DEPARTMENT OF ZOOLOGY
(AUTONOMOUS),
SHIVAJI UNIVERSITY, KOLHAPUR

Established: 1962

A^{++} Accredited by NAAC (2021) with CGPA 3.52

Structure and Syllabus in accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Master of Science
(Zoology)

under
Faculty of Science and Technology

(To be implemented from Academic Year 2024-25)

1. Preamble

The Department of Zoology, Shivaji University, Kolhapur started in the year 1964. It offers M.Sc. and Ph.D. Programme in Zoology. While designing this syllabus, emphasis was given to cover the syllabus of NET and SET examinations so that students will be able to qualify these exams easily. The syllabus is framed according to the guidelines of National Education Policy 2020 (NEP 2020), where students get an opportunity to select an elective course of his/her choice from the first semester of M.Sc. like Cell Biology, Animal Physiology, Entomology, Aquaculture and Fisheries, and Sericulture. Recently, the Department of Zoology has been granted the Academic Autonomy which is being implemented from the academic year 2024-25.

Appropriate number of hours are allotted for the lab Courses to offer skill development. During M.Sc. I, the lab courses are based on theory papers Viz. Molecular Cell Biology, Applied Entomology, Research Methodology in Zoology, Physiological Chemistry, Anatomy and Physiology. In Research Methodology, students will gain the knowledge of bioinstrumentation and biostatistics along with basics of Animal systematics. During M.Sc. II, students will study Genetics, Enzymology, Animal Cell Culture and Toxicology in theory classes and practical. Besides, students will have a theory and lab course of his/her specialization.

The syllabus offers opportunity of on job training or Field project to get an experience outside the walls of the classroom. During M.Sc. II, sufficient hours are allotted for Research Project to inculcate research attitude. The M.Sc. program in Zoology will help the students to understand the complex life processes at cellular and molecular level, the functioning of cells, tissues, organs and systems, develop technical skills in Entomology, Aquaculture and Fisheries and Sericulture. The students will be able to analyze a situation critically and make decisions in the areas of their specialization.

2. Duration

- The course is full time and of two years duration (four semesters).

3. Eligibility for Admission

- B. Sc. Zoology from any recognized University/Institutions.

4. Medium of Instruction: English

5. Programme Structure

Structure in Accordance with National Education Policy - 2020

With Multiple Entry and Multiple Exit Options

M. Sc. (Zoology) Part – I (Level-6.0)

AUTONOMOUS

SEMESTER-I (Duration- Six Month)										
		Teaching Scheme			Examination Scheme					
	Course Code	Theory and Practical			University Assessment (UA)			Internal Assessment (IA)		
		Lectures (Per week)	Hours (Per week)	Credit	Maximum Marks	Minimum Marks	Exam. Hours	Maximum Marks	Minimum Marks	Exam. Hours
Major Mandatory	MMT101	4	4	4	80	32	3	20	8	1
	MMT102	4	4	4	80	32	3	20	8	1
	MMPR 103	-	8	4	100	40	6	-	-	-
Major Elective	MET104	4	4	4	80	32	3	20	8	1
	MEPR 105	-	4	2	50	20	3	-	-	-
Research Methodology	RM	4	4	4	80	32	3	20	8	1
TOTAL (Sem - I)		--	28	**22**	**470**	--	--	**80**	--	--
SEMESTER-II (Duration- Six Month)										
Major Mandatory	MMT201	4	4	4	80	32	3	20	8	1
	MMT202	4	4	4	80	32	3	20	8	1
	MMPR 203	-	8	4	100	40	6	-	-	-
Major Elective	MET 204	4	4	4	80	32	3	20	8	1
	MEPR 205	-	4	2	50	20	3	-	-	-
OJT/FP	OJT/FP	-	-	4	100	40	3	-	-	-
TOTAL (Sem II)		--	--	**22**	**490**	--	--	**60**	--	--
Total (Sem I + Sem II)		--	--	**44**	**960**	--	--	**140**	--	--

• MMT – Major Mandatory Theory • MMPR – Major Mandatory Practical • MET – Major Elective Theory • MEPR – Major Elective Practical • RM - Research Methodology • OJT/FP- On Job Training/ Field Project	• Total Marks for M.Sc.-I: **1100** • Total Credits for M. Sc.-I (Semester I & II): 44 • ***Separate passing is mandatory for University and Internal Examinations***
*Evaluation scheme for OJT/FP shall be decided by concerned BOS	
• **Requirement for Entry at Level 6.0:** A. A student will be held eligible for admission to the M. Sc. Program in Zoology who has passed the B. Sc. Examination with Zoology as principal subject and also has passed the entrance examination conducted by the University. B. Performance in Entrance examination will only be considered for admission to M.Sc. Zoology.	
• **Requirement for Exit after Level 6.0:** **Students can exit after completion of Level 6.0 with credits of 44 and get Post Graduate Diploma in Zoology.**	
• **Requirement for Entry at Level 6.5: the student who exits after level 6.0 may join M. Sc. Part II (level 6.5) within next five year after exit.**	

6. Programme Outcomes (POs)

PO1: Apply the knowledge of Zoology in day today life.

PO2: Understand animals from their sub-cellular to ecosystem level.

PO3: Gain the knowledge of agro based entrepreneurship like Sericulture, aquaculture, apiculture and lac culture for providing lab-to-land benefits to Society.

PO4: Able to frame hypothesis, design experiment, analyze data & generate conclusions.

PO5: Able to work in different fields of biological sciences like animal cell culture, toxicology, enzymology, bioinstrumentation etc.

PO6: Students are able to address societal issues like pollution, health awareness, pest-parasite management, taxonomy and biodiversity conservation.

7. Course Codes

M. Sc. Semester - I		
Sr. No.	**Major Mandatory**	
MMT101	Molecular Cell Biology (4 credits)	**MSU0325MML939G1**
MMT102	Applied Entomology (4 credits)	**MSU0325MML939G2**
MMPR 103	Practical MMPR 103 based on MMT 101 and MMT 102 (4 credits)	**MSU0325MMP939G**
MEPR 105	Practical MEPR 105 based on MET 104 (2 credits)	**MSU0325MEP939G**
RM	Research Methodology (4 credits)	**MSU0325RML939G**
MET104	**Major Elective**	
	Molecular Biology of the Gene	**MSU0325MEL939G1**
	Animal Physiology	**MSU0325MEL939G2**
	Basic Entomology	**MSU0325MEL939G3**
	Fisheries Resources: Inland and Marine Fisheries	**MSU0325MEL939G4**
	General Sericulture and Mulberry cultivation	**MSU0325MEL939G5**
M. Sc. Semester - II		
	Major Mandatory	
MMT201	Physiological Chemistry (4 credits)	**MSU0325MML939H1**
MMT202	Anatomy and Physiology (4 credits)	**MSU0325MML939H2**
MMPR 203	Practical MMPR 203 based on MMT 201 and MMT 202 (4 credits)	**MSU0325MMP939H**
MEPR 205	Practical – MEPR 205 based on MET 204 (2 credits)	**MSU0325MEP939H**
OJT	On Job Training (4 credits) **OR**	**MSU0325OJ939H**
FP	Field Project (4 credits)	**MSU0325FP939H**
MET 204	**Major Elective**	
	Developmental Biology	**MSU0325MEL939H1**
	Applied Physiology	**MSU0325MEL939H2**
	Insect Anatomy and Physiology	**MSU0325MEL939H3**
	Fish Pathology and Reproductive Endocrinology	**MSU0325MEL939H4**
	Silkworm Biology & Rearing Technology	**MSU0325MEL939H5**

8. Syllabus

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Molecular Cell Biology (MMT 101)

Course Code: MSU0325MML939G1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, the student will have in depth knowledge of:
CO 1: Functioning of the nucleus and its importance.
CO 2: Structure and various functions of membrane, intracellular transport and sorting.
CO 3: Functioning of various cell organelles at molecular level.
CO 4: Cytoskeletal elements, Cell signaling and cell division.

Unit I: The Interphase Nucleus, Chromatin, and the Chromosome (15 Hrs.)
The ultrastructure of interphase nucleus, nuclear envelope, and nuclear pore complex,
Nuclear import and export, Nucleolus.
The DNA structure, Histone proteins, Packaging of DNA into chromatin.
Euchromatin and Heterochromatin, The C-value paradox,
Fine structure and classification of chromosomes.

Unit II: Membrane transport, protein sorting and vesicular trafficking (15 Hrs.)
Biomembrane structure and functions.
Transport of Ions and Small Molecules across the membrane.
transcellular transport.
Cell-cell junctions and their significance.
Protein sorting and vesicular trafficking.

Unit III: Cellular Respiration and Degradation (15 Hrs.)
Mitochondria: Biogenesis, membrane differences, structure, and functions.
Lysosomes: Origin, structural polymorphism and functions.
Peroxisomes: Biogenesis, ultrastructure and functions.
Endosomes: Late and early endosomes, assembly structure, and functions.
Proteasomes: Types, assembly structure and functions.

Unit IV: Cytoskeleton, Cell signaling and Cell division (15 Hrs.)
Cytoskeletal elements: microtubules, microfilaments, intermediate filaments and associated motor proteins

Cell signaling: Features of signal transduction, Molecular Mechanisms of Signal Transduction, Gated Ion Channels, Receptor Enzymes, G Protein-Coupled Receptors and Second Messengers, Regulation of Transcription by Steroid Hormones, Signaling by Mechanoreceptors, pain receptors, Taste receptors and olfactory receptors.

Cell Division: Cell cycle regulation, cyclin dependent kinases and check point pathways, Extracellular and Intracellular Cues Regulating Entry into Meiosis.

Reference books:

1. Molecular Biology of the Cell (7th Ed.) by Bruce Alberts, Rebecca Heald, Alexander Johnson, David Morgan, Martin Raff, Keith Roberts, Peter Walter, John Wilson, Tim Hunt, New York: Garland Science; 2022.
2. Molecular Cell Biology, 9th Ed. Harvey Lodish; Arnold Berk; Chris A. Kaiser; Monty Krieger; Anthony Bretscher; Hidde Ploegh; Kelsey C. Martin; Michael Yaffe; Angelika Amon, **W H Freeman & Co.** New York, US.
3. The cell: A molecular approach - Cooper
3. Molecular cell biology – Gerald carp

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Applied Entomology (MMT 102)

Course Code: MSU0325MML939G2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, Students will be able to
CO1: Demonstrate morphology and anatomy of insects.
CO2: Recognize various types of insect pests.
CO3: Work in Sericulture, apiculture and lac culture,
CO4: Appreciate the forensic entomology and nutritional entomology.

Unit I: (15 Hrs.)
1. Study of generalized insect: Grasshopper (Morphology and Anatomy, brief Account).
2. Types of Insect pests: Definition with suitable examples.
3. Types of Forest pests: Defoliators, Sapsuckers, Borers of trees, spike disease of Sandal, Soil insects damaging forest trees, control methods of forest pests.

Unit II: (15 Hrs.)
1. Stored grain pests: Rice weevil, Rice moth, Khapra beetle, Pulse beetle, Rust red floor beetle, Angoumois grain moth.
2. Veterinary entomology: Farm animal pests- Horse fly, Blowfly, Stable fly, Louse fly, Warble fly, Screw worm, Cattle louse, bird louse, Flea

Unit III: (15 Hrs.)
Sericulture: History of Sericulture, Life cycles of Mulberry and Non-mulberry Silkworms, Rearing technology of mulberry silkworm, Diseases and pests of Mulberry silkworm, Moriculture and cultural practices, Diseases and pests of Mulberry.

Unit IV: (15 Hrs.)
1. Apiculture: The honey bees, Social organization of honey bees, Life history of honey bees, Methods of bee keeping.

2. Lac culture: Lac insect- Taxonomy, distribution and life history, Host plants and lac insects, Strains of lac insect and their propagation, Cultivation practices, Lac extraction and uses.

3. Forensic entomology: History, Corpse associated arthropod classes, Role of arthropods in forensic entomology, Examples.

4. Nutritional entomology: Advantages of eating insects (Entomophagy), Examples of insects generally consumed, Nutritional value, Entomophagy as a source of income.

Suggested Readings:

1. Ambrose, D.P. (2015). The Insects. Structure, Function and Biodiversity. Kalyani publishers, New Delhi. 626pp.
2. Herms W. B. (1961). Medical Entomology. The Macmillan Company, New York And Brett-Macmillan Limited, Galt, Ontario. pp. 616.
3. Srivastava K. P. (1996). A Textbook of Applied Entomology, Volume- II. Kalyani Pulblishers, New Delhi. pp. 487.
4. David B. V. and Ramamurthy V. V. ((2015). Elements of Economic Entomology. Brillion Publishing, New Delhi. pp. 398.
5. Shukla G. S. and Upadhayay V. B. (2011) Economic Zoology. Rastogi Publications, Meerut, India. pp. 487.
6. Tembhare, D. B (2013). Modern Entomology. Himalaya Publishing House, India. pp 502.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Molecular biology of the gene (MET 104)

Course Code: MSU0325MEL939G1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, student will be able to …
CO1: Understand the genetic mapping techniques and blotting techniques.
CO2: Understand the importance of satellite DNA, Transposable DNA, Organelle DNA in human genome.
CO3: Discuss the of concept of gene, gene structure and transcription, post transcriptional control of gene expression.
CO4: Understand the significance of recombinant DNA technology and genetic manipulations by Knockout, transgenesis techniques and genome editing tools and applications.

Unit - I: Molecular Genetic Technique (15 Hrs.)

1. Chromosome as a carrier of genes
2. Linkage groups, genetics maps, crossing over and genetic recombination
3. Genetic recombination analysis in Drosophila
4. Hybridization techniques –Southern blotting, Northern blotting, In situ hybridization, DNA microarray

Unit - II: Genes, Genomics and Chromosome. **(15 Hrs.)**

1. Simple sequence DNA – satellite DNA
2. Transposable DNA elements
    a) DNA Transposons
    b) LTR Retrotransposons
    c) Non LTR Retrotransposons (SINES and LINES)
3. Organelles DNA
    a) Mitochondrial DNA
    b) Chloroplast DNA
4. Genomics- Genome wide Analysis of Gene Structure and Expression
5. Morphology and Functional Elements of Eukaryotic Chromosomes
    a) Chromosome number, size and shape at metaphase
    b) Banding patterns
    c) Chromosome painting and DNA sequencing

Unit - III: **(15 Hrs.)**

1. Gene and its expression:

a) Concept of gene
b) Transcriptional control of gene expression in prokaryote (Lac, trp - operon).

2. Transcriptional control of gene expression in eukaryotes:

a) RNA polymerases and gene control.
b) Regulatory sequences in protein coding gene.
c) Activators & Repressors of Transcription.
d) Regulation of transcription factor activity.
e) Regulation of elongation and termination of transcription.
f) Other eukaryotic transcription systems.

3. **Post transcriptional gene control and nuclear transport:**

a) Processing of pre m-RNA.
b) Regulation of pre m-RNA processing.
c) Macromolecular transport across the nuclear envelope.
d) Cytoplasmic mechanisms of post transcriptional control.

Unit - IV: Genetic engineering **(15 Hrs.)**

a) Recombinant DNA technology
b) Selection, screening and analysis of recombinants
c) Knockout gene technique
d) Production of transgenic mice
e) CRISPR-Cas9 based genome editing

Suggested Reading Material:

1. Molecular Cell Biology by Lodish *et. al.*
2. Molecular Biology of the gene by Watson
3. Principles of Gene Manipulation by S. B. Primerose

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Animal Physiology (MET 104)

Course Code: MSU0325MEL939G2
Total Credits: 04
Course Outcomes: Upon completion of the course, students will be able to…
CO1: Describe various aspects of neuromuscular physiology.
CO2: Illustrate the anatomy and physiology of sense organs.
CO3: Understand various concepts of reproductive physiology.
CO4: Know various techniques used in reproductive biology.

Unit - I: Membrane and Neuromuscular physiology **15 Hrs.**

1.1 Membrane Physiology and its potential.
1.2 Anatomy of nervous system – Neuroglia and neurons.
1.3 Physiology of nerve fiber its excitation and conduction.
1.4 Anatomy and physiology of skeletal, cardiac and smooth muscle
1.5 Neuromuscular junction- physiology and transmission.

Unit - II: Physiology of Sense organs **15 Hrs.**

2.1 Anatomy and physiology of Eye and Optics of eye.
2.2 Anatomy and physiology of Ear.
2.3 Anatomy, Histology and physiology of tongue.
2.4 Chemical Senses- Smell

Unit - III: Physiology of Reproduction **15 Hrs.**

3.1 Anatomy and physiology of male reproductive system.
3.2 Anatomy and physiology of female Reproductive system.
3.3 Maturation, capacitation of germ cells and fertilization.
3.4 Embryonic development.
3.5 Birth control measures.

Unit - IV: Recent trends in Reproductive biology **15 Hrs.**

4.1 Prenatal diagnostic tests
4.2 IVF and Embryo Transfer
4.3 Stem cells and Tissue culture.
4.4 Modern techniques in developmental biology.

Suggested Reading Material:

1. Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C. (eds) Americal Physiological Society, 1984.
5. Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.

6. Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co- Cartiar output & its regulation 1973.
7. Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
8. Guyton A.C. et al 1975 Dynamics& Control of the Body flerids Philadelphia, W.B. Saunders, Co., 1975.
9. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. SaundersCo., 1986.
10. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
11. Johnson L.R. et al Physiology of the gastrointestinal tract 1987 New York Raven press.
12. Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
13. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
14. Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,
15. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Basic Entomology (MET 104)

Course Code: MSU0325MEL939G3
Total Credits: 04
Course Outcomes: Upon successful completion of this course …

CO1: Students will gain knowledge about how insects originated and evolved, the distribution and diversity of insects, and why insects continue to dominate the world.

CO2: Students able to get an in-depth knowledge of the structure of the head, thorax, and abdomen of insects and their various appendages which are very important for insect identification.

CO3: Students get a detailed study of the historical background of insect classification, the types and components of insect classification, and an explanation of which insects belong to the different orders within the classification of insects.

Unit - I: INTRODUCTION TO INSECTS AND BODY PLAN (15 Hrs.)

1. INSECTS
- 1.1. Origin and evolution of insects.
- 1.2. Distribution and Diversity of Insects.
- 1.3. Dominance of insects.

2. BODY SEGMENTATION
- 2.1 Tagmosis
- 2.2 Modification

3. HEAD
- 3.1 Types and segmentation
- 3.2 Cranium
- 3.3 Tentorium

3.4 Cephalic appendages

4. CERVIX

Unit - II: INSECT BODY PLAN (15 Hrs.)

1. THORAX

1.1 Skeleton

1.2 Segmental regions – Tergum, Sternum and Pleuron

1.3 Thoracic appendages- Legs and Wings

2. ABDOMEN

2.1 Typical Abdomen

2.2 Skeleton

2.3 Abdominal appendages- Pregenital, Genital and post-genital.

Unit – III: SYSTEMATICS (15 Hrs.)

1. INSECT CLASSIFICATION

1.1 Historical background

1.2 Types of Classification

1.3 Components of classification

1.4 Type specimen

2. APTERYGOTE ORDERS

2.1 Entognathus: Collembola

2.2 Ectognathus: Thysanura

3. PTERYGOTE ORDERS

3.1 Odonata, Embidina, Phasmida, Orthoptera , Isoptera, Blattaria, Anopleura.

Unit – IV: SYSTEMATICS (15 Hrs.)

1. PTERYGOTE ORDERS

1.1 Hemiptera, Coleoptera, Diptera, Lepidoptera and Hymenoptera.

While describing Insect orders, details of the Habitat, External Morphology, Internal anatomy and Classification upto families with examples are expected.

Suggested Reading Material:

1. Ambrose, D.P., 2015. The Insects. Structure, Function and Biodiversity. Kalyani publishers, New Delhi. 626pp.
2. Chapman, R. F. (1998). The Insect structure and function, 4th Ed. Cambridge University Press, UK. PP 747.
3. Gillot, C. (1980). Entomology, 3rd Ed. Plenum Press, New York, pp 730.
4. Gullan, P. G. and Cranston, P. S., 2010. The insects. An outline of Entomology. Wiley Blackwell. pp. 565.
5. Mani, M. S. (1968). General Entomology. Oxford & IBH Publishing Co., pp 597.
6. Snodgrass, R. E. (1935). Principles of Insect Morphology, Tata Mc Graw -Hill, New York. pp 667.
7. Tembhare, D. B (2013). Modern Entomology. Himalaya Publishing House, India. pp 502.
8. Wigglesworth, V.B., 1939. The Principles of Insect Physiology. Sixth ed. Methuen and Co. Ltd., London. pp 741.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Fisheries Resources: Inland and Marine Fisheries

Course Code: MSU0325MEL939G4 (MET 104)
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Understand concepts of inland and marine fisheries resources

CO2: Learn about various technical aspects of fisheries.

CO3: Demonstrate various techniques in fishery management.

CO4: Appreciate fishery economics and its extension.

Unit - I: **(15 Hrs.)**

A. Marine Capture Fisheries:
Coastal fisheries: Sardine, Mackerel and Bombay duck; Off-shore fishery: Sole, Tuna, and Pomphret; Crustacean fishery and Molluscan fishery

B. Marine Fisheries:
Stratification of Marine habitat, and Groups of Marine Fishes

Unit - II: **(15 Hrs.)**

A. Freshwater Fisheries of India:
Riverine fisheries, Reservoir fisheries, and Sewage fed fisheries

B. Carp Seed Resources of India:
Pre-monsoon survey and selection of sites for spawn collection, Techniques of spawn collection, Spawn collection by nets, Identification, Segregation and transport, Present status of carp seed production in India.

Unit - III: **(15 Hrs.)**

A. Management of Inland Fishery Resources:
Fishery management in rivers and reservoirs; Reproduction, Competition, and Predation in fishes, Techniques in fishery management, Fertilization of water bodies.

B. Management of Marine Fishery Resources:

Biological basis of marine fishery management, Objectives of management: Biological and Non-biological, Concept of maximum sustainable yield, Fishery regulation and control of catch composition, Allocation of shares and limited entry, international fishery management i) Law of the sea, ii) Planning of future exploitation, iii) Fishery regulatory bodies; iv) Monitoring control and surveillance.

Unit - IV: **(15 Hrs.)**

Economics of Fisheries and Extension Programme:

Marketing and economics of fish farming, Co-operative fisheries societies, Role of government agencies in extension programme, Fisheries education, Training and extension, Problems of fisheries.

Suggested reading material:

1. Management of Marine Fisheries: J.A. Gullad.
2. Fishery Science: W.C. Royce.
3. Ecology, Utilization and Management of marine fisheries; G.A.Rounsefell.
4. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.
5. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.
6. Fish farming hand book: E.E. Brown and J.B. Gratzek.
7. Fresh water biology: K.F. Lagler.
8. Fish and Fisheries of India: V.G. Jhingran.
9. Advances in aquaculture: T.V.R. pillay.
10. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.
11. Fishery management: S.C. Agarwal.
12. Applied fishery science (Vol. I & II): S.M. Shafi.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: General Sericulture and Mulberry cultivation (MET 104)

Course Code: MSU0325MEL939G5
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Appreciate the scope of sericulture and its distribution
CO2: Illustrates various aspects of soil requirement for mulberry cultivation.
CO3: Demonstrate various methods of mulberry cultivation and its management
CO4: Identify and manage various mulberry pest and diseases.

Unit-I: History and scope of Sericulture. (15 Hrs.)

General account of global production of mulberry and non-mulberry silk,
Silk route, Geographical distribution of mulberry and non-mulberry sericulture,
Scope of sericulture in India

Unit-II: Soil science and requirements for mulberry (15 Hrs.)

Classification of different types of soil, Physical and chemical properties of soils,
Soil testing and Management, Selection and preparation of land for mulberry cultivation
Agro climatic zones and agro-climatic conditions for mulberry cultivation, Site suitability for mulberry garden establishment

Unit-III: Mulberry cultivation practices and management (15 Hrs.)

Characteristic features of popular mulberry varieties of tropical and temperate regions

Propagation of Mulberry- Scope and significance of sexual and asexual propagation, Methods of mulberry propagation

Mulberry crop production- Planning for establishment of mulberry garden

Concept and establishment of mulberry garden for chawki & late age worms,

Water management- Concept of irrigation, Methods of irrigation,

Frequency of irrigation and importance

Entrepreneurship in mulberry sapling production, Kisan nursery

Unit-IV: Management of Mulberry Pests and Diseases (15 Hrs.)

Pests: Lepidopteran pests, Coleopteran pests, Orthopteran pests, Dipterans pests, Hemipteran pests (Sap feeders), white fly. **Diseases:** Fungal diseases - Root rots, Powdery mildew disease. Leaf spot, Leaf rust etc. Bacterial diseases - Leaf blight diseases, Root knot diseases, Viral diseases - Mulberry leaf mosaic disease, Nematode diseases

Suggested Reading Material:

1. Anonymous (1972): FAO Manuals on Sericulture Vol. I – IV
2. Hanumappa (1978): Sericulture for Rural Development, Himalaya Publications, Delhi.
3. King, L.A. and Posse R.D. (1990): Baculovirus Expression System? Chapman and Hall, London.
4. Koshy, T.D. (1990): Exports and Development, Ashish Publications, New Delhi.
5. Singh, B.D.: Plant breeding, Kalyani Publishers, New Delhi.
6. Anonymous (1972): Hand Book of silk rearing, Agriculture techniques Manual I., Fuji Publication, Tokyo.
7. Jolly, M.S.: Appropriate Sericultural Techniques CSR and TI Mysore.
8. FAO, Volumes (1-4), Central Silk Board, Bangalore
9. Handbook on pest and disease control of mulberry and silkworm, Economic and Social Commission for Asia and Pacific, United Nations.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Research Methodology (RM)

Course Code: MSU0325RML939G
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,
CO 1: Understand various separation techniques.
CO 2: Know in detail spectroscopy and principles and types of microscopes and immunological techniques
CO 3: Appreciate and apply various concepts of biosystematics.
CO 4: Apply various statistical methods in research.

Unit I: Separation techniques: (15 Hrs.)

1. **Centrifugation techniques**. Basic principles of sedimentation and centrifuges and their uses, differential centrifugation, density gradient centrifugation.
2. **Chromatographic techniques** – Chromatography theory & practices, Molecular Sieve chromatography, affinity chromatography, ion exchange chromatography, HPLC, GLC, Thin layer chromatography.
3. **Electrophoretic techniques** – General principles, support media, electrophoresis of proteins and nucleic acids, Isoelectric focusing.

Unit II: (15 Hrs.)

1. **Spectroscopic techniques**: UV and Visible light Spectroscopy, Spectrofluorimetry.
2. **Microscopy**: Light microscope, phase contrast microscope, fluorescence microscope, Electron Microscope (SEM & TEM).
3. **Immunological techniques** -Immunoprecipitation, Labelling antibodies, immunoblotting, immunoassays, immunohisto/cytochemistry.

Unit III: **Biosystematics (15 Hrs.)**

1. Taxonomy: Introduction to taxonomy, Stages and importance of taxonomy; Problems, Aim and Tasks of Taxonomy.

2. Modern Trends in Taxonomy: Morphological approach, immature stages and Embryological approach, Ecological, behavioural and Cytological approach, Biochemical and Numerical taxonomy.

3. Kinds of Classification.

Unit IV. Biostatistics in research (15 Hrs.)

1. Application of statistics in Biology.
2. Measures of Central tendency: Arithmetic mean, mode and median.
3. Measures of dispersion: Range, quartile deviation, mean deviation, Standard deviation, coefficient of variation.
4. Probability and Probability distribution - Introduction, addition and multiplication theory; Binomial, Poisson and Normal distribution.

5. Correlation and Regression
6. Hypothesis testing and test - Student t-test, Chi- square test ($\chi 2$), Analysis of Variance.

References Books:

1. Principles and Techniques in Biochemistry and Molecular Biology by Wilson and Walker
2. Cell: A molecular approach By Cooper
3. Molecular Biology of the Cell by Lodish *et al.*
4. Fundamentals of Statistics- Gupta S. C., 2018
5. Basic Biostatistics and its applications- Datta A. K
6. Biostatistics and Biometry- Parihar and Parihar, 2018
7. An Introduction to statistical Methods, (23rd Edt.) by C. B. Gupta and Vijay Gupta, 2009.
8. Biostatistics by S. K. Pundir, 2022.
9. Introduction to Biostatistics by Larry Winner, Department of Statistics, University of Florida.
10. Camp, W.H. (1951): Biosystematics Britania 7: 113 – 127.
11. Huxley, J.S. (ed.) The New Systematics Oxford Uiv. Press London 538 pp.
12. Jeffrey, C. (1977): Biological nomenclature Indian Ed. Oxford and IBH Pub. Co. New Delhi 72 pp.
13. Mayr, E. (1969): Principles of systematic in Zoology Mc. Graw Hill N.Y. 428 pp.
14. Mayr, E. and E.G. Linsley and R.L. Usinger (1953): Methods and Principles of systematic Zoology, Mc Graw Hill N.Y. 328 pp.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Practical (MMPR 103)

Course Code: MSU0325MMP939G
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Demonstrate subcellular macromolecules by using histochemical techniques.
CO2: Demonstrate cell organelles with organelle specific cytochemical techniques.
CO3: Identify pest of stored grans, veterinary animals and human importance for their proper management.
CO4: Appreciate biology of economically important insects.

Practical MMPR 103: Based on MMT-101 & MMT-102

1. Demonstration of extracellular material
    a. Collagen
    b. Elastin
2. Demonstration of Glycosaminoglycans in the extracellular material using
    a. AB-1
    b. AB-2.5
    c. PAS
3. Demonstration of Nucleus by

i) Basic Dyes: TB, HE, Methylene blue.
ii) Feulgen reaction: Effect of temperature,

4. Lysosome demonstration (Acid phosphatase and any other method)
5. Golgi bodies demonstration (Cajal Method)
6. Demonstration of mitochondria
7. Effect of tonicity of solutions on plasma membrane –
   a) Isotonic, Hypotonic, Hypertonic
   b) Fragility test of RBC & Osmotic Resistance.
8. Study of generalized insect. Identification economic importance of following insect pests (6-8 pests from each category)
9. Pests of stored gains.
10. Household pests.
11. Pests of medical importance.
12. Pests of veterinary importance.
13. Forest pests.
14. Types of silk moths.
15. Rearing appliances of mulberry silk worm and demonstration.
16. Study of forensic insects
17. Study of nutritional insects.
18. Life cycle and types of honey bees.
19. Lac insect economic importance.
20. Field visit for demonstration of pest damage.
21. Field visit for collection of insects.
22. Any other practical set by concern teacher.

M. Sc. Zoology (Part I) (Level-6.0) (Semester I)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Practical (MEPR 105)

Course Code: MSU0325MEP939G
Total Credits: 02

Practical MEPR 105: Based on MET 104 (As per the elective chosen by a student)

Cell Biology:

Course Outcomes: Upon successful completion of this course, Students will be able to
CO1: Separate, estimate, and determine various biomolecules.
CO2: Demonstrate various blotting techniques.

Practical:

1. Isolation of DNA
2. Isolation of RNA
3. Estimation of DNA
4. Estimation of RNA
5. Separation of DNA by Agarose gel electrophoresis

6. Separation of RNA by Agarose gel electrophoresis.
7. Spectrophotometric analysis of nucleotides.
8. Spectrophotometric analysis of amino acids.
9. Isolation of Histones
10. Estimation of Histones.
11. Demonstration of Histones.
12. Estimation of phosphate from isolated nucleic acids.
13. Separation of proteins by SDS-PAGE
14. Western blotting
15. Northern blotting
16. Southern blotting.
17. Isolation of plasmids.
18. Any other practical set by concerned teacher.

Animal Physiology:

Course Outcomes: Upon successful completion of this course …

CO1: Students will be able to understand Animal House, Physiology lab and Equipment's.

CO2: Enable students to study anatomy and histology of reproductive organs.

CO3: Students will be able to handle and operate animals.

CO4: Able to understand advanced reproductive technologies.

Practical:

1. Study of Equipment's used in Animal Physiology laboratory.
2. Study of different Animal Models for Physiology Experiments.
3. Introduction to Animal House, Breeding and Rearing.
4. Study of Anatomy of Vertebrate model RAT/ MICE.
5. Study of Reproductive Cycle by Vaginal smear technique in RAT/ MICE.
6. Study of Histology of Male and Female Reproductive System in RAT/ MICE.
7. Study of Skeletal, Cardiac and Smooth Muscles in RAT/ MICE.
8. Study of sperm count in RAT/ MICE
9. Study of placental type in different animals.
10. Study of operative procedure for i) Pancreatectomy ii) Gonadectomy iii) Hysterectomy.
11. Study of Action potential in sciatic nerve. (Chemical and Voltage).
12. Collection of CSF in RAT/ MICE.
13. Study of Contraceptive devices/ Birth control measures.
14. Estimation of Protein content of RAT/ MICE blood.
15. Estimation of Glycogen content of RAT/ MICE (All muscles and liver)
16. Study of body temperature by using thermometer.
17. Visit to the IVF laboratory.
18. Any other practical set by concerned teacher.

Entomology:

Course Outcomes: Upon successful completion of this course students will be able to
CO1: Collect, preserve insect specimens and prepare microscopic slide for identification and record.
CO2: Mount different appendages of insects

Practical:

1. Collection and preservation of insects.
2. Study of mouth parts in insects.
3. Study of antennae in insects.
4. Mounting of tentorium.
5. Study of types of wings in insects.
6. Study of types of legs in insects.
7. Study of abdominal appendages in Cockroach and Grasshopper.
8. Study of locally available insect orders with examples.
9. Any other practical set by concerned teacher.

Aquaculture and Fisheries:
Course Outcomes: Upon successful completion of this course, Students will be able to
CO1: Identify various food fishes and shellfishes.
CO2: Demonstrate induced breeding techniques in aquaculture and maintain healthy fish culture ponds.

Practical:

1. Identification of important food fishes, prawns and mollusks upto the species level (Freshwater and Marine)
2. Estimation of the rate of oxygen consumption in fish
3. Fecundity assessment in fish
4. Slides of different types of scale
5. Demonstration of induced breeding technique by ovaprim /ovatide.
6. Estimation of DO, CO_2, Alkalinity, Inorganic nitrate and Phosphate from water sample
7. Qualitative analysis of digestive enzymes
8. Any other practical set by concerned teacher.

Sericulture:
Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Understand various moricultural activities.
CO2: Understand collection, preservation and identification various pests of silkworm food plants.
Practical:

1. Demonstration of mulberry cultivation.
2. Preparation of mulberry saplings
3. Demonstration of pruning and application of chemical fertilizers
4. Preparation of herbarium of mulberry and non-mulberry host plants.
5. Study of anatomy of leaf, stem and petiole
6. Collection and preservation of mulberry pests
7. Study root and foliar diseases of mulberry
8. Any other practical set by the concerned teacher.

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Physiological chemistry (MMT 201)

Course Code: MSU0325MML939H1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand the basic principles of Physics and Chemistry applicable in biology.
CO2: Understand the Metabolism of carbohydrates and its energetics.
CO3: Understand the chemistry of amino acids, proteins and nucleic acids.
CO4: Understand metabolism of lipids and their physiological significance.

Unit I: Chemical foundations of Biology (15 Hrs.)
Structure of atom,
Types of bonds, Van der Waal's electrostatic forces of attraction, hydrophobic interactions.
Chemical structure and properties of water, pH, pKa, buffers,
Thermodynamics in biological system: Enthalpy, Entropy and Gibb's free energy.

Unit II: Carbohydrate metabolism (15 Hrs.)
Structure, classification and functions of carbohydrates,
Glycolysis, regulation and energetics,
TCA cycle, regulation and energetics,
Electron transfer system structure and mechanism of action, oxidative phosphorylation and ATP generation,
Glycogenesis, glycogenolysis and gluconeogenesis
Pentose phosphate pathway and its significance

Unit III: Amino acids, Proteins and nucleic acids (15 Hrs.)
Amino acids: Classification of amino acids, biosynthesis and Oxidation of amino acids.
Proteins: Protein structure and functions: Primary, secondary, tertiary and quaternary structure
Nucleic acids: Structure of nucleotides. Structure of DNA and RNA, De novo and salvage pathway of synthesis of nucleotides

Unit IV: Lipid metabolism (15 Hrs.)
Lipids- structure, classification and functions, Steroidal hormones: structure and functions.
Catabolism of fatty acid – Beta oxidation, Carnitine shuttle, Significance of beta oxidation. Bioenergetics of Beta oxidation
Biosynthesis of saturated and unsaturated fatty acids.
Biosynthesis of triglycerides,
Biosynthesis of membrane phospholipids.
Biosynthesis of cholesterol
Biosynthesis of prostaglandins and leukotriene Lipoprotein metabolism

Reference Books

1. Lehninger-Principles of Biochemistry: Nelson and Cox
2. Biochemistry:, Tymoczko, Berg, Stryer
3. Review of physiological chemistry: H. Harper

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Anatomy and Physiology (MMT 202)

Course Code: MSU0325MML939H2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Learn about anatomy of digestive system and nutrition.
CO2: Understand various concepts of respiratory physiology.
CO3: Understand various aspects of circulatory physiology.
CO4: Illustrate anatomy and physiology of excretory and endocrine organs.

Unit I: Physiology of Digestive System: (15 Hrs.)
1.1 Anatomy and physiology of gastrointestinal tract, Salivary gland, Pancreas and Liver.
1.2 Digestion and absorption in gastrointestinal tract
1.3 Balanced diet, obesity and starvation.
1.4 Vitamins and their role in nutrition.

Unit II: Physiology of Respiration: (15 Hrs.)
2.1 Anatomy and physiology, respiratory tract and pulmonary ventilation.
2.2 Pulmonary air volumes and capacities.
2.3 Exchange of Oxygen and carbon dioxide.
2.4 Control of respiration.

Unit III: Physiology of Circulation: (15 Hrs.)
3.1 Blood, Composition of blood, blood coagulation.
3.2 Blood groups and blood transfusion.
3.3 Anatomy and physiology Heart and blood vessels, Heart blood supply.
3.4 Conduction system and pace maker.
3.5 Electrocardiogram, Cardiac Cycle and heart sound.

Unit IV: Physiology of Excretion and Endocrine System: (15 Hrs.)
4.1 Anatomy and physiology of the kidneys, nephron and mechanism of urine formation.
4.2 Urinary bladder, process of micturition, Hemodialysis and Artificial kidney.
4.3 Anatomy and physiology of Pituitary gland and Adrenal gland.
4.4 Anatomy and physiology of Thyroid and Parathyroid gland.

Reference:

1. Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.

3. Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C. (eds) American Physiological Society, 1984.
5. Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.
6. Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co- Cartiar output & its regulation 1973.
7. Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
8. Guyton A.C. et al 1975 Dynamics & Control of the Body fluids Philadelphia, W.B. Saunders, Co., 1975.
9. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.
10. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University press.
11. Johnson L.R. et al Physiology of the gastrointestinal tract 1987 New York Raven press.
12. Thompson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
13. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
14. Guthrie H.A. 1988. Introductory Nutrition 7th ed. St. Lonis C.V. Mosby Co.,
15. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your Mac Graw- Hill Book Co.,
16. DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. Saunders Co. 1989.
17. Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Developmental Biology (MET 204)

Course Code: MSU0325MEL939H1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand the fundamentals of basic concepts of development of animals
CO2: Appreciate the molecular basis of gametogenesis, fertilization and mechanism of blastulation.
CO3: Understand the process of gastrulation and neurulation
CO4: Appreciate animal development at molecular and genetic level.

Unit – I: **(15 Hrs.)**

An introduction to developmental biology:

Introduction, features of animal development, eukaryotic heritage, development among the unicellular eukaryotes, control of developmental morphogenesis and differentiation, origin of sexual reproduction, colonial eukaryotes, the evolution of differentiation, developmental pattern among metazoans

Unit - II: Gametogenesis, fertilization and early embryonic development (15 Hrs.)

Production of gametes,
Cell surface molecules in sperm-egg recognition in animals,

Process of fertilization, cleavage,
Blastulation in sea urchin, Amphioxus, Zebra fish, frog, chick and mammal.
Implantation in mammals

Unit – III: Gastrulation and Neurulation (15 Hrs.)

a. Gastrulation and formation of germ layers in sea urchin, frog, birds, reptiles and mammals;
b. Molecular mechanism of left –right axis formation- in amphibian, mammal and reptile
c. Neurulation-body segmentation, Hox gene control development

Unit – IV: Morphogenesis and organogenesis in animals (15 Hrs.)

a. Cell aggregation and differentiation in *Dictyostelium*- Life cycle of Dictyostelium, cell-cell signaling, cell adhesion molecules in *Dictyostelium*
b. Axes and pattern formation in *Drosophila*-Development of fruit fly, maternal effect gene,
c. Organogenesis – vulva formation in *Caenorhabditis elegans*-cell-cell interactions and chance in the determination of cell types
d. Eye lens induction- Cascades of induction –reciprocal and sequential inductive events

References

1. Developmental Biology By Gilbert
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York.
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London
4. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley & sons.
5. Cell & Molecular Biology by E.D.P. De Robertis

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) AUTONOMOUS
(Introduced from Academic Year 2024-25)

Title of Course: Applied Physiology (MET 204)

Course Code: MSU0325MEL939H2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Appreciate aspects of environmental physiology.
CO2: Understand various aspects of exercise physiology.
CO3: Explain basics concept of ergonomics and occupational physiology
CO4: Understand the ergonomics of various Equipment's.

Unit - I: Environmental Physiology 15 Hrs.

1.1. Physiology of high altitude.
1.2. Space Physiology and Weightlessness.
1.3. Physiology of deep sea diving.
1.4. SCUBA and its bio-applications.

Unit - II: Exercise Physiology **15 Hrs.**

2.1. Fundamental of physical and mental exercise.
2.2. Energy for exercise - Aerobics and Anaerobics.
2.3. Exercise physiology- Muscles in exercise, Respiratory exercise, Cardiovascular system exercise, Nervous system exercise and thermodynamics of exercise
2.4. Hormonal changes and exercise.
2.5. Exercise, meditation and mental health.

Unit - III: Ergonomics of Bio-equipment's **15 Hrs.**

3.1 Laboratory equipment's- Ergonomics and its applications.
3.2 Ergonomic working and applications of Sphygmomanometer, ECG and TMT.
3.3 Ergonomic working and applications of Spirometer and Grip ergometer.
3.4 Ergonomic working and applications of Ultrasound and C. T. Scan.
3.5 Ergonomic working and applications of Endoscopy and tissue biopsy.
3.6 Ergonomic working and applications of MRI and EEG.

Unit – IV: Ergonomics and Occupational Physiology **15 Hrs.**

4.1. Man- machine and working environment.
4.2 Occupational hazards or diseases and its management
4.3 Muscular atrophy and dystrophy.
4.4. Biological and mental stresses
4.5. Problems of Child labour.

Suggested Reading Material:

1. Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C. (eds) American Physiological Society, 1984.
5. Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.
6. Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co- Cartiar output & its regulation 1973.
7. Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
8. Guyton A.C. et al 1975 Dynamics& Control of the Body fluids Philadelphia, W.B. Saunders, Co., 1975.
9. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.
10. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
11. Johnson L.R. et al Physiology of the gastrointestinal tract 1987 New York Raven press.
12. Thompson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
13. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
14. Guthrie H.A. 1988. Introductory Nutrition 7th ed. St. Lonis C.V. Mosby Co.,
15. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your Mac Graw- Hill Book Co.,
16. DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. Saunders Co. 1989.

17. Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Insect Anatomy and Physiology (MET 204)

Course Code: MSU0325MEL939H3
Total Credits: 04
Course Outcomes: Upon successful completion of this course,

CO1: Students will understand the integument and anatomy, physiology of the digestive system of insects

CO2: Students will understand the respiratory, circulatory and excretory system of insects.

CO3: Students will understand the nervous and endocrine system of insects.

CO4: Students will understand the reproductive system and embryonic development of insects.

Unit – I: **(15 Hrs.)**

1. THE INTEGUMENT:

1. Structure of Integument.
2. Physiology of Integument.
3. Functions of Integument.

2. DIGESTIVE SYSTEM AND ITS PHYSIOLOGY

1. The Alimentary canal and associated glands.
2. Digestion and Absorption
3. Enzyme dynamics.

Unit – II: **(15 Hrs.)**

1. RESPIRATION

1. Organs of Respiration- Tracheae, Tracheoles, Airsacs and Spiracles.
2. Types of tracheal systems.
3. Mechanism of gaseous exchange within tracheole
4. Respiration in aquatic and parasitic insects.

2. CIRCULATION

1. Structure of Circulatory organs- Dorsal vessel and Accessory pulsatile structures.
2. Haemolymph- Composition and function.
3. Haemocytes- Types and function.
4. Mechanism of Circulation.

3. EXCRETION

1. Excretory organs – Malpighian tubules and other excretory structure.
2. Physiology of Excretion
3. Osmoregulation.

Unit – III: **(15 Hrs.)**

1. NERVOUS SYSTEM

1. Neuron- structure and type
2. Central nervous system.
3. Physiology

2. ENDOCRINE SYSTEM.

1. Endocrine organs.
2. Neurosecretory cells
3. Hormones and their functions

Unit – IV: **(15 Hrs.)**

1. REPRODUCTION.

1. Male Reproductive system.
2. Female Reproductive system.
3. Physiology and reproduction.

2. EMBRYONIC DEVELOPMENT

1. Cleavage and Blastoderm Formation.
2. Formation and Growth of germ band.
3. Gastrulation.
4. Formation of amnion
5. Segmentation

Suggested Readings:

1. Ambrose, D.P., 2015. The Insects. Structure, Function and Biodiversity. Kalyani publishers, New Delhi. 626pp.
2. Chapman, R. F. (1998). The Insect structure and function, 4th Ed. Cambridge University Press, UK. PP 747.
3. Gillot, C. (1980). Entomology, 3rd Ed. Plenum Press, New York ,pp 730 .
4. Gullan, P. G. and Cranston, P. S., 2010. The insects. An outline of Entomology. Wiley Blackwell. pp. 565.
5. Mani, M. S. (1968). General Entomology. Oxford & IBH Publishing Co., pp 597.
6. Snodgrass, R. E. (1935). Principles of Insect Morphology, Tata Mc Graw -Hill, New York. pp 667.
7. Tembhare, D. B (2013). Modern Entomology. Himalaya Publishing House, India. pp 502.
8. Wigglesworth, V.B., 1939. The principles of Insect Physiology. Sixth ed. Methuen and Co. Ltd., London. pp 741.

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Fish Pathology and Reproductive Endocrinology (MET204)

Course Code: MSU0325MEL939H4
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand fish diseases and their management
CO2: Utilize the knowledge of larvivorous fish in relation to public health
CO3: Understand the effect of aquatic pollutants on fish health.
CO4: Appreciate fish reproduction and its hormonal regulation.

Unit - I: Fish Pathology and Cure **(15 Hrs.)**

Signs of sickness in fishes, defensive devises in fishes against diseases, diseases of fishes, intrinsic causes of diseases, diseases caused by pathogens and parasites; their symptoms and treatments

Unit - II: **(15 Hrs.)**

A. Larvivorous Fish about Public Health:
Essential characters of Larvicidal Fish, Larvicidal fishes in India, Classification of Fishes based on Mosquitocidal activity

B. Aquatic Pollution:
Introduction, water pollution: causes and types, Major sources of aquatic pollution and their effects on fish and fisheries

Unit - III: **(15 Hrs.)**

A. Fish Health in Relation to Environment:
Abiotic factors influencing disease outbreak in fish, Effect of industrial waste on diseases and pathogens; Effect of agriculture waste on diseases and pathogens, Effect of pesticides substances on fish in relation to water quality.

B. Epizootic Ulcerative Syndrome (EUS):
History and areas affected by EUS, spread of disease and fish species affected, Present state of knowledge of EUS, Extension of range and human significance, Recommendations for treatment, Socio-economic impact of EUS.

Unit - IV: **(15 Hrs.)**

Reproductive Endocrinology:
Pituitary gonadotropins: role of gonadotropins in pre-spawning behaviour, role of gonadotropins in spawning behavior, Hormonal regulation in fish reproduction

Suggested reading material:

1. Fish physiology (Vol.I to XII): W.S. Hoar and D.J. Randall.
2. Fish endocrinology: A.J. Matty.
3. Fishery science: W.F. Royce.
4. Introduction to fishes: S.S. Khanna.
5. Pond fisheries: F.G. Martyshev.
6. Fresh water fishery biology: K.F. Lagler.
7. Coastal Ecosystem management: John Clark.
8. Applied Fishery Science Vol. I & II : S.M. Shafi.

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Silkworm Biology & Rearing Technology (MET 204)

Course Code: MSU0325MEL939H4
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand biology of various silkworms.
CO2: Illustrate anatomy and physiology of silkworm.
CO3: Appreciate rearing and management of silkworms.
CO4: Understand various silkworm diseases and their management.

Unit - I: Silkworm Biology **(15 Hrs.)**

Classification and Geographical distribution of Silkworm races
Life cycle of mulberry silkworm
Life cycle of non-mulberry silkworms
Eri, Muga and Tasar

Unit - II: Anatomy and Physiology of mulberry silkworm **(15 Hrs.)**
Digestive system, Circulatory system, Excretory system,
Nervous system, Respiratory system,
Reproductive system and Endocrine system
Anatomy, silk gland structure and function

Unit - III: Rearing technology and management practices **(15 Hrs.)**
Principles of silkworm rearing, Environmental conditions for silkworm rearing
Rearing Equipments, Management of rearing house and disinfection
Types of rearing houses, Types of silkworms and methods of commercial rearing
Chawki Rearing concept, shoot feeding and shelves rearing technology

Unit - IV: Silkworm diseases and management (15 Hrs.)

Protozoon diseases, Bacterial diseases, Viral diseases, Fungal diseases and their management practices Pests, Predators, Parasites of mulberry and non-mulberry silkworm and management

Suggested Reading Material:

1. Sarkar, D.C. (1988): Ericulture in India, CSB, Bangalore.
2. Annual report of Central Sericultural Research and Training Institute, Mysore.
3. Annual report of Central Sericultural Research and Training Institute, Bangalore.
4. Annual report of Central Tasar Research Institute, Ranchi.
5. Annual report of Central Muga Research Institute, Assam.
6. A Treatise on acid treatment of silkworm eggs, CSR and TI, Mysore.
7. Tips for successful silkworm cocoon crops, CSR and TI, Mysore.
8. Tips for successful bivoltine silkworm cocoon crops, CSR and TI, Mysore.
9. M.V. Samson, Chandrashekharaih, P. Gowde and Saheb B. (1995): Monograph on silkworm loose egg production, SSTC, CSB, Bangalore.
10. FAO, Volumes (1-4), Central Silk Board, Bangalore

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Practical (MMPR 203)

Course Code: MSU0325MMP939H
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Estimate biomolecules from biological materials.
CO2: Find out Bleeding time, clotting time, Hb%,
CO3: Determine physiologically important parameters such as breathing rate, heart beat, heart sounds
CO4: Understand the histology of digestive organs and endocrine glands

Practical MMPR-203: Based on MMT-201 & MMT-202

1. Estimation of glycogen.
2. Estimation of lipids & phospholipids.
3. Estimation of Vitamin C.
4. Estimation of Cholesterol.
5. To find saponification value for a given fat.
6. Preparation of phosphate buffer pH measurement.
7. To estimate free amino acids by Ninhydrin method.
8. To estimate protein content by Biuret method/ Lowry et.al./ Bradford method.
9. Estimation of glucose.
10. Estimation of casein from milk.
11. Estimation of Uric acid
12. Extraction of Starch.

13. Extraction of Glycogen.
14. Determination of Bleeding time
15. Determination of Clotting time
16. Estimation of Hemoglobin (Hb) concentration and oxygen carrying capacity
17. Enumeration of Red blood corpuscles (R.B.C)
18. Enumeration of white blood corpuscles (W.B.C)
19. Differential count of W.B.C.
20. Erythrocyte sedimentation rate (E.S.R)
21. Detections of digestive enzymes
22. Anatomy and histology of digestive and endocrine glands
23. To estimate amylase from saliva
24. To study normal constituents of urine
25. Measurement of breathing rate, heart beat and study of heart sound.
26. Any other practical set by the concerned teacher

M. Sc. Zoology (Part I) (Level-6.0) (Semester II)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Practical (MEPR 205)

Course Code: MSU0325MEP939H
Total Credits: 02
Course Outcomes: Upon successful completion of this course

Practical MEPR 205 Based on Elective MET 204

Cell Biology:

Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Understand the early embryonic development
CO2: Demonstrate organogenesis in Chick embryo.
CO3: Demonstrate Angiogenesis in chick embryo and effect of various chemicals on development.
CO4: Demonstrate regenerative potential of liver.

1. Study of eye lens differentiation in chick embryo.
2. Study of nervous system development in chick embryo.
3. Study of Angiogenesis in chick embryo.
4. Study of Dorsal nerve root development in chick embryo
5. Effect of colchicine on development of dorsal nerve root in chick embryo
6. Demonstration of stem cells
7. Study of gastrulation in amphioxus and frog
8. Study of partial hepatectomy in mice.
9. Any other experiments / practical set by the Department.

Animal Physiology

Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Estimate ions and other biochemical compounds of physiological importance.

CO2: Demonstrate physical fitness by using various techniques.
CO3: Understand the man machine environment
CO4: Know ergonomic principles at work.

Practicals:

1. To determine atmospheric pressure of air.
2. Determination of Peak Expiratory and Inspiratory Flow rate.
3. Study of Physical fitness by Step Test method
4. Determination of Grip strength.
5. To study effect of work load on finger muscle by Finger Ergometer.
6. To find out Blind spot of eyes.
7. Study of dermatoglyphics of Fingers and Palm.
8. Estimation of lactate content of RAT/ MICE blood
9. Estimation of Chloride content in rat blood.
10. Estimation of calcium content of RAT/ MICE blood.
11. Study of bio-equipment and their ergonomics features.
12. Visit to the industrial area to study man- machine environment.
13. Any other practical set by concerned teacher.

Entomology:

Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Understand physiology of insects with respect to various systems.
CO2: Understand haemocytes in insects.
CO3: Understand role of Malpighian tubules in excretion.
CO4: Understand respiration in insects.

1. Dissection of any pest to study the digestive, nervous and reproductive systems.
2. Study of Total Haemocyte Count (THC) in insects.
3. Study of Differential Haemocyte Count (DHC) in insects.
4. Chromatographic analysis of amino acids in insect haemolymph/any tissue.
5. Estimation of digestive enzymes in insects (amylase/invertase/trehalase).
6. Study of uptake of dyes in Malpighian tubules.
7. Study of phagocytosis in insect haemocytes.
8. Determination of moisture given out by insects during respiration.
9. Qualitative estimation of nitrogenous waste products in the excreta of Cockroaches.
10. Any practical set by the concerned teacher.
11. Project Work.

Aquaculture and Fisheries

Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Identify various diseases of fish.
CO2: Identify the sexual dimorphism in fish.
CO2: Conduct toxicity bioassays in fishes.
CO4: Extend consultancy services to fish farmers.

1. Identification of diseased fish – Bacterial, fungal and viral infections (Slides)
2. Blood glucose estimation in fish
3. Sexual dimorphism and secondary sexual characters in fishes
4. Short term bioassay of LC50 determination (Demonstration)
5. Field trips and study tours to fish farms, fisheries institute, or national laboratory etc..
6. Any practical set by the concerned teacher / Department.

Sericulture:

Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: Demonstrate various systems of silkworms.
CO2: Demonstrate the life cycle of mulberry and non-mulberry silkworms
CO3: Demonstrate the rearing of mulberry and non-mulberry silkworms.
CO4: Demonstrate silk gland of mulberry and non-mulberry silkworms

1. Morphology of egg, larva, pupa and adult of mulberry and non-mulberry silkworms
2. Dissection of Digestive system of silkworm
3. Dissection of Nervous system of silkworm
4. Dissection of Circulatory system of silkworm
5. Dissection of male reproductive system of silkworm
6. Dissection of female reproductive system of silkworm
7. Mounting of silk gland
8. Rearing of silkworm to study its life cycle.

9. Scheme of Teaching

a. Each unit in theory course shall comprise 15 lectures, each of 60 minutes duration and there shall be four lectures per theory course per week.
b. Each practical course shall be of four hours duration.

10. Examination Pattern

Theory:

Theory examinations will be conducted **semester wise.**
a. Entire programme of M. Sc. Zoology will be of **2200** marks. Every Semester will be of 550 marks.
b. Examination of each 4 credits **theory course** shall be of **100 marks** (80 university examination + 20 internal assessment).
c. University examination of 80 marks (3 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.

Practical:

a. Practical examinations will be conducted **Semester wise.**

b. Practical Examination of each major mandatory practical course shall be of 100 marks for 4 credits. Practical examination of major elective practical course will be of 50 marks for 2 credits.

On Job Training: OJT MSU0325OJ939H

On job training shall be of 100 marks for 4 credits. 70 marks will be for completion and submission of its report and 30 marks will be for presentation.

Field Project: FP MSU0325FP939H

Field project shall be of 100 marks for 4 credits. 70 marks will be for completion and submission of its project report and 30 marks will be for presentation.

Research Methodology: RM MSU0325RML939G

Research methodology course will be of 100 marks for 4 credits (80 marks university examination + 20 marks Internal assessment). The theory examination will be of 3 hours duration.

11. Nature of Question Paper and Scheme of Marking

Theory:

Pattern of question paper for MMT, MET and RM course.

There will be five descriptive type questions, each question carrying 16 marks.

Que. 1 Descriptive Question from Unit I 16
OR
Descriptive Question from Unit I

Que. 2 Descriptive Question from Unit II 16
OR
Descriptive Question from Unit II

Que. 3 Descriptive Question from Unit III 16
OR
Descriptive Question from Unit III

Que. 4 Descriptive Question from Unit IV 16
OR
Descriptive Question from Unit IV

Que. 5 Write notes on (Any two) 16
a. From Unit I
b. From Unit II
c. From Unit III
d. From Unit IV

For passing in MMT, MET and RM courses, student must score minimum 32 marks out of 80 in theory examination.

Practical:

Practical MMPR 103 based on MMT101 and MMT102,	**100 marks**
Que. 1 Experiment/Experiments Based on **MMT101**	20
Que. 2 Experiment/Experiments Based on **MMT101**	20
Que. 3 Experiment/Experiments Based on **MMT102**	20
Que. 4 Experiment/Experiments Based on **MMT102**	20
Que. 5 *Viva voce*	10
Que. 6 Journal	10

For passing in MMPR103, student must score minimum 40 marks out of 100 in practical examination

Practical MEPR 105 based on MET-104	**50 marks**
Que. 1 Experiment/Experiments Based on MET 104	20
Que. 2 Experiment/Experiments Based on MET 104	20
Que. 5 *Viva voce*	05
Que. 6 Journal	05

For passing in MEPR105, student must score minimum 20 marks out of 50 in practical examination

Practical MMPR 203 based on MMT201 and MMT202,	**100 marks**
Que. 1 Experiment/Experiments Based on **MMT201**	20
Que. 2 Experiment/Experiments Based on **MMT201**	20
Que. 3 Experiment/Experiments Based on **MMT202**	20
Que. 4 Experiment/Experiments Based on **MMT202**	20
Que. 5 *Viva voce*	10
Que. 6 Journal	10

For passing in MMPR 203, student must score minimum 40 marks out of 100 in practical examination

Practical MEPR 205 based on MET 204:	**50 marks**
Que. 1 Experiment/Experiments Based on MET 204	20
Que. 2 Experiment/Experiments Based on MET 204	20
Que. 5 *Viva voce*	05
Que. 6 Journal	05

For passing in MEPR 205, student must score minimum 20 marks out of 50 in practical examination

12. Equivalence of courses

M. Sc. Part I (Semester I and II)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Credit**	**Course Code**	**Title of New Course**	**Credit**
I	CC-103	Molecular Cell Biology	4	**MSU0325MML939G1**	Molecular Cell Biology	4
I	CC-102	Applied Entomology	4	**MSU0325MML939G2**	Applied Entomology	4
I	CCS-203	Molecular Biology of the Gene	4	**MSU0325MEL939G1**	Molecular Biology of the Gene	4
I	CCS-203	Animal Physiology	4	**MSU0325MEL939G2**	Animal Physiology	4
I	CCS-203	Basic Entomology	4	**MSU0325MEL939G3**	Basic Entomology	4
I	CCS-203	Fisheries Resources: Inland and Marine Fisheries	4	**MSU0325MEL939G4**	Fisheries Resources: Inland and Marine Fisheries	4
I	CCS-203	General Sericulture and Mulberry cultivation	4	**MSU0325MEL939G5**	General Sericulture and Mulberry cultivation	4
I	CCPR-205	Practical -I	4	**MSU0325MMP939G**	Practical – MMPR 103 based on MMT 101 and MMT 102	4
I	CCPR- 305	Practical III	4	**MSU0325MEP939G**	Practical – MEPR 105 based on MET 104	2
I	CC-101, CC-202	Bioinstrumentation and Biostatistics + Biosystematics	4+4 = 8	**MSU0325RML939G**	Research Methodology	4
II	CC-201	Physiological Chemistry	4	**MSU0325MML939H1**	Physiological Chemistry	4
II	CC-203	Anatomy and Physiology	4	**MSU0325MML939H2**	Anatomy and Physiology	4
II	CCS-204	Developmental Biology	4	**MSU0325MEL939H1**	Developmental Biology	4
II	CCS-204	Applied Physiology	4	**MSU0325MEL939H2**	Applied Physiology	4
II	CCS-204	Agricultural Entomology	4	**3rd Sem MSU0325MEL939H3**	Agricultural Entomology	4
II	CCS-204	Fish Pathology and Reproductive Endocrinology	4	**MSU0325MEL939H4**	Fish Pathology and Reproductive Endocrinology	4
II	CCS-204	Silkworm Biology & Rearing Technology	4	**MSU0325MEL939H5**	Silkworm Biology & Rearing Technology	4
II	CCPR-206	Practical II	4	**MSU0325MMP939H**	Practical – MMPR 103 based on MMT 201 and MMT 202	4
II	CCPR -406	Practical IV	4	**MSU0325MEP939H**	Practical – MEPR 205 based on MET 204	2

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Semester III and IV

Introduced from Academic Year 2025-26

5. Programme Structure : Semester III and IV

Structure in Accordance with National Education Policy - 2020
With Multiple Entry and Multiple Exit Options
M.Sc. (Zoology) Part – II (Level-6.5)
AUTONOMUS

Semester III (Duration- Six months)										
	Teaching Scheme				Examination Scheme					
	Theory and Practical				University Assessment (UA)			Internal Assessment (IA)		
	Course code	Lectures (per week)	Hours (per week)	Credit	Maximum marks	Minimum marks	Exam Hours	Maximum marks	Minimum marks	Exam Hours
Major Mandatory	MMT-301	4	4	4	80	32	3	20	8	1
	MMT-302	4	4	4	80	32	3	20	8	1
	MMPR-303	-	8	4	100	40	6	-	-	-
Major Elective	MET-304	4	4	4	80	32	3	20	8	1
	MEPR 305	-	4	2	50	20	3	-	-	-
Research Project	RP 306	-	8	4	100	40	6	-	-	-
TOTAL (Sem-III)		-	32	**22**	490	-	-	60	-	
Semester IV (Duration Six Months)										
Major Mandatory	MMT-401	4	4	4	80	32	3	20	8	1
	MMT-402	4	4	4	80	32	3	20	8	1
	MMPR-403	-	8	4	100	40	6	-	-	-
Major Elective	MET-404	4	4	4	80	32	3	20	8	1
Research Project	RP405	-	12	6	150	60	9	-	-	-
TOTAL (Sem -IV)		12	32	22	490	-	-	60	-	-
Total (Sem III + Sem IV)		-	-	44	980	-	-	120	-	-

<table>
<tr><td>• MMT – Major Mandatory Theory
• MMPR – Major Mandatory Practical
• MET – Major Elective Theory
• MEPR – Major Elective Practical
• RP - Research Project</td><td>• Total Marks for M.Sc.-II : 1100
• Total Credits for M.Sc.-II (Semester III & IV): 44
• Separate passing is mandatory for University and Internal Examinations</td></tr>
<tr><td colspan="2">RP405 includes 10 marks for seminars, 10 marks for Study tour, 50 marks for examination of experimental work based on elective MME403, 80 marks for evaluation of the project report by the external examiner.</td></tr>
<tr><td colspan="2">• Requirement for Entry at Level 6.5: the student who exits after level 6.0 may join M. Sc. Part II (level 6.5) within next five year after exit.</td></tr>
</table>

6. Programme Outcomes (POs)

PO1: Apply the knowledge of zoology in day today life.

PO2: Students are able to understand animals from their sub-cellular to ecosystem level.

PO3: Gain knowledge of agro based entrepreneurship like Sericulture, aquaculture, apiculture and lac culture for providing lab-to-land benefits to Society.

PO4: Students are able to frame hypothesis, design experiment, analyse data & generate conclusions.

PO5: Students are able to work to work in animal cell culture lab, taxonomy, able to operate different instruments in biological sciences like toxicity studies.

PO6: Students are able to work in different fields of biological sciences like animal cell culture, toxicology, enzymology, bio-instrumentation and taxonomy.

PO7: Students are able to address societal issues like pollution, health awareness, pest-parasite management and biodiversity conservation.

PO8: Students are able to gain knowledge on applied science and its application to sustainable development.

7. Course Codes

M.Sc. Semester - III		
Sr. No.	**Major Mandatory**	
MMT301	Genetics (4 credits)	**MSU0325MML939I1**
MMT302	Enzymology (4 credits)	**MSU0325MML939I2**
MMPR 303	Practical MMPR 303 based on MMT 301 and MMT 302 (4 credits)	**MSU0325MMP939I**
MEPR 305	Practical MEPR 305 based on MET 304 (2 credits)	**MSU0325MEP939I**
RP 306	Research Project (4 credits)	**MSU0325RP939I**
MET 304	**Major Elective**	
	Immunology	**MSU0325MEL939I1**
	Physiology of Health	**MSU0325MEL939I2**
	Agricultural Entomology	**MSU0325MEL939I3**
	Aquaculture Practices	**MSU0325MEL939I4**
	Cytogenetics and Breeding of silkworm	**MSU0325MEL939I5**
M.Sc. Semester - IV		
	Major Mandatory	
MMT401	Animal Cell Culture (4 credits)	**MSU0325MML939J1**
MMT402	Toxicology (4 credits)	**MSU0325MML939J2**
MMPR 403	Practical MMPR 403 based on MMT 401 and MMT 402 (4 credits)	**MSU0325MMP939J**
RP 405	Research Project (6 credits)	**MSU0325RP939J**
MET 404	**Major Elective**	
	Cell Pathology	**MSU0325MEL939J1**
	Clinical Physiology	**MSU0325MEL939J2**
	Pest Management Concepts	**MSU0325MEL939J3**
	Fishery Technology	**MSU0325MEL939J4**
	Silkworm seed, silk production technology and Economics	**MSU0325MEL939J5**

8. Syllabus

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Genetics (MMT 301)

Course Code: MSU0325MML939I1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to:
CO1 understand the basics of human chromosome and molecular basis of sex determination
CO2 understand how bacteria acquire resistance against antibiotics and bacteriophages, basics of population genetics.
CO3: understand the molecular mechanism of mutation with suitable genetic examples.
CO4: Able to upgrade different perspectives of Genetic counseling.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)

Title of Course: Genetics

Unit –I: Human Cytogenetics (15 Hrs.)

1. Human karyotype - banding, nomenclature
2. Techniques in human chromosome analysis
3. Numerical abnormalities of human chromosomes and related syndrome Nondisjunction, Aneuploidy, Patau syndrome, Edward syndrome, Down syndrome, Turner syndrome and Klinefelter syndrome
4. Genetic basis of sex determination in human beings.
5. Dosage compensation
6. Androgen Insensitivity Syndrome.

Unit- II: Microbial Genetics and Population Genetics (15 Hrs.)

1. Horizontal gene transfer in bacteria by conjugation, transformation and transduction
2. Acquisition of antibiotic resistance
3. Acquisition of Defence against bacteriophages
4. Hardy- Weinberg principle, Genetic drift, Genetic pool.

Unit- III: Mutations (15 Hrs.)

1. Introduction to the mutation- Types with examples.
2. Molecular basis of mutation-Radiation, Chemical and Biochemical Mutations.
3. Pleiotropy with examples.
4. Back mutation and Suppressor mutation.
5. Mechanisms of DNA repair.
6. Mutagenicity and carcinogenicity.

Unit- IV-Genetic counseling (15 Hrs.)

1. Introduction, Prospective and retrospective Genetic counselling.
2. Ethical aspects of Genetic Counselling.
3. Psychological approach in genetic counselling.
4. Family pedigree, symbols and types.
5. Prenatal Genetic Testing: Preimplantation Genetic Diagnosis, Chorionic Villus sampling,

Amniocentesis.

6. Modern lifestyle and acquired genetic defects.

Suggested Reading Material:

1. Concepts of Genetics By Klug and Cummings
2. Principles of Genetics By Tamarind
3. Genetics By Strickberger
4. Facts of Genetics By Robert Edger
5. Introduction to biochemical genetics By Mather and Jinks
6. Molecular Genetics By Gunther Stint
7. Principles of Genetics By Peter, Snustad and Michael
8. Genetics of population by Philip Hedrick
9. Principles of Population Genetics ByHartl and Clark
10. Gene Clones By Ernst Winnacker

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Enzymology (MMT 302)

Course Code: MSU0325MML939I2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, Students will be able to

CO1: Understand the nomenclature and classification of enzymes and cofactors.

CO2: Understand the purification techniques and enzymes structure.

CO3: Understand the enzyme kinetics and factors affecting the kinetics.

CO4: Understand the organization of enzymes and their industrial applications.

Unit- I: **(15 Hrs.)**

1. Nomenclature and Classification of Enzymes, Isoenzymes, Multienzyme Complexes.
2. Cofactors.- Inorganic, Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiamine diphosphate, Flavin nucleotides, Nicotinamide.

Unit- II: **(15 Hrs.)**

1. Purification of Enzymes: Objectives and strategies, Methods of separation: Centrifugation, Dialysis, Gel-filtration, Ion Exchange chromatography, Electrophoresis, Isoelectric focusing, Affinity chromatography.
2. Structure of Enzymes- Primary, Secondary, tertiary and quaternary, Active sites and Allosteric sites, Structure of chymotrypsin.

Unit- III: **(15 Hrs.)**

1. Enzyme Kinetics -Michaelis Menten equation., Briggs Haldane Hypothesis., The Line Weaver Burk Plot, The Halden relationship for reversible reaction, Effect of inhibitors on enzyme Kinetics, Effect of temperature, Thermal denaturation, Effect of pH on enzyme kinetics.
2. Enzyme Actions of Chymotrypsin, Fructose bisphosphate aldolase.

Unit- IV: **(15 Hrs.)**

1. Enzymes in Organized System- RNA nucleotidyl transferase, Pyruvate dehydrogenase.
2. Enzyme Technology- Use of microorganisms in brewing and cheese making
   Use of microorganisms in production of organic chemicals.
   Enzyme immobilization and immobilization techniques

Suggested Reading Material:

1. Fundamentals of Enzymology: Price N.C. and L. Stevens e.. Oxford, New York.
2. Dixon, M., Webb, E.C. (3rd Ed.) Longman, London.
3. Methods in Enzymology all volumes.
4. Scopes, R.K. Protein Purification, Principles and PracticeFerdinand, W. (1976) fundamentals of enzyme kinetics, Butterworths, London.
5. Enzyme by Palmer.
6. Niggins, I.J. Best D.J. and Jones, J. Biotechnology – Principles and applications, Black well, scientific oxford (1985).
7. Bulock, J. and Kristiansen, B- (1987) Basic biotechnology.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Immunology (MET 304)

Course Code: MSU0325MEL939I1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, student will be able to
CO1: understand the fundamentals of immune system and role and mechanism of defense cells and organs
CO2: Illustrate the significance of antigens, antibodies, complements, MHCs, cytokines and chemokines in immune functions.
CO3: Understand the different types of hypersensitivity reactions
CO4: Gain knowledge of mechanism of maturation, activation and differentiation of T and B cells.

Unit – I: Overview of Immune system **(15 Hrs.)**

1. Immune system- Innate and adaptive immunity.
2. Organs of Immune System- Primary Lymphoid Organs, Secondary Lymphoid Organs
3. Cells involved in immune response-Lymphoid Cells, B-lymphocytes, T-lymphocytes, Natural Killer Cells, Mononuclear Phagocytes, Granulolytic Cells, Mast Cells, Dendritic Cells

Unit – II: Molecules involved in immune functions **(15 Hrs.)**

1. Antigens: nature, epitope, haptens.
2. Antibodies: structure, classes and biological activity, molecular basis of antibody diversity, monoclonal antibodies.

3. The complement system.
4. Major histocompatibility complex and antigen presentation
5. Cytokines and chemokines,
6. Molecular basis of transplant rejection.
7. Tumor immunology

Unit – III: Hypersensitivity Reactions (15 Hrs.)

1. Classification of Hypersensitivity Reactions.
2. IgE- Mediated (Type I) Hypersensitivity.
3. Antibody-Mediated Cytotoxic (Type II) Hypersensitivity.
4. Immune Complex-Mediated (Type III) Hypersensitivity.
5. Type IV or Delayed- Type Hypersensitivity (DTH)

Unit – IV: T and B-Cell maturation, activation and differentiation (15 Hrs.)

1. T Cell maturation-Thymic selection of the t-cell repertoir
2. T -Cell Activation-TCR mediated signalling, effector and memory T cells
3. T cell differentiation- effector and memory T cells
4. B Cell maturation-Progenitor B cell proliferation
5. B -Cell Activation-signal drive in B cells
6. B cell differentiation-cellular events within germinal centers, induction

Suggested Reading Material:

1. Kuby Immunology, WH Freeman, USA.
2. W Paul Fundamentals of Immunology.
3. I.M. Roitt, Essential Immunology, ELBS edition.
4. Roiff, I Brosfott, J and Male D – Immunology.
5. Sharma, J.M. : Avian Cellular Immunology.
6. Karger and Basel: The year of Immunology 1988.
7. Zapata A.G. and Co oper, E.L. The immune system.
8. Laurie Hoffman – Goetz : Exercise and immune function.
9. Cooper E.L and Brazier M.A.B : Immunology.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Physiology of Health (MET 304)

Course Code: MSU0325MEL939I2
Total Credits: 04
Course Outcomes: Upon successful completion of this course students will be:

CO1: able to understand pathological conditions of digestive system.

CO2: able to understand pathophysiology of special senses.

CO 3: able to understand basics of abnormalities in respiratory and circulatory system

CO 4: able to understand basics of blood defects.

Unit I- Pathophysiology of gastrointestinal system

1. Digestive glands.
2. Swallowing and oesophagus.
3. Stomach.
4. Small intestine
5. Appendix
6. Large intestine- constipation, diarrhoea, and defecation.

Unit II- Pathophysiology of Special senses

1. Hearing defects
2. Ocular defects
3. Hyperthermia and Hypothermia.
4. Defects in Chemoreception.

Unit III- Pathophysiology of respiratory and circulatory systems

1. Respiratory insufficiency- Chronic pulmonary Emphysema, Pneumonia, Atelectasis, Asthma, Tuberculosis.
2. Hypoxia, Hypercapnia, Hypocapnia.
3. Haemolysis and clotting defects
4. Congenital and Ischemic heart diseases,
5. Hypertension, cardiac arrest and heart failure.
6. ECG-defect, Angiogram and Angioplasty.

Unit IV - Pathophysiology of Blood, immunity and Viral Diseases

1. Genetic blood disorders
2. Polycythaemia and Leukaemia
3. Types of immunity and its mechanisms
4. Hypo and Hypersensitivity mechanism
5. Viral Diseases and epidemiological implications.

Suggested Reading Material:

16. Human Physiology – by A.C. Guyton. Saunders Company Londan, Toronto.
17. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
18. Hurst J.W et al (eds) The Heart7th ed. New York McGraw- Hill Book Co. 1990.
19. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Micbel, C.C. (eds) Americal Physiological Society, 1984.
20. Gayton A.C. et al. Circulation Overall regulation Annu Re. Physiol. 34: 13 1972.
21. Guyton A.C. 1980 Arterial pressure & Hypertension Philadelphia, W.B. Saunders Co- Cartiar output & its regulation 1973.
22. Kaplan N.M. et al 1989- The Kidney in Hypertension (Perspectives in hypertension vol.2) New York. Raven Press.
23. Guyton A.C. et al 1975 Dynamics& Control of the Body flerids Philadelphia, W.B. Saunders, Co., 1975.
24. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. SaundersCo., 1986.
25. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
26. Johnson L.R. et al Physiology of the gastrointestinal tract 1987 New York Raven press.

27. Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
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29. Guthrie H.A. 1988. Introductory Hutrition 7th ed. St.Lonis C.V. Mosby Co.,
30. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2024-25)

Title of Course: Agricultural Entomology (MET 304)

Course Code: MSU0325MEL939I3
Total Credits: 04
Course Outcomes: Upon successful completion of this course, Students would,

CO1: Gain knowledge of pests on Cereals and Pulses.
CO2: Become familiar with important pests of fruits and fruit trees.
CO3: Get acquainted with important pests of sugar cane, fibre crops, and oilseed crops.
CO4: Acquire knowledge on important Pests of vegetable crops

Unit –I: (15 Hrs.)

1. Definition of Pest, Types of pests, Economic Threshold Level, Economic Injury Level, causes for insects assuming pest status, Types of damage to plants by insects.

2. Pests of Cereals:
Paddy stem borers *Scirpophaga incertulas,* Paddy Grasshopper *Hieroglyphus banian,* Leaf hopper *Nephoettix nigropictus ,* Army worm *Mythimna separate,* Maize stem borers *Chilo partellus*, and blister beetle *Mylabris pustulata*.

3. Pests of pulses:
Gram pod borer *Helicoverpa armigera*, Greasy cutworms *Agrotis epsilon*, Turplume moth *Exelastis atmosa*, Turpod bug *Clavigralla gibbosa*, Lentil pod borer *Etiella zinckenella*.

Unit –II: (15 Hrs.)

4. Pests of fruits:
Fruit sucking moth *Ophederus materna*, Anar butterfly *Virachola Isocrates,* Mango stone weevil *Sternochetus mangiferae,* Fruitfly *Bactrocera dorsalis,* Ber fruit fly *Carpomyia vesuviana,* Codling moth *Cydia pomonella*

5. Pests of fruit trees:
Citrus caterpillar *Papilio demoleus,* Citrus white fly *Dialeurodes citri,* Mango jassid *Amritodus atkinisoni,* Mango stem borer *Batocera rufomacula,* Banana weevil *Cosmopolitus sordidus,* papaya AK grasshopper *Poikilocerus pictus,* Grapevine thrips *Rhipiphorothrips cruentatus*

Unit –III: (15 Hrs.)

6. Pests of sugar cane:
Sugarcane woolly aphids *Ceratovacuna lanigera*, White grubs *Leucopholis lepidophora* borer *Chilo infuscatellus*, Pyrilla *Pyrilla perpusilla*,

7. Pests of fiber crops:

Cotton pink boll worm *Pectinophora gossypiella*, Red cotton bug *Dysdercus cingulatus*, Bihar hairy caterpillar *Spilarctia obliqua*.

8. Pests of Oilseed Crops:

Mustard Sawfly *Athalia lugens*, groundnut stemborer *Sphenoptera perotetti*, castor semilooper *Achea janata*, Til hawkmoth *Acherontia styx*.

Unit –IV: (15 Hrs.)

9. Pests of vegetable crops:

Cabbage caterpillar *Pieris brassicae*, Diamond back moth *Plutella xylostella*, Onion thrips *Thrips tabaci*, Brinjal fruit & shoot borer *Leucinodes orbonalis*, Brinjal mealy bug *Coccidohystrix insolita*, Red pumpkin beetle *Raphidopala foveicollis* .

10. Pests of plantation crops:

Coffee stem borer *Xylotrechus quadripes*, Cashew tree borer *Plocaederus ferrugineus*, coconut weevil *Diocalandra frumenti*, and Rhinoceros beetle *Oryctes rhinoceros*

11. Pests of Spices and Narcotics:

Chilli thrips *Scirtothrips dorsalis*, Hespirid caterpillar *Udaspes folus,* Cinamon butterfly *Papilio clytia*. Tobacco caterpillar *Spodoptera litura*

Suggested Reading Material:

1. Ambrose, D.P. (2015). The Insects. Structure, Function and Biodiversity. Kalyani publishers, New Delhi. 626pp.
2. Atwal A.S. and Dhaliwal G.S. (2015). Agricultural pests of South Asia and their Management. Kalyani Publishers, New Delhi. pp 678.
3. Awasthi V. B. (2009). Introduction to General and Applied Entomology. Scientific Publishers, Jodhpur. pp. 499.
4. David B. V. and Ramamurthy V. V. (2015). Elements of Economic Entomology. Brillion Publishing, New Delhi. pp. 398.
5. Pruthi H. S. (1969). Textbook on Agricultural Entomology. Job Press Private Limited, Kanpur. pp. 977.
6. Singh R. (2004). Elements of Entomology. Rastogi Publications, Meerut, India. pp. 564.
7. Shukla G. S. and Upadhayay V. B. (2011) Economic Zoology. Rastogi Publications, Meerut, India. pp. 487.
8. Srivastava K. P. (1996). A Textbook of Applied Entomology, Volume- II. Kalyani Pulblishers, New Delhi. pp. 487.
9. Tembhare, D. B (2013). Modern Entomology. Himalaya Publishing House, India. pp 502.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Aquaculture Practices (MET 304)

Course Code: MSU0325MEL939I4
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,
CO1: understand mariculture, carp culture and brackish water culture
CO2: know about the innovative concepts in aquaculture practices.
CO3: explain prawn culture and plankton culture.
CO4: know the details of mariculture and culture of pearl oysters

Unit 1: **(15 hrs.)**

A. Introduction:

Scope and principles of aquaculture, History of aquaculture, Objectives of aquaculture

B. Classification of Aquaculture:

Mariculture (Salmon culture, Eel culture, and Milkfish culture), Carp culture (Indian Major Carps, Common Carps, and Chinese Major Carps), Brackish water culture

Unit 2: **(15 hrs.)**

A. Fish Culture Practices: Aquaculture Management:

Monoculture and composite culture, Fish Hatchery management, Induced breeding and Stripping in fishes

B. Fertilization and Artificial Feeding in Aquaculture:

Need for fertilizing fish pond, Fertilizers (organic, inorganic and bio-fertilizers), Artificial fish feeds and their formulation, Balanced fish feeds and their preparation.

C. Aquatic Weeds and Their Control:

Introduction, position of aquatic weeds in fishery ponds, classification of aquatic weeds, aquatic weeds control measure, importance of aquatic weeds.

Unit 3: **(15 hrs.)**

A. Prawn Culture

Species of prawns, habit and habitat, food and feeding, types of prawn fishery, culture of freshwater prawn, culture of marine prawn, preservation and processing of prawns, pollutional impact on prawn fishery, environmental issues of prawn culture, fate of prawn culture.

B. Culture of Plankton:

Definition, occurrence, types of plankton, significance of plankton, and culture of plankton

Unit 4: **(15 hrs.)**

A Mariculture:

Production of marine molluscs through aquaculture, Species of edible molluscs, Culture of oyster and mussels, Different methods of culture – bottom culture, raft culture, long line culture.

B Pearl oysters

Species of pearl oyster, methods of pearl seed collection, techniques of pearl culture, Prospectus in India.

Suggested reading material:

1 Fishery Science: W.C. Royce.
2. Ecology, Utilization and Management of marine fisheries; G. A. Rounsefell.
3. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.
4. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.
5. Fish farming hand book: E.E. Brown and J.B. Gratzek.
6. Fresh water biology: K.F. Lagler.
7. Fish and Fisheries of India: V.G. Jhingran.
8. Advances in aquaculture: T.V.R. pillay.
9. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.
10. Fishery management: S.C. Agarwal.
11. Applied fishery science (Vol. I & II): S.M. Shafi.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Cytogenetics and Breeding of silkworm (MET 304)

Course Code: MSU0325MEL939I5

Total Credits: 04

Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand basic concepts of Mendelian and neo-mendelian genetics with respect to *B. mori.*

CO2: Gives knowledge of inheritance of various traits of mulberry silkworm and environmental influence on it.

CO3: Illustrate various silkworm breeding, its status in India and various methods of breeding.

CO4: Explains about selection methods of superior breeds.

Unit - I: Basics of silkworm genetics

1. Law of dominances, Segregation and Independent assortment. Gene interactions- intra and intergenetic.
2. Quantitative inheritance and polygenic characters in silkworm, Hereditary traits in silkworm, heritability and its estimation.
3. Linkage maps, inheritance of cocoon colour, Inheritance of voltinism, moultinism and its hormonal control and environment influence.

Unit - II: Silkworm cytogenetics

1. Chromosome number, euploidy, aneuploidy and polyploidy, an and nature of chromosomes, gynogenesis- androgenesis, Parthenogenesis in silkworm - types and induction.
2. Origin and distribution of silkworm races, Distinct characters, classification based on voltinism, moultinism and geographical distribution. Characteristic features of temperate and tropical races.
3. Improvement of silkworm races. Heritability in *B. mori* and its estimation.

Unit –III: Breeding of silkworm and management

1. Present status of silk worm breeding in India.
2. Silkworm breeding - scope and objectives; methods – line breeding, inbreeding, cross-breeding, outcrossing, mutation breeding. Selection methods and techniques, Advantages and disadvantages. Effect of inbreeding, Homozygosity, Heterosis in silkworm: genetic and theoretical basis, Hybrid vigor, and its utilization in sericulture.
3. Combining ability. Maintenance of races and strains, Management of genetic resources: Collection, conservation, characterization and evaluation of silkworm breeds and their maintenance.

Unit –IV: Specialized Breeding of silkworm

1. Breeding for special characters -cocoon, fiber denier, silkworm polyphagy.
2. Sex limited characters- sex determination, yellow cocoon races, sex limited races in India and its relevance to Indian sericulture.
3. Breeding for disease tolerant/resistant silkworms- defence response, disease resistance- screening and selection. Breeding for temperature tolerance.

Reference Books:

1. Basavaraja, H.K., Aswath, S.K., Suresh Kumar, N., Mal Reddy, N. and Kalpana, G.V. (2005) *Silkworm Breeding and Genetics.* Central Silk Board, Bangalore.
2. Dilip De Sarkar (1998) *The Silkworm – Biology, Genetics and Breeding*. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Eikichi Hiratsuka (2000) *Silkworm Breeding.* Oxford & IBH Publications, New Delhi.
4. Elcio P. Guimaraes, John Ruane, Beate D. Scherf, Andrea Sonnino and James D. Dargie (2007) Marker-Assisted Selection, FAO, Rome.
5. Falconer, D.S. (1972) *Introduction to Quantitative Genetics*. Oliver & Boyd, Edinburgh.
6. Kovalev, P.A. (1970) *Silkworm Breeding Stocks*. Central Silk Board, Bangalore.
7. Larnar, M.F. and Donald, H.P. (1969) *Modern Developments in Animal Breeding*. Academic Press, London.
8. Sreerama Reddy, G. (Ed.) (1998) *Silkworm Breeding.* Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
9. Yokoyama, T. (1959): Silkworm Genetics illustrated: Japan Society for Promotion of Science, Tokyo.
10. Tazima, Y. (1978): The silkworm. An important laboratory tool, Hodansha Publication, Tokyo.

M. Sc. Zoology (Part II) (Level-6.5) (Semester III)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Practical MMPR 303: Based on MMT-301 & MMT-302

Based on CC-301: Genetics

1. Human lymphocyte culture.
2. Preparation of metaphasic chromosomes from human lymphocyte culture.
3. Study of human chromosomes explaining aspects of chromosome structure.
4. Study of human normal karyotype.
5. Manual preparation of human karyotype from metaphasic chromosomes.
6. Assessing quality and quantity of metaphases.
7. Harvesting of mitotic chromosomes from rat bone marrow.
8. Estimation of mitotic index.
9. Study of X chromosome heterochromatinization by Barr body staining.
10. G banding of rat chromosomes/Human chromosomes.
11. Genetic examples based on Mutations, Pleiotropy and Pedigree.
12. Karyotype identification with reference to Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs).
13. Identification of cases of Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome from photographs by morphological/ symptomatic features
14. Principle of Fluorescence In Situ Hybridization, Interpretation of results FISH for Patau syndrome, Edward Syndrome, Down syndrome, Klinefelter syndrome and Turner syndrome (from photographs).
15. Drosophila culture
16. Sexual dimorphism in Drosophila
17. Study of heritable characters in Drosophila
18. Examples based on Hardy-Weinberg Equilibrium
19. Symbols used in Pedigree analysis
20. Studies of Human pedigrees concerned with autosomal recessive disorders, Autosomal dominant disorders, X linked dominant disorders and X linked recessive disorders.
21. Clinical test for Phenylketonuria by Guthrie test /Ferric chloride test
22. Study of bacterial transformation
23. Study of bacterial transduction
24. Any experiment set by a teacher

Based on CCO-302: Enzymology

1. Estimation of proteins.
2. Estimation of Amylase / any other suitable enzyme.
3. Effect of pH on Amylase activity / any other suitable enzyme.
4. Effect of temperature on Amylase activity / any other suitable enzyme.
5. Michaelis – Menten constant determination for Amylase / any other suitable enzyme.
6. Effect of modifiers on enzyme activity / Thermolability of enzyme.
7. Isolation of Amylase or any other enzyme.
8. Any other practical set by the concern teacher.

(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Practical (MEPR 305)

Course Code: MSU0325MEP939I
Total Credits: 02

Practical MEPR 305: Based on MET 304 (As per the elective chosen by a student)

Cell Biology:

1. Histology of Lymphoid organs- Spleen, Thymus, Ilium, Lymph node, Bone marrow
2. Study of different types of lymphocytes.
3. Study of Lymphocyte count
4. Study of cell surface antigen.
5. Immunization of experimental animals and detection of antibodies.
6. Immunodiffusion
7. To estimate the antigen concentration using rocket electrophoresis
8. Dot immunobinding assay to detect antibodies in the serum
9. To perform ELISA.
10. Study of allergic reactions.
11. Induction of granuloma
12. Study of different types of cells in granuloma
13. Quantitative analysis of granuloma
14. Any other practical / experiments set by the Department.

Animal Physiology:

1. Study of Routine haematological values with blood indices.
2. Study of Electrocardiogram (ECG).
3. Study of Arterial blood pressure (BP).
4. Effect of Insulin on blood sugar level.
5. Effect of Adrenaline on blood sugar level.
6. Study of colour index from blood sample by using haemocytometer.
7. Study of Vascularization (Angiogenesis) in Chick animal model
8. Study of Histological changes in the liver of diabetic rats
9. Study of Fatty liver, pancreatic abnormality in Rat.
10. Study of Rectal Temperature in Rat or Mice.
11. Detection of Field of Vision or Blind spot.
12. Tests for detection of colour vision.
13. Test for Cochlear function and Audiometry.
14. Tests for coordination and movements
15. Examinations for Sensory systems.
16. Thermography in rat or in mammals
17. Effect of temperature on heartbeat.
18. Demonstration of the role of hormones in the developmental stage. (Chick Model)
19. Determination of Calcium in a given sample of blood plasma.
20. Estimation of blood Cholesterol.

21. To study pathophysiology of muscle fibre – smooth, skeletal and cardiac muscle (Histology and Histochemistry).
22. Any other practical set by the concerned teacher.

Entomology:

Course Outcomes: Upon successful completion of this course …

CO1: Enable students to collect, preserve small insect specimens and prepare microscopic slide for identification and record.

CO2: Identify the pests of cereals, pulses, fiber crops

CO3: Identify the pests of fruits, fruit trees, oil seed crops and vegetable crops

CO3: Collect, preserve and identify various insect pests.

1. Pests of cereals.
2. Pests of pulses.
3. Pests of fiber crops.
4. Pests of fruit and fruit trees.
5. Pests of Oil seed crops.
6. Pests of Vegetable crops.
7. Other agricultural important insect pests
8. Field visit to study nature pest damage.
9. Any practical set by the concerned teacher

Aquaculture and Fisheries:

1. Identification of fishes, prawns and mollusks.
2. Study of different nets, crafts and gears (models/drawings).
3. Estimation of glycogen, protein and lipids from fish tissue.
4. Study of fish products and by-products.
5. Any other experiment set by the concerned teacher

Sericulture:

1. Study of racial characters of the silkworm, *Bombyx mori*: Egg, larva, cocoon (pupa) and adult stages of univoltine, bivoltine and multivoltine type.
2. Estimation of fecundity and hatching percentage in various silkworm races /breeds.
3. Study of mutants of *Bombyx mori*: Larval (Ursa, Zebra and Knobbed), egg colour (pere), eye colour (white and red eye) and cocoon colour.
4. Study of inbreeding depression in silkworm.
5. Study of larval and cocoon character / segregation in F_1 and F_2 progenies of *multi* x *bi* hybrids to observe Mendelian pattern of inheritance.
6. Study of adult longevity in *Bombyx mori* – multivoltine and bivoltine races /breeds and sexes.
7. Assessment of qualitative and quantitative traits of silkworm for breeding.
8. Characterization of silkworm breeds/races - Bivoltine & Multivoltine
9. Evaluation of heterosis and over - dominance in F_1 silkworm hybrid.
10. Estimation of heritability of characters.
11. Any other practical set by concerned teacher.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)

(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Animal Cell Culture (MMT 401)

Course Code: MSU0325MML939J1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand the basic requirement for animal cell culture, laboratory set up and aseptic conditions
CO2: Illustrate growth media requirement of mammalian cell culture.
CO3: Gain knowledge of various invitro cytotoxicity and viability assays, growth parameters in culture.
CO4: Understand concept of surgical manipulations of IVF, culturing of differentiated cells, preparation of feeder layer and reconstituted basement membrane rafts.

Unit - I: Laboratory design, aseptic techniques, types of culture and cryopreservation (15 Hrs.)

1. Design of Tissue Culture Laboratory
2. Equipments : Laminar Flow Hoods, CO2 incubator, Microscopes, centrifuge, Refrigerators and Freezers, pipetting aids, Miscellaneous Equipments.
3. Glass wares/plastic wares and filters for tissue culture
4. Basic Aseptic Techniques
5. Primary cell culture, Established cell line, transformed cell line
6. Cryopreservation for Storage and shipment

Unit - II: Growth media and Basic Techniques of mammalian cell culture (15 Hrs.)

1. Physical requirements and Nutritional Requirements of Cells
2. Natural media
3. Basal salt solution (BSS)-Various types
4. Minimum Essential Medium(MEM)
5. Serum dependent defined media
6. Serum independent defined media – Cell specific media
7. Antibiotics in media
8. Types of cell cultures – Open and closed cell cultures
9. Monolayer, Suspension, Clonal culture, Mass culture: micro carrier culture, Stem cell cultures (ESC)

Unit - III: Biology and Characterization of cultured cells and applications of Animal cell culture (15 Hrs.)

1. Viability measurement and cytotoxicity
2. Contamination Testing of Culture
3. Karyotyping
4. Measurement of growth parameters
5. Cell cycle analysis and Synchronization of cultures

Unit - IV: Applications of Animal cell culture, Cell surgery and tissue engineering (15 Hrs.)

1. Evaluation of Chemical carcinogenicity, Cell malignancy Testing
2. Uses of Embryonic stem cells and Pluripotent stem cells
3. Hybridoma cell preparations and their properties
4. Surgical manipulation of *in vitro* fertilization : ICSI, Assisted zona hatching, cytoplasmic transfer
5. Capillary culture Unit
6. Techniques for culturing differentiated cells: Use of feeder layer, use of Reconstituted basement membrane rafts.

Suggested Reading Material:

1. Morgan, S.I. Animal Cell culture 1993 Bio. Scientific Publishers Ltd Oxford.
2. Freshney, R.I. Culture of Animal Cells: A manual of Basic Technique, 1994, John Wiley & Sons Inc. Pub. USA.
3. Butler, M. Mammalian Cell Biotechnology.: A practical Approach 1991 IRL Press Oxford.
4. Jenni P. Mather & David Barnes Eds: Animal Cell culture Methods. Methods in Cell Biology Vol. 57 Academic press.
5. Cell Culture: Methods in Enzymology, vol. 58 1979/recent volume. Academic Press.
6. Kuchler, R.J. Biochemical Methods in Cell culture & vivology 1977. Dowden, Huchinson & Ross, Inc. Strausberg, USA.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: TOXICOLOGY (MMT 402)

Course Code: MSU0325MML939J2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Gain knowledge of toxic compounds, its effects on health and environmental deterioration.
CO2: Imparts knowledge of types of toxicities, toxicological tests and its application in toxicity assessments.
CO3: Understand harmful effects and toxicokinetics of commonly used toxicants like pesticides and metal ions.
CO4: Gain knowledge of Bioaccumulation and biotransformation of various persistent toxicants and its issue in toxicity.

Unit- I: (15 hrs.)

Concept and Scope of Toxicology: Definition, History, Recent development, Disciplines of toxicology, Classification of toxicants, Toxic effects, Principle aspects and importance of toxicology, Types of toxicity test methods: based on exposure duration, acute and chronic toxicity test, calculation of LD_{50} / LC_{50} by graphical and statistical methods

Unit II: (15 hrs.)

Routes of entry Inhalation (breathing), Absorption (skin contact), Ingestion (eating), Injection, Dose, Duration, Frequency-response relations; Factors influencing toxicity; Types of human exposure-Categories of toxic effects; Dose - response relationship and genotoxicity; Target organs and mechanism of action.

Unit III: (15 hrs.)

Heavy metal toxicity: Mercury, Lead and Cadmium source and their impacts on animals, Synthetic pesticides of Organochlorine, Organophosphate, Carbamate and synthetic Pyrcthroids toxicity symptoms, Biotransformation sites, Biotransformation reaction (Phase I and Phase II) of organochlorine and organophosphate and Factors affecting biotransformation of xenobiotics.

Unit- IV: (15 hrs.)

Food additives: contaminants, adulterants, food poisoning. Poisons, Toxins, and Venoms, Molecular and functional diversity of natural toxins and venoms, Natural roles of toxins and venoms, Major sites and mechanisms of toxic action, Animal venoms and toxins and toxin and venom therapy.

Suggested Reading Material:

1. Sharma, P. D. 1996 Environmental Biology and Toxicology, Rastrogi Publication, Meerut, India.
2. Bhattacharya, S. 2011. Environmental Toxicology, Books and Allied (P) Ltd., Kalkata.
3. Panday, K. and Shukla, J.P. 2010. Elements of Toxicology, Wisdom Press, New Delhi.

E-resources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4144270/
2. https://www.ncbi.nlm.nih.gov/pubmed/2190453
3. https://ehs.unl.edu/documents/tox_exposure_guidelines.pdf
4. http://medcraveonline.com/JBMOA/JBMOA-04-00085.pdf
5. http://farmasi.unud.ac.id/ind/wp-content/uploads/Bio-Transformation-of-Xenobiotics.pdf
6. https://www.nap.edu/read/2126/chapter/6

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Cell Pathology (MET 404)

Course Code: MSU0325MEL939J1
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand cells stress response, basic mechanism of cell death by apoptosis and necrosis
CO2: Understand the basics of cancer biology
CO3: Understand the biology of aging
CO4: Impart knowledge of effect of metabolic inhibitors

Unit - I: Cell in stress and death (15 Hrs.)

1. Different types of stressful conditions on cell and cell response
2. Cell death and its regulation: Apoptosis-molecular mechanism and regulation
3. Cell organelles during cell degeneration/necrosis

Unit - II: Cancer Biology **(15 Hrs.)**

1. Tumor cells and onset of cancer
2. The genetic basis of cancer
3. Oncogenic mutations in growth promoting proteins
4. Mutations causing loss of growth inhibiting and cell-cycle controls
5. Carcinogens and caretaker genes

Unit - III: Aging **(15 Hrs.)**

1. Definition, Mechanism of ageing (Theories of ageing)
2. Internal and external causes of aging
3. Molecular and Cellular changes during aging
4. Immunological changes during aging
5. Strategies against ageing

Unit - IV: Effects of inhibitors on **(15 Hrs.)**

1. DNA synthesis (Mitomycin)
2. RNA synthesis (Actinomycin and Rafampicin).
3. Protein synthesis (Cyclohexamide, Tetracyclins, Chloramphenicol,
4. streptomycins).
5. Mitochondrial metabolism (CN, CO, Actinomycin –A, Azide etc.)

Suggested Reading Material:

1. Cell & Molecular Biology by Gerald Karp (2005) published by John Wiley& sons.
2. Molecular cell biology by Lodish, Berk, Matsudaira, Kaiser, Krieger (2004) published by W. H. Freeman & company, New York.
3. The Cell by Bruce Alberts, published by Garland publishing Inc. New York & London.
4. Laboratory Investigation –Vol.14, 1965,.
5. Inhibitors of nucleic acid synthesis by Kersen & Kersen.
6. Inhibitors of Protein Synthesis FBII publication.
7. Metabolic Inhibitors Vol. I –IV.
8. Molecular Biology of gene by James Watson

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-2026)

Title of Course: Clinical Physiology (MET 404)

Course Code: MSU0325MEL939J2
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Students will be able to understand Endocrine pathologies.

CO2: Enable to understand excretory defects with its symptoms.

CO 3: Provides recent information about neuropathology.

CO 4: Able to understand the basics of cancer.

Unit I- Pathophysiology of Endocrine glands **(15 hrs.)**

1. Pituitary glands
2. Thyroid glands
3. Parathyroid glands
4. Endocrine pancreas.
5. Adrenal gland
6. Gonads- Testis, Ovaries.

Unit II- Pathophysiology of Renal system **(15 hrs.)**

1. Acute renal failure- Peripheral internal and post renal failure.
2. Chronic renal failure – injury to glomeruli and interstitium
3. Hypertension and kidney diseases.
4. Uremic toxicity, dialysis and artificial kidney.
5. Kidney transplantation.

Unit III- Pathophysiology of Nervous system **(15 hrs.)**

1. Disorders of Cerebrospinal fluid (CSF)
2. Pathophysiology of Psychosis
3. Pathophysiology of Epilepsy
4. Pathophysiology of Alzheimer's diseases
5. Pathophysiology of Parkinson's
6. Inherited neurological disorders.

Unit IV – Cancer Biology **(15 hrs.)**

1. Different types, characters of cancers.
2. Brain cancer
3. Breast cancer
4. Skin cancer
5. Gonadal cancer
6. Biopsy: Types, procedures and prognosis.

References:

1. Human Physiology – by A.C. Guyton. Saunders Company London, Toronto.
2. Shepherd G.M. Neurobiology, New York Oxford University Press 1987.
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5. Brooks V.B. 1986. The neural Basis of motor control New York, Oxford University Press.
6. Johnson L.R. et al Physiology of the gastrointestinal tract 1987 New York Raven press.
7. Thompson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill book co., 1987.
8. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
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10. Felig P et al (eds) 1987. Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,
11. DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.
12. Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.

13. Wozney J.M. et al 1988. Novel regulators of bone formation: Molecular clones & cultivates science 242: 1528.
14. Martin R.B. & Burr D.B. 1989. Structure, function & adaptation of compact Bone New York, Raven Press 1989.
15. Knobil E. et al (eds) The physiology of Reproduction New York, Raven Press 1988.
16. Leung P.C.K. et al (eds) Endocrinology & Physiology of reproduction New York Plenum Pub. Corp. 1987

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: PEST MANAGEMENT CONCEPTS (MET 404)

Course Code: MSU0325MEL939J3
Total Credits: 04
Course Outcomes: Upon successful completion of this course students will be able

CO1: to understand methods and principles of pest control
CO2: to understand biological pest control
CO3: to understand chemical pest control
CO4: to understand Integrated Pest Management.

Unit –I: **(15 Hrs.)**

Methods and principles of pest control,

1. Natural control of Insect Pests: Biotic and Abiotic Factors.
2. Cultural, Mechanical, Physical and Legal control of Insect Pests.

Unit –II: **(15 Hrs.)**

3. Biological Pest Control:
Definition, history, methods, biocontrol agents, aspects of biocontrol, organizations, Biocontrol programs in India.

4. Microbial Control:
Definition, Pathogens used in microbial control (Fungi, Bacteria, Viruses, Protozoans, Nematodes etc.) Toxins produced and mode of action and application.

Unit –III: **(15 Hrs.)**

5. Genetic Control: Definition, methods and application.
6. The role of Hormonal and Radiation Control in Pest Management.
7. Behavioral Control:
Pheromones – mode of action and applications.
8. Chemical Control:
Plant origin and synthetic (organic and inorganic) insecticides, chemistry, mode of action and applications.

Unit –IV: **(15 Hrs.)**

9. Integrated Pest Management:

Definition,Need of IPM,Tactics and strategies of pest management (IPM),

10. Recent Advances in Pest management

a. The role of Antifeedent, Attractants, Repellents and Chemo-sterillants in Pest Management.

b. Green Chemistry in pesticides: Mode of action and Applications of Neem in plant protection.

Suggested Reading Material:

1. Agricultural Pests of India and South East Asia – A.S. Atwal, 1986.
2. A textbook of applied Entomology, Vol. II-.K.P. Shrivastava.
3. Genetic control of insect pests- G. Davidson.
4. Biological Pest Suppression – Copell & Martins, 1977.
5. Agrochemicals and Pest Management – T.V. Sathe 2003.
6. Biological Pest Control – T.V. Sathe, P. M. Bhoje, 2000
7. Insect sex pheromones – Martin.
8. Pest Management: Ecological concepts – T.V. Sathe and Jyoti Oulkar, 2010.
9. Vermiculture and Organic Farming – T.V. Sathe, 2004.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Fishery Technology (MET 404)

Course Code: MSU0325MEL939J4
Total Credits: 04
Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand the scientific method and concepts in fishing technology.

CO2: Understand the techniques of breeding food fishes and maintenance of fresh water aquarium

CO3: Understand the Biotechnology in Aquaculture

CO4: Understand the post harvest technology

Unit 1:

Fishing Technology:

Conventional fishing methods: types of crafts and gears, Unconventional fishing methods, Modern methods of fishing, Rules and regulations for fishing operations and safety at sea.

Unit 2:

A. Techniques of Breeding Food Fishes:

Breeding habits of food fishes, Environmental control of reproductive cycles, Fecundity studies of fishes.

B. Maintenance of Freshwater aquarium:

Introduction, Equipment's used in the maintenance of Aquarium, Common diseases of aquarium fishes, Common freshwater aquarium fishes, and maintenances routine

Unit 3:

Biotechnology in Aquaculture:

Prospects of aquaculture biotechnology, Biotechnological tools in diagnosis of diseases in aquaculture, Application of hybridism technology in aquaculture, Cryopreservation technology in fishes, Application of biotechnology in health management in aquaculture

Unit 4:

Post-Harvest Technology:

Reasons for spoilage of fishes, methods for fish preservation, refrigeration, deep freezing, freeze drying, salting, smoking, drying, canning, demerits of fish preservation, fish by products, HACCP for fish processing industry.

Suggested reading material:

1 Fishery Science: W.C. Royce.
2. Ecology, Utilization and Management of marine fisheries; G. A. Rounsefell.
3. Fisheries development of India: U.K. Shrivastava and M. Dharma Reddy.
4. Aquaculture research needs for 2000 AD: Jaw. Kai. Wang and P. V. Dehadari.
5. Fish farming hand book: E.E. Brown and J.B. Gratzek.
6. Fresh water biology: K.F. Lagler.
7. Fish and Fisheries of India: V.G. Jhingran.
8. Advances in aquaculture: T.V.R. pillay.
9. Fishes an introduction to ichthyology: P.B. Moyle and J.J. Cech.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Silkworm seed, silk production technology & Economics (MET 404)

Course Code: MSU0325MEL939J5

Total Credits: 04

Course Outcomes: Upon successful completion of this course, students will be able to,

CO1: Understand silkworm seed production, its storage, incubation and embryonic development.
CO2: Gain knowledge about assessment of silk and cocoon properties.
CO3: Illustrate silk processing including cocoon storage, reeling and spinning.
CO4: Learn concept of marketing of cocoons and silk; economics of sericulture and silk processing industries.

Unit –I: Silkworm seed production technology

General concept of grainage. Concept of P4, P3, P2 and P1, Rearing of P1 seeds;

Grainage: Location and capacity; model grainage; grainage equipment and their uses; disinfection and hygiene; Silkworm egg production process – bivoltine and multivoltine. Embryonic development, Diapause and non-diapause eggs, Incubation of eggs and related aspects; Byproducts of grainage and their utilization. Entrepreneurship in silkworm seed production (LSP)

Unit –II: Silk production technology and management

Physical and commercial characteristics of multivoltine and bivoltine cocoons.
Cocoon markets – organization and functions; cocoon sorting – objectives and procedure; defective cocoons.
Storage & preservation of cocoons in silk reeling units, Cocoon stifling, Cocoon cooking, Silk reeling, re-reeling, Raw silk testing, Spun silk yarn, Silk weaving.

Byproducts of silk reeling industries.

Entrepreneurship development in silk reeling, weaving and marketing

Unit –III: Organization, marketing, value addition and economics of sericulture

Organizational set up of sericulture in state and country

Economics: Principles of economics, micro and macro economics; classification of costs – explicit and implicit, fixed, variable, marginal, average; profits – gross and net.
Economics of mulberry cultivation practices, commercial cocoon production, seed cocoon production, raw silk production

Marketing concepts for seed, raw silk and finished products.

Entrepreneurship development in value added products

(Mulberry tea, fodder, pharma , cosmetics products and cocoon handicrafts)

Unit –IV: Extension Education in Sericulture:

Extension education: Objectives and importance; principles, concepts and functions of extension education; teaching and learning process.
Extension programme management; sericulture development through plans; major programmes in sericulture.
Classification of various extension teaching methods its importance

Extension teaching methods adopted in sericulture. Use of audio-visual aids in sericulture. Training: meaning, principles, methods and training programmes in sericulture.
Central Silk Board, Directorate of Sericulture, Mahareshim abhiyan, Various govt., schemes.

Reference Books:

10. Akira Nakamura (2000) Fiber Science and Technology. Oxford & IBH Publications, New Delhi.
11. Gubrajani, M.L. (1986): Silk Dyeing, printing and finishing, IIT, New Delhi.
12. Byung, Jo. (1987): Silk Textile Engineering, Moon, Halk Publication Scol. Korea.
13. Rayner Hollin (1903): Silk Throwing and Waste Silk Spinning Scott. Greewood and Sons, London.
14. Koshy, T.D. (1990): Exports and Development, Ashish Publications, New Delhi.
15. Anonymous (1972): Hand Book of silk rearing, Agriculture techniques Manual I., Fuji Publication, Tokyo.
16. Jolly, M.S.: Appropriate Sericultural Techniques CSR and TI Mysore.
17. Strunnikov, V.A. (1983): Control of silkworm reproduction, Development and sex MIR publications, Moscow.
18. Annual report of Central Sericultural Research and Training Institute, Mysore.
19. Annual report of Central Sericultural Research and Training Institute, Bangalore.
20. A Treatise on acid treatment of silkworm eggs, CSR and TI, Mysore.

21. M.V. Samson, Chandrashekharaih, P. Gowde and Saheb B. (1995): Monograph on silkworm loose egg production, SSTC, CSB, Bangalore.
22. Water Management in silk reeling machine, CSTRI CSB, Bangalore, 1995.
23. Hand spinning on CSTRI spinning wheel, 1995, Mysore.
24. Bivoltinegrainage for tropics, M.S. Jolly.
25. Economics of sericulture under rain fed conditions, M.S. Jolly.
26. Silkworm rearing and disease of silkworm (1956): Printed by the Director of printing, Stationary and publications at the Government Press.
27. Gopalchar, A.R.S. (1978): Three decades of Sericultural progress, CSB, Bangalore.
28. Narasimpanna, M.N. and Ullal, R.S. (1981): Hand book of practical Sericulture, CSB Publication.
29. Tanaka, Y. (1964): Sericology, CSB Publication Bangalore.
30. Ullal, S.R. (1968): Sericulture in USSR A study report, CSB, Bangalore.
31. Berch (1979): Insect Pheromones.
32. Boyer, H.W. and Nicosia S. (1979): Genetic Negineering, Elsetie/ North Holland, Biomedical Press, Amsterdam, New York.
33. Davidson, G. (1974): Genetic control of Insect Pests, Academic Press, London.
34. Gorbman, A and Bern, H. (1974): Text Book of Comparative endocrinology Wiley Eastern, New Delhi.
35. Lavine, L. (1969): Biology of the gene, Saint Louis, Mosby.
36. Mohan Rao M.M. (1988): A text Book of Sericulture BSP Publications, Sultan Bazar, Hyderabad.
37. Ahuja, H.L. Advanced Economic Theory, S. Chand and CO. Ltd. New Delhi.
38. Stonier and Hauge: A Text book of Economic Theory.
39. Crop production, Sericulture and Apiculture Part VI, Report of the National Commission on Agriculture, 1976.
40. Hisao, Aruga: Principles of Sericulture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Practical – (MMPR 403)

Course Code: MSU0325MMP939J
Total Credits: 04

Practical MMPR-403: Based on MMT-401 & MMT-402

Based on CC-401: Animal Cell culture

1. Study of equipments required for Animal Cell culture
2. Study of laboratory design of Animal Cell culture
3. Washing and sterilization of glassware for animal cell culture
4. To test the sterility of the BSS/MEM/Serum
5. Enzymatic Dissociation of cells for primary cell culture
6. Chemical dissociation of cells for primary cell culture
7. Primary culture of fibroblasts by explant culture
8. Study of Viability by trypan blue dye exclusion method
9. Primary Culture of Fibroblast by cell dissociation
10. Measurement of LDH activity in the culture medium
11. MTT assay
12. Passaging of fibroblast culture
13. In vitro chick embryo culture
14. Any experiment designed by a teacher.

Based on CCO-402: Toxicology

1. Evaluation of acute toxicity by using static renewal bioassay test (In fish / Insect).
2. Determination of LC_{50} of toxicant in fish / stored grain pest by employing probit analysis.
3. Effect of toxicant on O_2 consumption rate in fish.
4. Effect of toxicant (sublethal dose) on fish gill and alimentary tract in fish and in insect on alimentary canal haemolymph (Mulberry silkworm)
5. Detection of heavy metal from animal issue by AAS (Lead/cadmium/chromium).
6. Detection of pesticide by TLC method from water sample (organochlorine/ organophosphate).
7. Evaluation of toxicity by Comet assay
8. Study of Micronucleus assay
9. Effect of toxicants on mitosis
10. Cytotoxicity determination by MTT, LDH and neutral red uptake assay.
11. Acetylcholinesterase assay for pesticide toxicity
12. Any experiment designed by a teacher.

M. Sc. Zoology (Part II) (Level-6.5) (Semester IV)
(NEP-2020) Autonomous
(Introduced from Academic Year 2025-26)

Title of Course: Research Project (RP 405)

Course Code: MSU0325RP939J
Total Credits: 06

It includes 10 marks for seminars, 10 marks for the Study tour, 50 marks for the examination of experimental work based on elective MME403, and 80 marks for the evaluation of the project report by the external examiner. Two credits are exclusively reserved for satisfactory completion of experimental protocols based on the elective course as under

Practical Based on Elective (MET404)

Cell Biology:

1. Study of unilateral renal necrosis
2. Study of histology of stressed kidney
3. Study of histology of necrotic kidney
4. Age related lipid peroxidation in various organs of rat / mouse.
5. Drug induced lipid peroxidation in liver & kidney (CCl4 / any suitable drug).
6. Histochemical demonstration of lipofuscin granules by oil red O.
7. Demonstration of lipofuscin granules by carbol fuchsin.
8. Any other practical / experiments set by the Department.

Animal Physiology

1. Study of Endocrine disorders.
2. Urine Examination: Physical and Chemical.
3. Urine Examination: Microscopic observation for – different types of cells and casts.
4. Study of different types of Urine crystals and miscellaneous structures in Urine.
5. Kidney function tests.
6. Histochemical detection of uric acid crystals by using the AgNO3 Formalin method.
7. Study of Biopsy Protocol and Investigation Techniques.
8. Study of different types of Cancer.
9. Dusting and identification of fingerprints.
10. Study of different stress factors (Natural and Induced) as per animal model.
11. Effect of toxicant / drug to the digestive/ reproductive cell/ glands (Histology and Histochemistry).
12. Study of developmental brain deformities with prognosis in chick embryo model.
13. Study of animal models (Invertebrate & Vertebrate) used in forensic investigation.
14. Study of Digitalization and modern techniques in Animal physiology.
15. Any other practical set by the concerned teacher.

Entomology:

1. Study of insecticide appliances.
2. Insect pest damage detection.
3. Study of economically important parasitoids (Biocontrol agents).
4. Study of economically important insect predators (Biocontrol agents).
5. Study of vertebrate biocontrol agents of insect pests.
6. Study of insect traps in pest control method.
7. Effect of contact pesticides on insects.
8. Effect of fumigants on insects.
9. Any practical set by the concerned teacher.

Aquaculture and Fisheries

1. Identification and control measures of aquatic weeds and insects
2. Assessment of pollutants from farm water – heavy metals and pesticides
3. Estimation of primary productivity of water sample by light and dark bottle experiment.
4. Qualitative and quantitative study of zooplankton.
5. Method of fish preservation.
6. Any other experiment set by the concerned teacher.

Sericulture:

1. Identification of textile fibres by microscopic, physical and chemical tests.
2 Study of physical and commercial characters of cocoons in multivoltine and bivoltine races / breeds.
3.Sexing in silkworm pupae and moths.
4. Acid treatment (hot and cold) of hibernating silkworm eggs and mother moth examination.
5. Mounting of embryo – pin head and blue egg stages.
6. Sorting of cocoons – identification of good and defective cocoons.
7. Cocoon stifling and cooking.
8. Determination of alkalinity and hardness of reeling water by titration methods.
9. Reeling techniques: Epprouvette, Charaka, Multi-end and Automatic reeling devices.
10. Study of different types of silk wastes.
11. Preparation of garlands / handicrafts by silk waste / pierced cocoons.
12. Visit to silk reeling establishments.
13. Visit to field and farmers rearing house to study sericulture technologies adopted.

9. Scheme of Teaching

a. Each unit in theory course will be taught in 15 lectures, each lecture of 60 minutes duration and there will be four lectures per theory course per week.
b. Each practical course shall be of minimum three hours duration.

10. Examination Pattern

Theory:

Theory examinations will be conducted **semester wise.**

a. Entire programme of M. Sc. Zoology will be of **2200** marks. Every Semester will be of 550 marks.
b. Examination of each 4 credits **theory course** shall be of **100 marks** (80 university examination + 20 internal assessment).
c. University examination of 80 marks (3 hours' duration) will be conducted at the end of each Semester. Internal assessment of 20 marks will be done before the semester examination during each semester.

Practical:

a. Practical examinations will be conducted **semester wise.**
b. Practical Examination of each major mandatory practical course shall be of 100 marks for 4 credits. Practical examination of major elective practical course will be of 50 marks for 2 credits.

11. Nature of Question Paper and Scheme of Marking

Theory:

Pattern of question paper for MMT, MET and RM course.

There will be five descriptive questions, each carrying 16 marks.

Que. 1 Descriptive Question from Unit I 16
OR
Descriptive Question from Unit I

Que. 2 Descriptive Question from Unit II 16
OR
Descriptive Question from Unit II

Que. 3 Descriptive Question from Unit III 16
OR
Descriptive Question from Unit III

Que. 4 Descriptive Question from Unit IV 16
OR
Descriptive Question from Unit IV

Que. 5 Write notes on (Any two) 16
a. From Unit I
b. From Unit II
c. From Unit III

d. From Unit IV
For passing in MMT, MET and RM courses, student must score minimum 32 marks out of 80 in theory examination.

Practical:

Practical MMPR 303 based on MMT301 and MMT302,	**100 marks**
Que. 1 Experiment/Experiments Based on **MMT301**	20
Que. 2 Experiment/Experiments Based on **MMT301**	20
Que. 3 Experiment/Experiments Based on **MMT302**	20
Que. 4 Experiment/Experiments Based on **MMT302**	20
Que. 5 *Viva voce*	10
Que. 6 Journal	10

For passing in MMPR303, student must score minimum 40 marks out of 100 in practical examination

Practical MEPR 305 based on MET-304	**50 marks**
Que. 1 Experiment/Experiments Based on MET 304	20
Que. 2 Experiment/Experiments Based on MET 304	20
Que. 5 *Viva voce*	05
Que. 6 Journal	05

For passing in MEPR305, student must score minimum 20 marks out of 50 in practical examination

Practical MMPR 403 based on MMT401 and MMT402,	**100 marks**
Que. 1 Experiment/Experiments Based on **MMT401**	20
Que. 2 Experiment/Experiments Based on **MMT401**	20
Que. 3 Experiment/Experiments Based on **MMT402**	20
Que. 4 Experiment/Experiments Based on **MMT402**	20
Que. 5 *Viva voce*	10
Que. 6 Journal	10

On Job Training:
On job training shall be of 100 marks for 4 credits. 70 marks will be for completion and submission of its report and 30 marks will be for presentation. The candidate has to summarize the day wise duties and achievements during the training program and the skills/ expertise obtained during the training program in the form of powerpoint presentation.

Field Project:
Field project shall be of 100 marks for 4 credits. 70 marks will be for completion and submission of its project report and 30 marks will be for the presentation before the panel of examiners (Internal and External Examiner) in the form of Open defence.

Research Project 306: MSU0325RP939I

It will be of 100 marks (Four Credits). 70 marks will be for the successful completion and submission of project report and 30 marks will be for the presentation before the panel of examiners (Internal and External Examiner) in the form of Open defence.

Research Project 405: MSU0325RP939J

It will be 150 marks (six credits) ***includes 10 marks for seminars, 10 marks for Study tour, 50 marks for examination of experimental work based on elective MET 404, 80 marks for evaluation of the project report by the external examiner. The evaluation will be carried out by the panel of examiners (Internal and External Examiner) in the form of Open defence.***

For passing in Research Project Practical protocol, the student must score minimum 20 marks out of 50 in practical examination

12. Equivalence of courses

M. Sc. Part II (Semester III and IV)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Credit**	**Course Code**	**Title of New Course**	**Credit**
III	CC-301	Genetics	4	**MSU0325MML939I1**	Genetics	4
III	CCO-302	Enzymology	4	**MSU0325MML939I2**	Enzymology	4
III	CCPR-405	Practical III	4	**MSU0325MMP939I**	Practical MMPR 103	4
III	CCPR-405	Practical III	4	**MSU0325MEP939I**	Practical MEPR 305 based on MET 304	2
III				**MSU0325RP939I**	Research Project	4
III	CCS-403	Immunology	4	**MSU0325MEL939I1**	Immunology	4
III	CCS-403	Physiology of Health	4	**MSU0325MEL939I2**	Physiology of Health	4
III	CCS-403	Agricultural Entomology	4	**MSU0325MEL939I3**	Agricultural Entomology	4
III	CCS-403	Aquaculture Practices	4	**MSU0325MEL939I4**	Aquaculture Practices	2
III	CCS-403	Cytogenetics and Breeding of silkworm	4	**MSU0325MEL939I5**	Cytogenetics and Breeding of silkworm	4
IV	CC-401	Animal Cell Culture	4	**MSU0325MML939J1**	Animal Cell Culture	4
IV	CCO-402	Toxicology	4	**MSU0325MML939J2**	Toxicology	4
IV	CCPR-406	Practical IV	4	**MSU0325MMP939J**	Practical MMPR 403	4
IV	CCS-404	Cell Pathology	4	**MSU0325MEL939J1**	Cell Pathology	4
IV	CCS-404	Clinical Physiology	4	**MSU0325MEL939J2**	Clinical Physiology	4
IV	CCS-404	Pest Management Concepts	4	**MSU0325MEL939J3**	Pest Management Concepts	4
IV	CCS-404	Fishery Technology	4	**MSU0325MEL939J4**	Fishery Technology	4
IV	CCS-404	Silkworm seed, silk production technology and Economics	4	**MSU0325MEL939J5**	Silkworm seed, silk production technology and Economics	4