. Aftercare and rehabilitation of animals after use in scientific Experiments

4.3.2.5.3.5. Situations where euthanasia of animals is permissible.

4.3.2.5.3.6. Guidelines for anaesthesia and euthanasia.

4.3.2.5.4. Institutional Animal Ethics Committee (IAEC)- functions, CCSEA Standard Operating Procedures (SOP) for IAEC, Composition of IAEC.

REFERENCES:

1. Gilbert, S.F., Barresi, M.J.F. (2018). *Developmental biology. 11th Ed.* Sinauer

Associates, Inc., Sunderland, Massachusetts.

2. Wolpert, L., Beddington, R., Jessell, T., Lawrence, P., Meyerowitz, E., Smith, J.

(2002). *Principles of Development, 2nd*, Oxford University Press. ISBN 0-19-924939-3.

3. Kalthoff, K. (1996). *Analysis of biological development*. McGraw-Hill Book Co, Inc, New York. ISBN 0070333084/9780070333086.

4. Mandal, J., & Parija, S. C. (2013). Ethics of involving animals in research. *Tropical Parasitology*, 3(1),4–6.

5. National Ethical Guidelines For Biomedical And Health Research Involving Human Participants: Indian Council Of Medical Research, 2017.

6. Guidelines on the Regulation of Scientific Experiments on Animals: Committee for the Purpose of Control and Supervision of Experiments on Animals (CCSEA), 2021.

Websites:

1. <https://doi.org/10.4103/2229-5070.113884>
2. <https://www.niehs.nih.gov/health/topics/science/sya-iccvam>
3. <https://crueltyfreeinternational.org/about-animal-testing/alternatives-animaltesting>

**MSZNG03001; Open Elective (Multi-Disciplinary); Research methodology
Credits 4 – 72 Hours**

Course Outcome

CO1: Explain the purpose of each step in tissue processing. (K3)

CO2: Troubleshoot common problems encountered during microtomy. (K4)

CO3: Explain the mechanisms and theory behind staining techniques. (K2)

CO4: Evaluate the strengths and weaknesses of different phylogenetic methods for specific research questions. (K5)

CO5: Analyze a scientific article to identify strengths and weaknesses in its structure and content. (K4)

Module 1 Histology

18 Hours

Part 1

Fixation of Histology Samples: Aims of Fixation, Tissue Changes in Fixation, Ideal fixative, Types of fixation, Mechanism of fixation, Commonly used laboratory fixatives, Mercury-salt containing fixatives,

Processing of Tissue in Histopathology Laboratory: Factors affecting tissue processing, dehydration, clearing, infiltration and embedding, tissue processing methods, precautions during tissue processing

Decalcification of Bony and Hard Tissue for Histopathology Processing

Part 2

Tissue Microtomy: Principle and Procedure: different types of microtomes, sectioning paraffin blocks (steps of sectioning), microtome knives and angles.

Frozen Section microtomy: indication of frozen sections, #Cryostat Sectioning, factors affecting good quality sections.

Module 2 Staining of microtome sections

18 Hours

Part 1

Staining Principle and General Procedure of Staining of the Tissue: Dyes Used for Staining, Mechanisms and Theory of Staining, factors affecting staining, metachromasia, Progressive and regressive staining, mordant, staining procedure.

Haematoxylin and Eosin Stain of the Tissue Section

Part 2

Special Stains for the Carbohydrate, Protein, Lipid, Nucleic Acid and Pigments

Connective Tissue Stain: Principle and Procedure (in brief)

Amyloid Staining (in brief)

Stains for the Microbial Organisms (in brief)

Immunocytochemistry in Histology and Cytology: Basic Principles, Immunocytochemistry Technique (in brief)

Flow cytometry: Principle, technique and applications. (in brief)

Fluorescent In Situ Hybridization Techniques in Pathology: Principle, Technique and Application (in brief)

Module 3 Phylogenetic trees

18 Hours

Part 1

Phylogenetic tree, parts of a phylogenetic tree, data types for preparation of phylogenetic tree (morphological data, protein data, nucleotide data).

Preparing a multiple sequence alignment, principles, free-software available for preparation of multiple sequence alignments, different algorithms (CLUSTAL, MUSCLE, MAFFT, Tcoffee)

Morphological data curation: preparation of presence-absence matrix (with two suitable examples).

Part 2

Preparation of a molecular phylogeny: free-software used to prepare a molecular phylogeny (introduce two programmes).

Methods of molecular phylogeny creation: Distance methods, parsimony methods, model-based inference (ML and Bayesian). Suitable software examples for preparation of each of these types of trees to be mentioned.

Nucleotide substitution models (only conceptual details expected), protein substitution matrices (only conceptual details expected), why model-based inference is better? Models for morphological data analysis.

Online resources for molecular phylogeny creation.

Concept of outgroup, gene-tree, species-tree, super-tree and bootstrapping.

Module 4 Preparation of a scientific publication

18 Hours

Part 1

Argument matrix & Background

Argument matrix, How to set the background of a research article

Reference management & Methods

Referencing using Zotero (or other opensource tools), How to write methods section?

Results & data sharing

formatting tables and figures properly, How to write results section? Data sharing policy, ways to share data through online databases (NCBI, ArXive, figshare, github etc.).

Discussion & Additional information

How to write a discussion? How to write a title, abstract & list keywords?

Part 2

Publication ethics

Publication ethics, plagiarism, predatory journals, paid and free journals, open-access journals

Research quality metrics

Impact factors, citation metrics (i10, h-index).

References

E. O. Wiley & Bruce S. Lieberman, 2011. *Phylogenetics: theory and practice of phylogenetic systematics*. Wiley-Blackwell, New Jersey pP 390.

Sahni, P., & Aggarwal, R. (Eds.). (2018). *Reporting and publishing research in the biomedical sciences*. Springer.

Dey, P. (2018). *Basic and advanced laboratory techniques in histopathology and cytology*. Springer Singapore.

MSZNG03 E01: Elective I: Introduction to Entomology

Credits 4 – 72 Hours

Course Outcomes:

- CO1. Comprehend insect morphology and classification (K2)
- CO2. Analyze adaptations of insects owing to morphological innovations (K3)
- CO3. Identify different groups of insects based on key characters (K5)
- CO4. Evaluate the contribution of insect groups to their habitats (K5)
- CO5. Apply knowledge on insects to help manage pests and generate beneficial products (K4)

MODULE 1. External morphology

(25 Hrs)

1.1. Segmentation and division of the body

1.2. General morphology of the head –

- 1.2.1. Opisthognathous, hypognathous and prognathous
- 1.2.2. Head segmentation- theories about the segmentation of the head
- 1.2.3. Head skeleton- different sutures and sclerites
- 1.2.4. Tentorium
- 1.2.5. Modification in head capsules
- 1.2.6. Cephalic appendages
 - 1.2.6.1. Antenna: structure, function & types
 - 1.2.6.2. Gnathal appendages: types, structure & function
 - 1.2.6.3. Mouth parts of insects
- 1.2.7. Cervix

1.3. Thorax

- 1.3.1. Thoracic segmentation
- 1.3.2. Thoracic skeleton
- 1.3.3. Endothorax
- 1.3.4. Thoracic appendages
 - 1.3.4.1. Modifications of thoracic legs
 - 1.3.4.2. Wings: origin and evolution of wings, structure, venation, wing coupling apparatus, morphological variations

1.4. Abdomen

- 1.4.1. Segmentation
- 1.4.2. Skeletal composition
- 1.4.3. Pregenital and post genital segments
- 1.4.4. Abdominal appendages
- 1.4.5. External genitalia: male and female

MODULE 2. Insect classification

(17 hrs)

2.1. Introduction to classification of insects.

Mention Apterygota, Exopterygota, Endopterygota, Hemimetaboly and Holometaboly.

2.2. Apterygota

Diagnostic characteristics, biology and economic importance of the following Orders: Collembola, Protura, Diplura, Archeognata (Microcoryphia) and Thysanura. Locomotion in Collembola.

2.3. Exopterygota: Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order.

1. Ephemeroptera.
2. Odonata - mention dragon flies and damsel flies, mouthparts of naiads, mating behavior.
3. Isoptera- Castes, Termitarium, economic importance.
4. Phasmida.
5. Blattaria- mention economic importance and important species.
6. Mantoidea & Mantophasmatodea.
7. Orthoptera- Families: Acrididae, Tetrigidae, Tettigonidae, Gryllidae, Gryllotalpidae. Stridulatory organs in Orthoptera; Locusts.
8. Thysanoptera.
9. Hemiptera; Families- Cicadidae, Jassidae, Cercopidae, Membracidae, Aphididae, Nepidae, Gerridae, Pentatomidae, Reduviidae. Medical importance
of Reduviidae; Polymorphism in Aphids; Stridulation in Cicada.
10. Psocoptera.
11. Phthiraptera- mention Pediculus humanus and its parasitic adaptations.
12. Dermaptera- Sexual dimorphism and parental care.
13. Plecoptera.

14. Embioptera.

15. Zoraptera.

MODULE 3. Insect Classification: Endopterygota (15 Hrs)

3.1. Endopterygota : Diagnostic characteristics, biology and economic importance of the following Orders and families mentioned under each order.

1. Coleoptera- Families: Curculionidae, Scarabaeidae, Carabidae, Cerambycidae, Lampyridae, Chrysomelidae, Elateridae, Meloidae. Mention cantharidin and bioluminescence.
2. Lepidoptera. Butterflies and Moths. Families: Noctuidae, Sphingidae, Saturnidae, Pyralidae, Papilionidae, Nymphalidae, Hesperiiidae, Pieridae, Lycaenidae, Geometridae .
3. Hymenoptera: Families: Vespidae, Sphecidae, Megachilidae, Apidae, Eumenidae, Xylocopidae, Formicidae, Evanidae, Braconidae, Ichneumonidae, Chalcididae, Eulophidae, Eurytomidae, Pteromalidae. Parasitic hymenoptera and biological control.
4. Diptera: Suborders: Nematocera and Brachycera. Families: Muscidae, Culicidae, Calliphoridae, Sarcophagidae, Simuliidae, Tipulidae, Glossinidae, Drosophilidae, Psychodidae.
5. Siphonoptera.
6. Strepsiptera.
7. Neuroptera.
8. Mecoptera.
9. Megalaoptera.
10. Raphidioptera.
11. Trichoptera.

MODULE 4. Ecology and Behaviour

(15 hrs)

4.1. Insects and the Abiotic Environment

- 4.1.1 Temperature
- 4.1.2 Moisture
- 4.1.3 Light
- 4.1.4 Air and water currents
- 4.1.5 Environmental pollutants

4.2. Insects and the biotic environment

- 4.2.1 Intraspecific interaction
- 4.2.2 Interspecific interaction
- 4.2.3 Coadaptation or coevolution

4.3. Exocrine Glands and Endocrine structures

4.3.1 Exocrine Glands, Functions in Defense, Intra and interspecific communication and secretion of structural materials.

4.3.2 Endocrine structures, Neurosecretory cells

4.4. Development of Insects

4.4.1 Fertilization

4.4.2 Embryogenesis

4.4.3 Organogenesis

4.4.4 Egg laying

4.4.5 Postembryonic morphogenesis

4.4.6 Other types of development

4.4.7 Regulation of growth and metamorphosis

4.4.8 Diapause, Polymorphism, Regeneration and Aging.

4.5. Social insects – social organisation

4.5.1 Caste differentiation

4.5.2 Aspects of social behaviour with reference to honey bee, termite and ant

4.6. Communication – acoustic, visual, tactile and chemical method (pheromones)

4.7. Adaptations of parasitic and predatory insects

References

1. Ananthkrishnan, T.N. (1992): *Dimensions of Insect-Plant Interactions*, Oxford & IBH Publishing Co. Pvt. LTD.
2. Aswathy, V.B. (1998): *Introduction to General and Applied Entomology*. ISBN.
3. Borror, D.J. and Delong, D.M. (1964). *An Introduction to the study of Insects*. Holt Rineheart and Winston, New York.
4. Carde, R, T. and Bell, W.J. (1995): *Chemical Ecology of Insects-2*. Chapman and Hall, New York
5. Essig, E. O. (1974): *College Entomology*. Mac Millon Co. London
6. Richard, W. and Davies, R.G.G. (1977). *Imm's general text book of Entomology, 10th edition*, Chapman & Hall.
7. Mani, M.S. (1974): *Modern classification of Insects*. Satish Book Enterprise., Agra.
8. Mani, M.S. (1982): *A general text book of entomology*, Oxford & IBH, New Delhi.
9. Nayar, K.K., Ananthkrishnan, T.N., & David, B.V. (1976). *General and Applied Entomology*, Tata Mac Grew Hill. New Delhi.
10. Ross, H.H. et al., *A general text book of entomology*, John Wiley Sons NY. Scientific Publishers, Jodhpur.
11. Snodgrass, R, E. (1935): *Principles of Insect Morphology*. Mac GrawHillBook.

12. Tembhare, D.B., *Modern Entomology*, Himalaya publishing House
13. Wilson, E.O. (1972): *The Insect societies*. Belknap, Harward University Press.
14. Gillot, C.(2005).*Entomology. 3rded.* Springer.
15. Romoser, W.S. and Stoffolano, J.G.(1994). *The Science of Entomology.3rd ed.* WCB Publishers, Oxford, England.
16. Wigglesworth, V.B. (1964). *The life of Insects*.Heindenfield and Necolson, London.
17. Ambrose, D. P., (2015). *The Insects: Structure, Function and Biodiversity*. New Delhi: Kalyani Publishers.

SEMESTER IV

MSZNG04C17: Microbiology and Biotechnology

Credits 4 – 72 Hours

Course Objectives

CO1. Understand the importance of biotechnology and microbiology in biological studies (K2).

CO2. Remember the techniques and practices of biotechnology and microbiology (K1).

CO3 Understand intellectual property rights K2).

CO4 Develop the awareness about the guidelines of biosafety (K6).

A- Microbiology

Module 1

16 Hrs

1.1. History and scope of Microbiology - 2 Hours

1.2. Microbial Diversity: Place of microorganisms in the living world – criteria used in Microbial taxonomy; Classification of bacteria – past and present status – classification based on morphology, gram's staining and culture characteristics. Classification based on Bergey's manual of systematic bacteriology (details of sections not expected) Classification of viruses-classification based host, morphology and nucleic acid characteristics. 6 Hours

1.3. Structural organization of bacteria and viruses: Ultra structure of bacterial cell wall, cell membrane – flagella – pili – capsule and genome: Bacterial gene regulation – Operons; Structure and architecture of bacteriophages. 4 Hours

1.4 Bacterial culturing: Physical and chemical methods of sterilization – growth media mixed microbial population – selection of pure culture – physical conditions of growth – growth curve – storage and transport of microbes 6 Hours

Module 2

19 Hrs.

2.1. Microbial toxins: Exotoxins – endotoxin and other virulence factors 3 Hours

2.2. Disinfectants and antibiotics: Methods of testing antimicrobial substances – mechanism and action of important classes of disinfectants and antibiotics - drug resistance of antibiotics- 4 Hours

2.3. Microbes and diseases: Bacterial diseases – Streptococcal diseases – pneumococcal diseases- Diphtheria-Tuberculosis- Plague – Anthrax – Syphilis – Tetanus – Leprosy- UTI; Viral diseases – Chicken pox – Small pox – Rabies – Covid - AIDS – Hepatitis- HPV- KFD- 8 Hours

2.4. Microbes and Pollution: Major pollution problems – pathogens, microbial toxins, oxygen depletion, biodeterioration, eutrophication, hazardous transformation etc., and management of pollution problems using microorganisms. 4 Hours

B- Biotechnology

Module 3

20 Hrs.

3.1. Biotechnology and its applications:

- (a) Medical, Agricultural, Industrial and Environmental applications
- (b) Gene therapy and its types

- (c) RNAi and Gene silencing
- (d) Terminator genes.
- (e) Transgenic animals and plants.

3.2. Recombinant DNA Technology

- (a) Gene cloning
- (b) Enzymes: Restriction enzymes, Ligases, DNA Polymerases, Reverse transcriptase, Alkaline phosphatase, Phosphonucleotide kinase, RNase, DNase, Terminal transferase and SI Nuclease.
- (c) Cloning vectors: Plasmids (pBR 322, pUC8, pUC9 Ti-DNA plasmid), Cosmids, Phagemids, Artificial chromosomes (YAC,BAC and MAC), Shuttle vectors and Expression vectors.

3.3. Gene library and Genetic markers

- (a) Gene library: Genomic library, cDNA library and Expression libraries
- (b) Screening of Gene libraries: DNA hybridization, Immunological Assay, Screening by protein activity, Genetic complementation and Hybrid Arrest Translational systems.
- (c) Genetic markers (RFLP, AFLP, RAPD) and its applications

Module 4

17 Hrs

4.1. Gene amplification, Gene Sequencing and gene expression analysis

- (a) Gene amplification: Polymerase Chain Reaction (PCR); Types and applications
- (b) Gene Sequencing methods: Maxam and Gilbert method, Sanger method, Automated sequencing method, NGS (Sequencing by synthesis, Pyrosequencing, Ion torrent and Nanopore sequencing).
- (c) Microarray and gene expression analysis.

4.2. Biotechnology: Hazards, Biosafety and Intellectual Property Right (IPR)

- (a) Hazards of environmental engineering
- (b) Biosafety guidelines and regulations
- (c) IPR, IPP, Patenting, Copyright and Trade mark

References (Microbiology):

1. Prescott, Harley and Klein, *Microbiology*, McGraw – Hill
2. Jacquelyn G Black, *Microbiology: Principles and Exploration*, John Wiley & Sons
3. Nester *et al*, *Microbiology: A human perspective*. McGraw Hill
4. Albert G Moat *et al*, *Microbial physiology*, John Wiley & Sons
5. Kathleen Park Talaro, Arthur Talaro, *Foundations in Microbiology*, Mc Graw Hill
6. Alcamo, *Foundations of Microbiology*, Jones and Bartiett Publishers

7. Cappuccino James, *Microbiology: A Laboratory Manual*; Pearson Education
8. Tortora Gerard, Berdell R Funke and Christine L Case (2011), *Microbiology: An introduction (9th Ed.)*. Pearson education
9. Edward A I, *Microbiology*. Tata McGraw Hill
10. Lim Daniel, *Microbiology*. Mc Graw Hill
11. Pelczar M J Jr, Chan E C S Krieg, *Microbiology*
12. Godkar, PB (1998), *A Text book of Medical Laboratory Technology*, Bhalani Publishing house, Mumbai
13. Ronald M. Atlas and Richard Bartha((2008). *Microbial Ecology Fundamentals and Applications (4th Ed.)*. Pearson Education.

References (Biotechnology):

1. *Principles of gene manipulation- An Introduction to Genetic Engineering*. Old, RW & Primrose, S.B – 1994 5th Edn. Blackwell Sci Pub.
2. *Molecular Cloning- A Laboratory Manual*; Sambrook, J., Fritsch, E. F. and Maniatis, T. 1989.. Second Edition. Cold Spring Harbor Laboratory Press.
3. *Recombinant DNA technology- Concepts and Biomedical Applications*; Steinberg, M., Guyden, J., Calhann, D, Staiano- Coico, L.,Coico, R,1993. Ellice Horwood Prentice Hall.
4. *Recombinant DNA*; Watson, J. D., Gilman, M., Witkowski, J. and Zoller, M. 1992. Second Edition. Scientific American Books, WH Freeman & Co.
5. *From Genes to Clones: Introduction to Gene* - Winnacker, E. L. 1987.
6. *Molecular Biotechnology* 5th Edition Bernard R. Glick, Jack J. Pasternak, Cheryl L. Pattern ASM Press 2017
7. *Gene cloning and DNA analysis: An Introduction*; 6th Edition. T.A. Brown Wiley Blackwell 2013
8. *Modern Biotechnology: Connecting Innovations In Microbiology and Biochemistry to Engineering Fundamentals*; Nathan S. Mosier, Michael R. Ladisch Wiley 2009
9. *Biotechnology in Agriculture and Forestry*; 66: Editors: Jack M. Widholm and Toshiyuki Nagata : Springer 2012
10. *Environmental Biotechnology: New Approaches and Prospective Application*: Marian Petre (Editor) 2013
11. Beir, F.K, Crespi, R.S and Straus J: 1982 *Biotechnology and patent protection*; Oxford and IBH Publishing Co. New Delhi.
12. *Department of Biotechnology (1990) Recombinant DNA Safety guidelines*. Govt. of India, New Delhi.
13. Krattinger, A.F Lesser, W and Mudge G: *Implementation of Biosafety Regulatory Mechanisms under the Biodiversity Convention*.

14. Narayanaswami K: 1994, *Safety and regulatory arrangements in Biotechnology in Sohal and Srivastava (eds) Environment and Biotechnology.*
15. Brown T A, *Gene Cloning and DNA Analysis*; Balackwell Science.
16. Click B R and pasternack J J *Molecular Biotechnology: principles and Applications of Reobmbinant DNA.* Panima.
17. James D Watson et al., *Recombinant DNA: A short Course.* Scientific American Books, W H Freeman & Co.
18. Old R W & Primrose S B, *Principles of Gene Manipulations*, Black Well Science
19. Winnaker E L, *From Genes to Clones: Introduction to Gene Technology.* VCH Publications. Purohit S S & Mathur S.K *Biotechnology: Fundamental and Application.* Agrobios.
20. Eric Grace, *Biotechnology Unzipped: promises and Realities.* University Press.
21. Fumento Michael, *Biotechnology demystifying the concepts.*
22. Meyers Roberts A, *Molecular Biology Biotechnology*, John Wiley

MSZNG04E02: Elective II: Invertebrate Systematics and Characteristics
Credits 4 – 72 Hours

Course Outcome:

- CO1: Categorize an unknown organism into a phylum based on its features. (K3)
 CO2: Assess the effectiveness of an adaptation for survival in a particular environment. (K5)
 CO3: Judge the effectiveness of different reproductive strategies for population growth and survival. (K5)
 CO4: Explain how the body plan and adaptations of an invertebrate species allow it to fill its ecological niche.(K2)
 CO5: Apply knowledge of invertebrate systematics to solve real-world problems.(K3)

Module 1

16 Hours

Part 1

1.1 Ptorozoa: General characteristics; Phylum Ciliophora, Amoeboid Protozoans (Amoebozoa, Foraminifera, Radiozoa, Heliozoa), Flagellated Protozoans (Zooflagellated protozoans and parasitic forms, free living forms, phytoflagellated protozoans), Spore forming Protozoans (Aicomplexa, Microsporidea, Mysoxpora)

Part 2

- 1.3 Porifera: General Characteristics, classification upto orders, diversity, features of reproduction and development
 1.4 Placozoa: General characteristics
 1.5 Cnidaria: General characteristics, classification up to orders, characteristics of each classes in detail
 1.6 Ctenophora: General caractereistics, classification upto classes, features of reproduction.

Module 2

16 Hours

Part 1

- 2.1 Mesozoa: Class Orthonectida and Class Rhombozoa
 2.2 Nemertea: General characteristics, Classification, reproduction and development.
 2.3 Rotifers and Acanthocelphalans: Phylum Rotifera – characteristics, classification upto classes, digestive system, nervous and sensory system, excretion and water balance; Phylum Acanthocephala (mention salient features)
 2.4 Nematodes: General characteristics, Body covering and cavities, musculature, internal pressure, locomotion, behaviour, reproduction and development, parasitic nematodes and beneficial nematodes.
 2.5 Nematomorpha, Priapulida, Kinoryncha, Loricifera: General characteristics of each of the four phylums.
 2.6 Myxozoa, Gnathostomulida, Gastrotricha, Chaetognatha and Cycliphora: Characteristics of these minor phyla.

Part 2

- 2.7 Mollusca: General Characteristics; Features of Polyplacophora, Aplacophora, Monoplacophora, Gastropoda (prosobranchia, opisthobranchi, pulmonata), Bivalvia (protobranchia, lamellibranchia, septibranchia), Scaphopoda, Cephalopoda, Circulation, Nervous, Digestive, Excretory and reproductive systems, development
 2.8 Annelida and Sipuncula: Characteristics, Polychaeta, Clitellata, Pogonophora, Echiura, Digestive, Nervous system and sense organs, circulatory system; Phylum Sipuncula

Module 3: Arthropoda to Echinodermata

16 Hours

Part 1

- 3.1 Arthropoda: Characteristics, Subphylum Trilobitomorpha, subphylum Chelicerata, Subphylum Mandibulata; Reproduction, development, Digestion, Excretion, Blood Pigments
 3.2 Tardigrada and Onychophora: General characteristics of Phylum Tardigrada and Phylum Onychophora

Part 2

- 3.2.1 Lophophorates: Phylum Phoronida, Phylum Brachiopoda, Phylum Bryozoa and Phylum Entoprocta; reproduction, digestion and nervous system of lophophorates.
 3.2.2 Echinodermata: General Characteristics, Class Crinoidea, Class Stellerioidea, Class Concentricycloidea, Class Echinoidea, Class Holothuroidea; Reproduction and development, Nervous system.
 3.2.3 Hemichordata: General characteristics and classification.

Module 4**16 Hours****Part 1**

- 4.1.1 Classification by cell number, embryology, body symmetry, developmental pattern, evolutionary relationships; hydrostatic skeleton
 4.1.2 Invertebrate locomotion and support: Ameboid locomotion, cilia and flagella, muscle and skeletons.
 4.1.3 Invertebrate feeding mechanisms: Intracellular and extracellular digestion, feeding strategies.
 4.1.4 Invertebrate Excretion and osmoregulation: nitrogenous wastes and water conservation, osmoregulation and habitat, excretory and osmoregulatory structures.

Part 2

- 4.2.1 Invertebrate circulation and gas exchange: Internal transport, circulatory systems, hearts and pumping mechanisms
 4.2.2 Invertebrate Nervous systems and sense organs: Nervous systems and body plans, independent effectors, bioluminescence, invertebrate sense organs.
 Invertebrate Hormones and Pheromones
 4.2.3 Invertebrate Reproduction and Development: Asexual reproduction, Sexual Reproduction (Patterns of sexuality, gamete diversity), larval forms.

References

1. Pechenik, Jan A.. Biology of the Invertebrates. United Kingdom, McGraw-Hill, Higher Education, 2005.
2. Brusca, R. C., & Brusca, G. J. (2002). *Invertebrates* (No. Ed. 2). Sinauer Associates Incorporated.

MSZNG04E03: Elective III: Chordate comparative anatomy and phylogeny
Credits 4 – 72 Hours

Course Outcomes

CO1: Explain the functions of each chordate characteristic and their evolutionary significance (K2)

CO2: Compare and contrast different hypotheses regarding the origin of chordates (annelid/arthropod vs. echinoderm) based on available evidence.(K4)

CO3: Describe the role of Hox genes in the evolution of diverse vertebrate body plans.(K3)

CO4: Evaluate the importance of different systems and their evolution for the diversification and success of vertebrates.(K5)

Module 1

16 Hours

Part 1 (Chordate characteristics and body plan)

1.1 Chordate Phylogeny

1.2 Chordate Characteristics

1.2.1 Notochord

1.2.2 Pharyngeal slits

1.2.3 Endostyle or thyroid gland

1.2.4 Dorsal and tubular nerve cord

1.2.5 Postanal Tail

1.3 Chordate body plan.

Part 2 (Chordate origin and phylogeny)

1.4 Protochordates

1.4.1 Hemichordata: Entropneusta, Pterobranchia, Hemichordate phylogenetic affinities to chordates, Hemichordate phylogenetic affinities to echinoderms

1.4.2 Cephalochordata

1.4.3 Urochordata: Ascidiacea, Larvacea, Thaliacea

1.5 Overview of protochordates

1.6 Hypothesis regarding chordate origins:

1.6.1 Chordates from annelids and arthropods

1.6.2 chordates from Echinoderms, Auricularian hypothesis, larval echinoderm to chordate tadpole

1.7 Chordate origins and phylogenetic affinities.

Module 2

16 Hours

Part1 (Evolution of vertebrates)

2.1.1 Vertebrate origins

2.1.2 Vertebrate classification: Overview of Agnathan evolution, Gnathostomes, Teleostomi, Tetrapods, Amniotes

2.1.3 Overview of early embryonic development of vertebrates (brief discussion only no type to be studied), Development of Coelom and its compartments

2.1.4 Maturation: metamorphosis, Heterochrony

2.1.5 Hox Genes and their role in vertebrate evolution

Part 2 (Comparative anatomy of integumentary system)

2.2.1 General Features of the integument, dermis, epidermis,

2.2.2 Integument of fishes

2.2.3 Integument of Tetrapods

2.2.4 Specializations of the integument

Module 3

16 Hours

Part 1 (Comparative anatomy of the skull)

3.1 Skeletal system: Skull

3.1.1 Chondrocranium

3.1.2 Splanchnocranium

3.1.3 Dermatocranium

3.2 Overview of skull morphology

3.3 Phylogeny of the skull

Part 1 (Comparative anatomy of the Respiratory system)

3.4 Respiratory system: respiratory organs in chordates, ventilatory mechanisms,

3.5 phylogeny of respiration and respiratory structures in chordates

3.6 Circulatory system: Blood, artery, vein, capillaries

3.6.1 Single and double circulation

3.7 Phylogeny of cardiovascular system in chordates

3.8 Comparative account of vertebrate heart

3.9 Lymphatic system

Module 4**16 Hours****Part 1 (Comparative anatomy of the Circulatory systems)**

4.1 Digestive system

4.2 Buccal cavity,

4.3 pharynx

4.4 Alimentary canal

4.5 Associated glands of digestion

4.6 Function and evolution of digestive system

Part 2 (Comparative anatomy of the urogenital, endocrine and nervous systems)

4.7 Urogenital system

4.7.1 Urinary system, Structure of mammalian kidney,

4.7.2 phylogeny of kidney in vertebrates,

4.7.3 evolution of vertebrate kidney

4.8 Nervous system: types of cells,

4.8.1 peripheral nervous system

4.8.2 central nervous system

4.9 Sensory organs in chordates: General sensory organs, special sensory organs,

Self study topics (only for internal assessment)

5.1 Muscular system

5.1.1 Origin of muscles, classification of muscles (skeletal, cardiac, smooth), Muscle functions

5.2 Skeletal system: Axial skeleton

5.2.1 Types of vertebrae

5.2.2 Ribs

5.2.3 Sternum

5.2.4 Gastralia

5.3 Embryonic development of vertebrae in major groups of vertebrates

5.4 Phylogeny of vertebrae in major group of vertebrates

5.5 Appendicular skeleton

5.5.1 Basic components: fins and limbs

5.5.2 Origin of paired fins

5.5.3 phylogeny of appendicular skeleton

5.5.4 Evolution of appendicular skeleton: Dual origin of pectoral girdle, adaptive advantage of lobe fins

5.5.5 Swimming and terrestrial locomotion

5.6 Endocrine organs in chordates, endocrine coordination, endocrine system and environment

Reference

Kardong, K. V. (1997). *Vertebrates: comparative anatomy, function, evolution*. Heinle and Heinle Publishers.

MSZNG03&04 C14; Microbiology and Biotechnology- Practical**(Credits 3– 72 Hrs)****Course Outcomes:**

CO1. Knowledge about different parts of a microscope and their functions

CO2. Acquiring the skills for staining bacteria and fungi

CO3. Identifying the roles of different components of a microbial culturing medium

CO4. Describing different sterilization techniques used in the laboratory

CO5. Acquiring necessary skills for extracting and quality control nucleic acids from tissue extracts and microbes

Microbiology

1. Microscopy; Principle, parts, handling and care
2. Staining of Bacteria; Simple staining, Gram staining and negative staining
3. Fungal staining
4. Bacterial Motility determination
5. Sterilization
5. Media preparation
3. Culture methods; Streak plate, pour plate and spread plate
4. Fungal culture
5. Antibiotic sensitivity testing
6. Applied microbiology; MBRT, mesophilic count of fish, antibiosis by soil microorganisms, water quality analysis, Isolation of bacteria from food and their identification.

Biotechnology

1. Isolation of DNA – bacterial, yeast, plasmid, animal
2. Isolation of total RNA from tissues
3. Separation of DNA by electrophoresis.
4. Cloning in plasmid.

5. Bacterial transformation
6. Demonstration of blotting techniques
7. PCR amplification of genes – bacterial and animal

References

Microbiology

1. Cappuccino, J. G., & Sherman, N. (2013). *Microbiology: a laboratory manual*. Pearson Higher Ed.

Biotechnology

1. Ausubel, F. M., Brent, R., Kingston, R. E., Moore, D. D., Seidman, J. G., Smith, J. A. and Struhl, K. (2002). *Short Protocols in Molecular Biology*. John Wiley and Sons Inc.
2. Sambrook, J. and Russell, D. W. (2001). *Molecular cloning: A laboratory Manual*. CSHL Press, New York.
3. Wilson Keith and Walker John (2006). *Principles and Techniques of Biochemistry and Molecular Biology 6th Ed.*, Cambridge University Press, New York.

**MSZNG03&04 C15; HISTOLOGY AND DEVELOPMENTAL BIOLOGY
PRACTICAL**

(Credits 3 – 72 Hrs)

Course Outcomes:

CO1. Knowledge about culturing drosophila and identifying sexes

CO2. Acquiring the skills for vital staining chick embryo and studying the early development.

CO3. Identifying the larval forms of different animals

CO4. Describing the changes at any stage of chick embryo (18hrs/24hrs/ 48hrs)

CO5. Acquiring necessary skills for preparing histological sections

1. Maintenance of *Drosophila melanogaster* culture, life cycle study, and sex determination.
2. Studies on chick embryos by vital staining using the window method.
3. Preparation of stained permanent mount of any stage of chick embryo (18hrs/24hrs/ 48hrs).
4. Preparation of whole and stained mounts of larval forms.
5. Identification of *Meloidogyne* species from root-knot using females and preparation of stained mount of males and juveniles.
6. Studies on the life cycle of mosquitoes. Identification of important mosquito species by using eggs, larvae, pupae, and adults.
7. Studies on the developmental stages of any soil mite in plastic vials based with a suitable medium.
8. Observation and mounting of developmental stages of any plant mite species [egg, larva, protonymph, deutonymph, adults (male and female)].

HISTOLOGY

1. Study of prepared permanent slides of animal tissue sections
2. Preparation of microscopic slides of stained sections of tissues (such as liver , kidney, lung, intestine, pancreas, testis, ovary etc.)
 2. Histochemical staining for carbohydrates, proteins and DNA

References

1. Balinsky, B. I. (1981). *An introduction to Embryology 5th Ed.* Holt Saunders Publ., Philadelphia.
2. Browder, L. W., Erickson, C. A. and Jeffery, R. W. (1991). *Developmental Biology 3rd Ed.* Saunders College Publ., Philadelphia.
3. Diwan, A. P. and Dhakad, N. K. (1995). *Avian Embryology, 1st Ed.* Anmol Publ. Pvt. Ltd., New Delhi.
4. Jenkin, P. M. (1970). *Control of growth and metamorphosis, 1st Ed.* Pergamon Press, Oxford.
5. Melissa A Gibbs (2003). *A Practical guide to Developmental Biology*, Oxford University Press 118 pages, B/w illus, figs
6. Laura R. Keller, John H, Evans, Thomas C.S. Keller (1998). *Experimental Developmental Biology: A Laboratory Manual* Paperback pp 114 Spl Edition, Academic Press
7. Yolanda P Cruz (1993) *Laboratory Exercise in Developmental Biology* pp 241. Academic Press, <https://doi.org/10.1016/C2009-0-03524-7>

**MSZNG03&04E04: Invertebrata, Chordata and Research Methodology –
Practicals**

(3 credits -72 Hrs)

Course Outcomes:

- CO1. Knowledge about different morphological structures of invertebrates
- CO2. Acquire the skills dissecting different organs like mouth parts, sting apparatus and genitalia of different insects.
- CO3. Identify different insects using morphological features
- CO4. Practice skills for collection and preservation of invertebrates
- CO5. Acquire necessary skills for preparing histological sections

1. Comparative study of any three animal tissues (preparation and study of permanent slides; Like Kidney, Lungs, Liver, Muscle etc.)
2. Histochemical staining for carbohydrates, proteins and DNA
3. Demonstration of cell forms from invertebrate blood smear preparation
4. Estimation of the rate of oxygen consumption of a Fish
5. Preparation of a dichotomous key of the given specimen (photographs or preserved specimen may be provided), build a character matrix and prepare a phylogenetic tree using the prepared character matrix using Maximum Parsimony method.
6. Conduct BLAST searches using DNA and Protein sequences – report best hit, e-value and percent identity
7. Prepare a multiple sequence alignment using the downloaded set of sequences (calculate alignment scores)
8. Find the best nucleotide substitution model for a set of given sequences, make a note on nucleotide substitution models/evolutionary models
9. Prepare a regression plot to study length-weight relationship of fishes
10. prepare a life table and survivorship curve using the given data
11. using camera lucida prepare a sketch of the given specimen
12. using a stereo microscope prepare photograph of the given specimen and prepare scientific drawings.
13. Visualise a DNA sequence chromatogram using suitable software and prepare a .fasta file of the sequence (Demonstration)
14. DNA barcoding an animal species – Specimen collection, preservation, DNA isolation, PCR and electrophoresis to be demonstrated and notes to be prepared.
15. Study of insect mouth parts – mounting.
16. Comparative study of vertebrate bones – skull bones, vertebra and girdles (preparation is optional)
17. Study of the different types of antennae- prepare permanent slides of at least 5 types of antennae (To be submitted during practical examination)

18. Preparation of keys for identification of insects up to family level (common families of Orders Orthoptera, lepidoptera, Hemiptera and Coleoptera).
19. Preparation of stained slides of insect haemolymph and identification of haemocytes.
20. Collection and preservation of insects. Students shall submit insects belonging 15 orders and 30 families (including 5 whole mounts) at the time of practical examination }.
21. Collection, identification and preservation of pests of local crops. The collection should include a minimum of 20 crop pests. The collection has to be submitted during the practical examination.
22. Study of histology of salivary gland, crop, gizzard, hepatic caeca, mesenteron and ovary of any insect by preparing permanent histology slides.
23. Preparation of whole mounts external genital organs in different insects.
24. A study tour for the purpose of collecting insects belonging to different ecological niches other than local is required with a report of the field study which is to be included in the record of drawing for evaluation at the practical examination.

References

1. Borror, D.J. & D.M. DeLong. (1964). *An Introduction to the Study of Insects*. 7th Edn. Holt Rinehart & Winston, New York.
2. Pedigo, L. P (2009). *Entomology & Pest Management Practice*. 6th Edn. Hall India Pvt. Ltd., New Delhi.
3. Mani, M.S. (1962). *General Entomology*. Oxford & IBH, New Delhi.
4. Mani, M.S. (1974). *Modern Classification of Insects*. Satish Book Enterprise, Agra.
5. Nayar, K. K., Ananthkrishnan T.N. & David B.V (1976). *General and Applied Entomology*, Tata Mac Grew Hill, New Delhi.
6. Richards, O.W. & Davies R.G.G (1977). *Imm's General Text Book of Entomology*. Chapman & Hall, London.
7. Romoser, W.S. and Stoffolano, J.G. (1994). *The Science of Entomology*. 3rd Edition. WCB Publishers, Oxford, England.

MSZNG03&04C16; Project (with presentation)

(3 credits-54 Hrs)

MSZNG04C18; Viva Voce

(1 Credit)

MSZNG04C19; Personal collection with Field study report

(1 credit)

Model Question Paper – MSZNG03C13**DEVELOPMENTAL BIOLOGY AND ANIMAL ETHICS****Time 3 hours****Maximum Marks: 60****Part A****Answer any five of the following each question carries 3 marks**

1. What is primary inducer
2. Explain differentiation
3. What is totipotency
4. Explain cortical reaction
5. What is metamorphosis
6. What teratogenesis

Part B**Answer any three of the following each question carries 6 marks**

7. Explain gastrulation
8. Describe different types of specification
9. Explain differentiation of neurones
10. Explain the formation of primitive streak
11. Describe the advantages and disadvantages of using animal models in experiments

Part C**Answer any three questions each question carries 9 marks**

12. Explain gametogenesis in mammals
13. Describe the roles of segmentation genes in embryonic development
14. Explain different types of regeneration
15. Describe the contributions of Hans Spemann & Hilde Mangold for developmental biology
16. Explain the CPCSEA Guidelines for using animals in scientific experiments

MSZNG03O01; Open Elective (Multi-Disciplinary); Research methodology

Time 3 hours

Maximum Marks: 60

Part A

Answer any five of the following each question carries 3 marks

1. Explain the importance of fixation in histology
2. What is cryostat
3. describe Amyloid Staining
4. What is CLUSTAL
5. What is gene tree
6. Explain boot strap

Part B

Answer any three of the following each question carries 6 marks

7. Explain the use of a microtome
8. Explain Connective Tissue Staining
9. Explain Immunocytochemistry Technique
10. Describe the use of Online resources for molecular phylogeny creation
11. Explain the Reference management & Methods

Part C

Answer any three questions each question carries 9 marks

12. Explain the Processing of Tissue in Histopathology Laboratory
13. Explain the General Procedure of Staining of the Tissue
14. Explain the construction of a phylogenetic tree using morphological data
15. Describe the steps in a scientific publication
16. Explain the ethics in publication

Model Question Paper – MSZNG03 E01:

Elective 1: Introduction to Entomology

Time 3 hours

Maximum Marks: 60

Part A

Answer any five of the following each question carries 3 marks

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Part B

Answer any three of the following each question carries 6 marks

- 7.
- 8.
- 9.
- 10.
- 11.

Part C

Answer any three questions each question carries 9 marks

- 12.
- 13.
- 14.
- 15.
- 16.

Model Question Paper – MSZNG04C17

Microbiology and Biotechnology

Time 3 hours

Maximum Marks: 60

Part A

Answer any five of the following each question carries 3 marks

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Part B

Answer any three of the following each question carries 6 marks

- 7.
- 8.
- 9.
- 10.
- 11.

Part C

Answer any three questions each question carries 9 marks

- 12.
- 13.
- 14.
- 15.
- 16.

Model Question Paper – MSZNG3E01

Invertebrate Systematics and Characteristics

Time 3 hours

Maximum Marks: 60

Part A

Answer any five of the following each question carries 3 marks

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Part B

Answer any three of the following each question carries 6 marks

- 7.
- 8.
- 9.
- 10.
- 11.

Part C

Answer any three questions each question carries 9 marks

- 12.
- 13.
- 14.
- 15.
- 16.

Model Question Paper – MSZNG4E02

Chordate comparative anatomy and phylogeny

Time 3 hours

Maximum Marks: 60

Part A

Answer any five of the following each question carries 3 marks

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

Part B

Answer any three of the following each question carries 6 marks

- 7.
- 8.
- 9.
- 10.
- 11.

Part C

Answer any three questions each question carries 9 marks

- 12.
- 13.
- 14.
- 15.
- 16.

