

SHIVAJI UNIVERSITY, KOLHAPUR

SYLLABUS

For

M.Sc. Zoology
(Semester Pattern)
M. Sc. Sem. III to IV



Estd. 1962

NAAC 'A' Grade

Choice Based Credit System
(CBCS)

To be implemented From

June, 2020 onwards

**M.Sc. Programme Structure of Zoology
Part – II(CBCS pattern) (2020-2021)**

SEMESTER – III (Duration 6 months)

Sr. No	Course Code	Teaching Scheme						Examination Scheme											
								Theory									Practical (CPPR)		
		Theory			Practical			Theory (UA)			Internal (IA)			Total		Total			
		No. of Lectures	Hours	Credit	No. of Lectures	Hours	Credit	Max.	Min.	Hours	Max.	Min.	Hours	Max.	Min.	Max.	Min.	Hours	
1	CC-301	4	4	4	16	16	8	80	40	3	20	8	1	100	40	Practical Examination is Annual.			
2	CBE-302	4	4	4				80	40	3	20	8	1	100	40				
3	CCS-303	4	4	4				80	40	3	20	8	1	100	40				
4	CCS-304	4	4	4				80	40	3	20	8	1	100	40				
	OE-II/SWM-II	2	2	2															
	TOTAL	16	16	16	16	16	8	320			80	-		400	-				
SEMESTER – IV (Duration 6 months)																			
5	CC-401	4	4	4	16	16	8	80	40	3	20	8	1	100	40	Practical Examination is Annual.			
6	CBE-402	4	4	4				80	40	3	20	8	1	100	40				
7	CCS-403	4	4	4				80	40	3	20	8	1	100	40				
8	CCS-404	4	4	4				80	40	3	20	8	1	100	40				
	OE-II/SWM-II	2	2	2															
9	CCPR-405	-						-									200	80	16
10	CCPR-406	-						-									200	80	16
	TOTAL	16	16	16	16	16	8	320			80			400		400	-	-	
	Grand Total	32	32	32	32	16	16	640			160			800		400	-	-	

<ul style="list-style-type: none"> • Student contact hour per week: 16 hrs (min.) 	<ul style="list-style-type: none"> • Total Marks for M. Sc. II :1200
<ul style="list-style-type: none"> • Theory lectures: 60 minutes Each 	<ul style="list-style-type: none"> • Total credits for M. Sc. II (Semester III &IV): 52
<ul style="list-style-type: none"> • CC- core course 	
<ul style="list-style-type: none"> • CE- Core Elective (Within Department): Core elective papers shall be minimum 2 or more 	
<ul style="list-style-type: none"> • OE – Open elective 	
<ul style="list-style-type: none"> • SWM – SWAYAM UGC online courses 	
<ul style="list-style-type: none"> • CCPR- core course practical 	<ul style="list-style-type: none"> • Total Credit for M. Sc. Course: 96
<ul style="list-style-type: none"> • <i>Separate passing is mandatory for theory, internal and Practical</i> 	<ul style="list-style-type: none"> • Total Marks for M. Sc. Course: 2400

M.Sc. Programme Structure of Zoology
Part – II(CBCS pattern) (2020-2021)

Sr. No.	Course Code	Course Title	Credits
SEMESTER - III			
1	CC-301	Genetics	4
2	CBE-302	Enzymology	4
		Laboratory Animals in Biomedical Research	
Cell Biology			
3	CCS-303	Molecular Biology of the Gene	4
4	CCS-304	Developmental Biology	4
Physiology			
	CCS-303	Animal Physiology	4
	CCS-304	Applied Physiology	4
Entomology			
3	CCS-303	Basic Entomology	4
4	CCS-304	Agricultural Entomology	4
Aquaculture and Fisheries			
3	CCS-303	Fisheries Resources — Inland and Marine Fisheries	4
4	CCS-304	Fish Pathology and Reproductive Endocrinology	4
Sericulture			
3	CCS-303	General Sericulture and management of mulberry	4
4	CCS-304	Silkworm Biology & Rearing Technology	4
5	OE-I/SWM-I		2
SEMESTER - IV			
1	CC-401	Animal Cell Culture	4
2	CBE-402	Toxicology	4
		Evolution and Behaviour	
Cell Biology			
3	CCS-403	Immunology	4
4	CCS-404	Cell Pathology	4

Physiology			
3	CCS-403	Physiology of Health	4
4	CCS-404	Clinical Physiology	4
Entomology			
3	CCS-403	Insect Anatomy and Physiology	4
4	CCS-404	Pest Management Concepts	4
Aquaculture and Fisheries			
3	CCS-403	Aquaculture Practices	4
4	CCS-404	Fishery Technology	4
Sericulture			
3	CCS-403	Silkworm Biology & Rearing Technology	4
4	CCS-404	Silkworm seed, silk production technology and Economics	4
5	OE-II / SWM - II		2
PRACTICAL ANNUAL			
9	CCPR-405	Practical – III (Based on CC-301, CBE-302, CCS-303, CCS-304)	8
10	CCPR-406	Practical – IV (Based on CC-401, CBE-402, CCS-403, CCS-404, Project, seminar based on specialization, Submission of tour/field visit report)	8
Total Credits			48

M.Sc. Zoology
Choice Based Credit System
M. Sc. II, Sem.-III
CC-301: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. Genetics basis of sex determination in human beings.
5. Y linked genes, X linked genes,
6. Dosage compensation
7. Testicular feminization 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 Defense 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 to Genetic counseling.
2. Ethical and psychological approach in genetic counseling
3. Family pedigree.
4. Inheritance and acquired genetic defects
5. Prenatal genetic counseling and diagnosis.

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 By Hartl and Clark
10. Gene Clones By Ernst Winnacker

M.Sc. Zoology
Choice Based Credit System
M. Sc. II, Sem.- III
CBE-302:Enzymology

Unit- I: (15 Hrs.)

1. Classification and Nomenclature of Enzymes, Isoenzymes, Multienzyme Complexes.
2. Cofactors.- Inorganic, Organic: Pyridoxyl Phosphate, Biotin, Lipoic acid, Thiaminediphosphate, 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 temperate., 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, The Pyruvate dehydrogenase.
2. **Enzyme Technology**- Use of isolated enzymes in industrial processes, Immobilized enzymes.

Suggested Reading Material:

1. Fundamentals of Enzymology : Price N.C. and L. Stevens e.. Oxford, New York.
2. Dixon, M., Webb, E.C; et al. (3rd Ed.) Longman, London.
3. Methods in Enzymology all volumes.
4. Scopes, R.K. Protein Purification, Principles and Practice Ferdinand, 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, Blackwell, scientific oxford (1985).
7. Bulock, J. and Kristiansen, B- (1987) Basic biotechnology.

M.Sc. Zoology
Choice Based Credit System
M. Sc. II, Sem.- III
CBE-302:Laboratory Animals in Biomedical Research

Unit –I: Animal Care and Management of Laboratory Animals. (15 Hrs.)

- Rat
 - Mouse
 - Rabbit
 - Guinea pig
- i) Animal House – Necessities Design and maintenance:
Infrastructure, Cages, Conditions and other requirements for
Maintenance, Biology of four laboratory animals
- ii) Breeding cycles and Breeding and maintenance
- iii) Nutritional requirements for normal breeding and maintenance
- Modifications for nutritional experimental work (at least two examples viz. protein deficient diet and supplementation)

Unit - II: Animal ethics and associated laws and issues (15 Hrs.)

Unit - III: Physiological models and their use in drug testing (15 Hrs.)

- A. Testing for Endocrinological and Reproductive Biological studies
- *In vivo* studies of estrous cycle, implantation, pregnancy
 - Gonadectomy, Adrenalectomy, Hypophysectomy, Sham operated rats
 - Hormonal supplementation studies
- B. For liver toxicity (Acute, chronic, cirrhosis)
- Drug induced liver toxicity CCl₄ model, paracetamol model, cirrhosis model
- C. Aging Models:
- Drug induced models (Galactosamine)
 - Naturally aged animals
- D. Models for diabetes
- Physiological models
- E. Hypercholesterolemia models
- Thyroidectomised rat
 - Drug induced (Sodium cholate) rats
- F. Models to study immunological phenomena
- Paw edema
 - Granulomata
 - Hypersensitivity models
 - Surgical models
 1. Thymectomy
 2. Splenectomy

G. Other animal models

- Angiogenesis in chick
- Chick development model
- Other animal models.

Unit – IV: New trends in Animal Experimental Biology

(15 Hrs.)

- i) Cloned animals and their use:
 - Preparation of the Cloned animals and maintenance
- ii) Genetically engineered animals and their use
 - To develop and maintain
 - Transgenic animals
 - Knock out animals.

Suggested Reading Material:

1. Javier Guillen Laboratory Animals (2nd Edition) Regulations and Recommendations for the Care and Use of Animals in Research, Academic Press.
2. George G. Krinke (Ed.). Handbook of Experimental animal, The laboratory RAT, Academic Press
3. Institute of Animal Resources (1954), Handbook of Laboratory Animals, National Academy of Sciences-National Research Council, Washington, D. C.
4. Jann Hau and Gerald L. Van Hoosier, Jr (Eds.) (2003) Handbook of Laboratory Animal Science (Vol. 1), Essential Principles and Practices, CRC Press, Washington, D.C.
5. Institute for Laboratory Animal Research (2011) Guide for the Care and Use of Laboratory Animals (8th Edition), The National Academies Press, Washington, D. C.

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Cell Biology
Elective paper - I
CCS-303: Molecular biology of the gene

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

1. Chromosome as a carrier of genes
2. Linkage groups, genetics maps, crossing over and genetic recombinations
3. Genetic recombinations analysis in Drosophilla
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 Transposones
 - b) LTR Retrotransposones
 - 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

Suggested Reading Material:

1. Genes by Benjamin Lewin.
2. Molecular Biology of the gene by Watson
3. An introduction to genetic engineering By Desmond S.T. Nicholl

M.Sc. Zoology
Choice Based Credit System
M.Sc.-II, Sem.- III
Core Course Specialization: Physiology
Elective paper - I
CCS-303:Animal Physiology

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 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: Resent 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 London, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart 7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Michel, C.C. (eds) American Physiological Society, 1984.
5. Guyton 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- Cardiac 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 bookco., 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.Louis C.V. Mosby Co.,
15. Felig P et al (eds) 1987. Endocrinology & Metabolism New York MacGraw- Hill Book

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Entomology
Elective paper - I
CCS-303: Basic Entomology

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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Aquaculture and Fisheries
Elective paper - I

CCS-303: Fisheries Resources — Inland and Marine Fisheries

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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Sericulture
Elective paper - I

CCS-303: General Sericulture and management of mulberry

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 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. Gubrajani, M.L. (1986): Silk Dyeing, printing and finishing, IIT, New Delhi.

4. Ferguson, A. (1980): Biochemical Systematics and Evolution: Blankie Publications: Glasgo, London.
5. Yokoyama, T. (1959): Silkworm Genetics illustrated: Japan Society for Promotion of Science, Tokyo.
6. King, L.A. and Posse R.D. (1990): Baccuiovirus Expression System? Chapman and Hall, London.
7. Byung, Jo. (1987): Silk Textile Engineering, Moon, Halk Publication Scol. Korea.
8. Rayner Hollin (1903): Silk Throwing and Waste Silk Spinning Scott. Greewood and Sons, London.
9. Koshy, T.D. (1990): Exports and Development, Ashish Publications, New Delhi.
10. Singh, B.D.: Plant breeding, Kalyani Publishers, New Delhi.
11. Tazima, Y. (1978): The silkworm. An important laboratory tool, Hodansha Publication, Tokyo.
12. Anonymous (1972): Hand Book of silk rearing, Agriculture techniques Manual I., Fuji Publication, Tokyo.
13. Jolly, M.S.: Appropriate Sericultural Techniques CSR and TI Mysore.
14. Strunnikov, V.A. (1983): Control of silkworm reproduction, Development and sex MIR publications, Moscow.
15. Jolly, M.S. Sen S.K. and Ahsan M.M. (1974): Tassar culture, CSTRI, Ranchi.
16. FAO, Volumes (1-4), Central Silk Board, Bangalore

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Cell Biology
Elective paper - II
CCS-304: DEVELOPMENTAL BIOLOGY

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 Neuralation (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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Physiology
Elective paper - II
CCS-304: Applied Physiology

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' **15 Hrs.**

- 3.1 Laboratory equipment's- Ergonomics and its applications.
- 3.2 Ergonomic working and applications of Spigmomanometer, 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 London, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart 7th ed. New York McGraw- Hill Book Co. 1990.
4. Hand Book of Physiology Vols. Circulation. Renkin, E.M. & Michel, C.C. (eds) Americal Physiological Society, 1984.
5. Guyton 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 gastrointestind tract 1987 New York Raven press.
12. Thampson J.C. et al (eds) Gastrointestinal Endocrinology. New York McGraw Hill bookco., 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 BookCo.,
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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Entomology
Elective paper - II
CCS-304: AGRICULTURAL ENTOMOLOGY

Unit –I: **(15 Hrs.)**

1. Definition of Pest, General characters, Habitats, Damage, Economic Threshold Level, Economic Injury Level, Causes for insect assuming pest status, Types of damage to plant by insects and their estimation.

Identification, characteristics, biology, damage and Management of important agricultural pests.

2. Pests of Cereals:

Paddy and Jowar stem borers, midge fly, aphid, Grasshopper, Paddy Leaf hoppers, armyworm, cutworm, and blister beetle.

3. Pests of pulses:

Gram pod borer, Cutworms, Turplume moth, TurpodBug, Turpod fly, Lentilpodborer, and Beanfly.

Unit –II: **(15 Hrs.)**

4. Pests of fruits and fruit trees (Temperate):

Sanjose scale, apple wooly aphid, white fly, cherry stem borer, codling moth, apple stem borer, peach fruit fly and Almond weevil.

5. Pests of fruits and fruit trees:

Citrus caterpillar, citrus psylla, citrus white fly, citrus fruit moth, Mango stem borer, Mangojassid, Mango mealy bug, Mango stone weevil, Mango fruitfly, Grapevine mealy bug, grapevine thrips, Pomegranate (anar) butterfly, Banana weevil, papayaAK grasshopper

Unit –III: **(15 Hrs.)**

6. Pests of sugar cane:

Sugarcane woolly aphids, White grubs, borers, Pyrilla, Whitefly, Mealybug, Termites.

7. Pests of fiber crops:

Cotton pink boll worm, Spotted boll worms, American boll worm, Red cotton bug, Dusky cotton bug, cotton aphid, cotton leafroller, Bihar hairy caterpillar on jute and sun hemp capsid.

8. Pests of Oilseed Crops:

Mustard aphid, Mustard Sawfly, groundnut aphid, groundnut stemborer, cutworm, Bihar hairy caterpillar white grub, castor semilooper, castor capsule borer, Til hawkmoth, linseed gall midge, Sunflower head borer, safflower aphid.

Unit –IV:

(15 Hrs.)

9. Pests of vegetable crops:

Cabbage caterpillar, Diamond back moth, potato tuber moth, Onion thrips, Brinjal fruit & stem borer, Jassid, mealy bug, whitefly, Red pumpkin beetle and Hadda beetle.

10. Pests of plantation crops:

Coffee stem borer, coffee shoot-hole borer, Tea mosquito bug, coconut weevil, and Rhinoceros beetle

11. Pests of Spices and Narcotic:

Chilli thrips, castor capsule borer, white grub, Bihar hairy caterpillar, Tobacco caterpillar, Tobacco aphid and Hesperid caterpillar.

Suggested Reading Material:

1. Agricultural pest of India and South East Asia, By A.S. Atwal, Kalayni publ. New Delhi.
2. Hand Book of Economic Entomology for South India by T.U. RamkrishnaAyyar.
3. A textbook of Agricultural Entomology. ICAR New Delhi by Druthi S.H.
4. A text book of Applied Entomology, By K.P. ShrivastavaKalyani Publ. New Delhi.
5. Agrochemicals and pest management, DPH New Delhi by T.V. Sathe.
6. Modern Entomology by Tembhare

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Aquaculture and Fisheries
Elective paper - II
CCS-304: Fish Pathology and Reproductive Endocrinology

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

Signs of sickness in fishes, defensive devices 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 in Relation to Pulic 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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Sericulture
Elective paper - II
CCS-304: Silkworm Biology & Rearing Technology

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.)

Protozoan 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): Sericulture 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. Statistical Biennial, CSB Publication, Bangalore.
7. Bibliography on Mulberry, CSIR and IIT, Mysore.
8. A Treatise on acid treatment of silkworm eggs, CSR and TI, Mysore.
9. Probe / Kematic soils of tropical mulberry garden and their management, CSR & TI,

Mysore.

10. Tips for successful silkworm cocoon crops, CSR and TI, Mysore.
11. Tips for successful bivoltine silkworm cocoon crops, CSR and TI, Mysore.
12. M.V. Samson, Chandrashekharaih, P. Gowde and Saheb B. (1995): Monograph on silkworm loose egg production, SSTC, CSB, Bangalore.
13. CSTRI improved multiple reeling machines, CSRTI CSB Bangalore, 1995.
14. CSTRI improved Charkha, 1995, SCTRI, CSB, Bangalore.
15. Water Management in silk reeling machine, CSTRI CSB, Bangalore, 1995.
16. FAO, Volumes (1-4), Central Silk Board, Bangalore

M. Sc. Zoology
Choice Based Credit System
M. Sc. II, Sem.-IV
CC-401: Animal Cell Culture

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

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
Choice Based Credit System
M. Sc. II, Sem.-IV
CBE-402: TOXICOLOGY

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 LD₅₀/ LC₅₀ 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 Pyrethroids 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, Rastroggi 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
Choice Based Credit System
M. Sc. II, Sem.-IV
CBE-402: EVOLUTION AND BEHAVIOUR

Unit- I: (15 Hrs.)

A. Emergence of evolutionary thoughts

Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Spontaneity of mutations; The evolutionary synthesis.

B. Origin of cells and unicellular evolution:

Origin of basic biological molecules; Abiotic synthesis of organic molecules; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

Unit- II: Paleontology and Evolutionary History: (15 Hrs.)

A. The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms.

B. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, origin of new genes and proteins; Gene duplication and divergence.

Unit- III. The Mechanisms of Evolution: (15 Hrs.)

A. Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift;

B. Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

Unit - IV: Brain, Behaviour and Evolution: (15 Hrs.)

A. Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks;

B. Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Suggested Reading Material:

1. Organic evolution by Veer Bala Rastogi
2. Evolutionary Biology by S P Singh and B S Tomar
3. Introduction to Evolutionary Biology by Fatik Baran Mandal
4. Evolutionary Biology: Volume 6 by Theodosius Dobzhansky, Max K. Hecht, et al.
5. Animal Behaviour (Ethology) by Agarwal V.K.
6. Textbook Of Animal Behaviour by Mandal Fatik Baran

7. Lee Alan Dugatkin (2004) Principles of Animal Behaviour (2dn Ed.), W. W. Norton and Company, New York, London
8. Peter Kappeler (Ed.), Animal Behaviour: Evolution and Mechanisms, Springer Heidelberg Dordrecht London New York

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Cell Biology
Elective paper - III
CCS-403: Immunology

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 repertoire
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
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Physiology
Elective paper - III
CCS-403: Physiology of Health

Unit – I: Pathophysiology of gastrointestinal system (15 Hrs.)

- 1.1. Digestive glands
- 1.2. Swallowing and esophagus
- 1.3. Stomach
- 1.4. Small intestine
- 1.5. Appendix
- 1.6. Large intestine- constipation, diarrhea, and defecations.

Unit – II: Pathophysiology of respiratory and circulatory systems (15 Hrs.)

- 2.1. Respiratory insufficiency- Chronic pulmonary Emphysema, Pneumonia, Atelectasis, Asthama, Tuberculosis.
- 2.2. Hypoxia, Hypercapnia, Hypocapnia.
- 2.3. Haemolysis and clotting defects
- 2.4. Congenital and Ischemic heart diseases,
- 2.5. Hypertension, cardiac arrest and heart failure.
- 2.6. ECG-defect, Angiogram and Angioplasty.

Unit – III: Pathophysiology of Renal system (15 Hrs.)

- 3.1. Acute renal failure- Peripheral internal and post renal failure.
- 3.2. Chronic renal failure – injury to glomeruli and nephron
- 3.3. Hypertensions and kidney diseases.
- 3.4. Uremic toxicity, dialysis and artificial kidney.
- 3.5. Kidney transplantation.

Unit – IV: Pathophysiology of Nervous (15 Hrs.)

- 4.1. Disorders of Cerebrospinal fluid (CSF)
- 4.2 Pathophysiology of Psychosis
- 4.3 Pathophysiology of Epilepsy
- 4.4 Pathophysiology of Alzimers diseases
- 4.5 Pathophysiology of Parkinson's
- 4.6. Inherited neurological disorders.

Suggested Reading Material:

1. Human Physiology – by A.C. Guyton. Saunders Company London, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart 7th 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. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.

8. Guthrie H.A. 1988. Introductory Nutrition 7th ed. St.Louis C.V. Mosby Co.,
9. Feligetal (eds) 1987.Endocrinology & Metabolism New Your MacGraw- Hill Book Co.,
10. DeGroot L.J. et al 1989. Endocrinology 2nd ed. Philadelphia, W.B. saunders Co. 1989.
11. Kannan, C.R. 1988. The adrenal gland New York Plenum Pub. Corp.
12. Wozney J.M. et al 1988. Novel regulators of bone formation: Molecular clones &cultivates science 242: 1528.
13. Martin R.B. & Burr D.B. 1989. Structure, function & adaptation of compact Bone New York, Raven Press 1989.
14. Knobil E. et al (eds) The physiology of Reproduction New York, Raven Press 1988.
15. Leung P.C.K. et al (eds) Endocrinology & Physiology of reproduction New York Plenum, Pub. Corp. 1987.

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Entomology
Elective paper - III
CCS-403: Insect Anatomy and Physiology

Unit – I: (15 Hrs.)

1. THE INTEGUMENT:

- 1.1. Structure of Integument.
- 1.2. Physiology of Integument.
- 1.3. Functions of Integument.

2. DIGESTIVE SYSTEM AND ITS PHYSIOLOGY

- 2.1. The Alimentary canal and associated glands.
- 2.2. Digestion and Absorption
- 2.3. Enzyme dynamics.

Unit – II: (15 Hrs.)

1. RESPIRATION

- 1.1 Organs of Respiration- Tracheae, Tracheoles, Airsacs and Spiracles.
- 1.2 Types of tracheal systems.
- 1.3 Mechanism of gaseous exchange within tracheole
- 1.4. Respiration in aquatic and parasitic insects.

2. CIRCULATION

- 2.1. Structure of Circulatory organs- Dorsal vessel and Accessory pulsatile structures.
- 2.2. Haemolymph- Composition and function.
- 2.3 Haemocytes- Types and function.
- 2.4 Mechanism of Circulation.

3. EXCRETION

- 3.1 Excretory organs – Malpighian tubules and other excretory structure.
- 3.2 Physiology of Excretion
- 3.3 Osmoregulation.

Unit – III: (15 Hrs.)

1. NERVOUS SYSTEM

- 1.1 Neuron- structure and type
- 1.2 Central nervous system.
- 1.3 Physiology

2. ENDOCRINE SYSTEM.

- 2.1 Endocrine organs.
- 2.2 Neurosecretory cells
- 2.3 Hormones and their functions

Unit – IV: (15 Hrs.)

1. REPRODUCTION.

- 1.1. Male Reproductive system.
- 1.2. Female Reproductive system.
- 1.3. Physiology and reproduction.

2. EMBRYONIC DEVELOPMENT

- 2.2. Cleavage and Blastoderm Formation.
- 2.3. Formation and Growth of germ band.
- 2.4. Gastrulation.
- 2.5 Formation of amnion
- 2.6 Segmentation

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
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Aquaculture and Fisheries
Elective paper - III
CCS-403: Aquaculture Practices

Unit - I: (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 - II: (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 - III: (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 - IV: (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 involved, methods of 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
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Sericulture
Elective paper - III
CCS-403: Breeding of silkworm , mulberry and cytogenetics

Unit - I: Mendel's principles (15 Hrs.)

Law of dominances, Segregation and Independent assortment, monohybrid, dihybrid and poly-hybrid crosses

Silkworm as laboratory tool for genetic studies, Heredity and environment,

Genotype and phenotype, heredity and variation, distinguishing heredity and environmental variation in pure line and inbred line, Heredity traits and effect of environment on silkworm stages.

Unit - II: Chromosomes and effect of environment (15 Hrs.)

Linkage maps, inheritance of cocoon colour, environmental influence and hormonal control

Inheritance of voltinism, multivoltinism, environment influence and hormonal control

Sex determination, sex linked, sex limited traits and their special significance in sericulture

Chromosome number and nature of chromosomes, parthenogenesis, gynogenesis androgenesis, polyploidy and population genetics

Unit –III: Breeding of silkworm and management (15 Hrs.)

Origin and distribution of silkworm races,

Present status of silk worm breeding in India,

Pre-requisites, aims and objectives of silkworm breeding

Methods of breeding- Line breeding, Cross breeding, Mutation breeding

Selection methods- Individual and family selection, Advantages and disadvantages

Effect of inbreeding, Homozygosity,

Heterosis and combining ability in silkworm, Hybrid vigor for different characters,

Hybrid vigor and environment

Theoretical basis of heterosis and utilization of heterosis in sericulture

Combining ability tests, Maintenance of races and strains

Management of genetic resources: Collection, conservation, characterization and evaluation of silkworm breeds and their maintenance

Unit –IV: Breeding of Mulberry and management (15 Hrs.)

Cytological aspects of mulberry with an emphasis on their chromosomes,

Linkage and Crossing over- Linkage groups and linkage maps,

Objectives of plant breeding, Genetic viability and it's role in plant breeding, Methods of reproduction and breeding methods in self pollinated and cross pollinated plants, Breeding for draught and disease resistant plants, Mutations and polyploidy and its role in host plant breeding. Polyploidy and its practical utility

Suggested Reading Material:

1. Hand spinning on CSTR spinning wheel, 1995, Mysore.
2. Bivoltine grainage for tropics, M.S. Jolly.
3. Economics of sericulture under rain fed conditions, M.S. Jolly.
4. Economics of sericulture under irrigated conditions, M.S. Jolly.
5. Silkworm rearing and disease of silkworm (1956): Printed by the Director of printing, Stationary and publications at the Government Press.
6. Gopalchar, A.R.S. (1978): Three decades of Sericultural progress, CSB, Bangalore.
7. Narasimpanna, M.N. and Ullal, R.S. (1981): Hand book of practical Sericulture, CSB Publication.
8. Tanaka, Y. (1964): Sericology, CSB Publication Bangalore.
9. Ullal, S.R. (1968): Sericulture in USSR A study report, CSB, Bangalore.
10. Berch (1979): Insect Pheromones.
11. Boyer, H.W. and Nicosia S. (1979): Genetic Neginengineering, Elsetie/ North Holland, Biomedical Press, Amsterdam, New York.
12. Davidson, G. (1974): Genetic control of Insect Pests, Academic Press, London.
13. Gorbman, A and Bern, H. (1974): Text Book of Comparative endocrinology Wiley Eastern, New Delhi.
14. Imms, A.D. (1961) General Text book of Entomology Edn. 9 Rev. by O.W. Rochards and R.G. Davis.
15. Lavine, L. (1969): Biology of the gene, Saint Louis, Mosby.
16. FAO, Volumes (1-4), Central Silk Board, Bangalore

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Cell Biology
Elective paper - IV
CCS-404: Cell Pathology

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: Ageing (15 Hrs.)

1. Mechanism of ageing (Theories of ageing)
2. Cellular changes during ageing
3. Molecular changes during ageing
4. Immunological changes during ageing
5. Accumulation of toxins and chemical garbage, formation of lipofuscin granules
6. Ageing and cell cycle
7. Strategies against ageing

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

1. DNA synthesis (Mitomycin)
2. RNA synthesis (Actinomycin and Rifampicin).
3. Protein synthesis (Cyclohexamide, Tetracyclins, Chloramphenicol, streptomycins).
4. 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
Choice Based Credit System
M. Sc.-II, Sem.- III
Core Course Specialization: Physiology
Elective paper - IV
CCS-404: Clinical Physiology

Unit – I: Pathophysiology of Endocrine glands (15 Hrs.)

- 1.1. Pituitary glands
- 1.2. Thyroid glands
- 1.3. Parathyroid glands
- 1.4. Endocrine pancreases.
- 1.5. Adrenal gland
- 1.6. Gonads- Testis, Ovaries.

Unit – II: Pathophysiology of Special senses (15 Hrs.)

- 2.1. Hearing defects
- 2.2. Ocular defects
- 2.3. Hyperthermia and Hypothermia.
- 2.4. Defects in Chemoreception.

Unit – III: Pathophysiology of Blood and immunity (15 Hrs.)

- 3.2. Genetic blood disorders
- 3.3. Polycythemia and Leukemia
- 3.4. Types of immunity and its mechanisms
- 3.5. Hypo and Hypersensitivity mechanism

Unit – IV: Cancer Biology (15 Hrs.)

- 4.1. Introduction and mechanism of different types of carcinoma
- 4.3. Brain cancer
- 4.4. Breast cancer
- 4.4. Skin cancer
- 4.5. Malignancy of Gonadal cells
- 4.6. Altered biomechanics in cancer cells.

Suggested Reading Material:

1. Human Physiology – by A.C. Guyton. Saunders Company London, Toronto.
2. Shepherd G.M. Neuro Biology, New York Oxford University Press 1987.
3. Hurst J.W et al (eds) The Heart 7th ed. New York McGraw- Hill Book Co. 1990.
4. Brenner B.M. & Rector, F.C. (Jr) 1986. The kidney 3rd ed. Philadelphia, W.B. Saunders Co., 1986.
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 bookco., 1987.
8. Setchell K.D.R. et al eds 1988. The Bile Acids New York Plenum Pub. Corp.
9. Guthrie H.A. 1988. Introductory Nutrition 7th ed. St. Louis C.V. Mosby Co.,
10. Felig P et al (eds) 1987. Endocrinology & Metabolism New York MacGraw- Hill BookCo.,

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

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Entomology
Elective paper - IV
CCS-404: PEST MANAGEMENT CONCEPTS

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. Behavioural 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 JyotiOulkar, 2010.
9. Vermiculture and Organic Farming – T.V. Sathe, 2004.

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Aquaculture and Fisheries
Elective paper - IV
CCS-404: Fishery Technology

Unit - I: (15 Hrs.)

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 - II: (15 Hrs.)

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, Equipments used in the Maintenance of Aquarium, Common diseases of aquarium fishes, Common freshwater aquarium fishes, Maintenance routine

Unit - III: (15 Hrs.)

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 - IV: (15 Hrs.)

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
Choice Based Credit System
M. Sc.-II, Sem.- IV
Core Course Specialization: Sericulture
Elective paper - IV
CCS-404: Silkworm seed, silk production technology and Economics

Unit –I: Silkworm seed production technology and management (15 Hrs.)

Concept of P4,P3,P2 and P1 , Rearing of P1 seeds
Silkworm egg production process
Embryonic development,
Diapause and non-diapause eggs,
Incubation of eggs and related aspects
Entrepreneurship in silkworm seed production (LSP)

Unit –II: Silk production technology and management (15 Hrs.)

Brief introduction of natural and synthetic fibers
General silk industry in various states of India
Assessments cocoon properties
Storage & preservation of cocoons in silk reeling units, Cocoon cooking,
Silk reeling, Cocoon stifling, re-reeling, Raw silk testing, Spun silk yarn, Silk weaving.
Entrepreneurship development in silk reeling,weaving and marketing

Unit –III: Organization ,marketing, value addition and economics of sericulture (15 Hrs.)

Organizational set up of sericulture in state and country
Economics of mulberry cultivation practices
Economics of commercial cocoon production
Economics of seed cocoon production
Economics of 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: (15 Hrs.)

Central Silk Board, Directorate of Sericulture
Methods and various departments involved in extension education
Concept of Extension education
Classification of various extension teaching methods its importance
Mhareshimabhiyan , Various govt .,schemes

Suggested Reading Material:

1. Odum, E.P. (1971): Fundamentals of Ecology, Philadelphis, Saunders.
2. Wigglesworth, V.B. (1956): Insect Physiology Edn. 5 Rev. Methuen, London.
3. Novak, V.J.A. (1995): Insect hormones Chapman and Hall, London.
4. Chapman, R.R. (1985): Insect Structure and Functions, ELBS Publ. New Delhi.
5. Ganga, G and Chetty, S.J. (1997): An Introduction to Sericulture, 2nd Edition, Oxford and IBH Publishing Co. Ltd. New Delhi.
6. Mohan Rao M.M. (1988): A text Book of Sericulture BSP Publications, Sultan Bazar, Hyderabad.
7. Ahuja, H.L. Advanced Economic Theory, S. Chand and CO. Ltd. New Delhi.
8. Stonier and Hauge: A Text book of Economic Theory.
9. Crop production, Sericulture and Apiculture Part VI, Report of the National Commission on Agriculture, 1976.
10. Hisao, Aruga: Principles of Sericulture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
11. Sinha, H.: The Development of India Silk. Oxford and IBH Publishing Co. Ltd. New Delhi.
12. Devaika Lecturers in Sericulture.
13. Sarkar, D.D. Silkworm Biology, Genetics and Breeding. Vikas Publications, New Delhi.
14. Sathe TV and Jadhav AD, (2001) Sericulture and pest management. Daya publication New-Dehli.
15. Jadhav AD et al., (2012). KimyaReshimShetitoonLaxyadhishHonyachi, Silk Society of India, Nagpur
16. FAO, Volumes (1-4), Central Silk Board, Bangalore

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
CCPR- 405: Practical III

Practical based on paper (CC-301, CBE-302, CCS-303, CCS-304)

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

Based on CBE-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.

Based on CBE-302: Laboratory Animals in Biomedical Research

1. Handling and feeding of the animals
2. To study estrous cycle (rat and mouse) and breeding
3. Gonadectomy and Steroidal hormone supplementation study
4. CCl₄ toxicity *in vivo* and *in vitro*.
5. Paracetamol toxicity *in vivo* and *in vitro*.
6. Studies of drug induced and natural ageing
7. Study of Diabetes Models
8. Study of Surgical and drug induced hypercholesterolemia in rat
9. Study of Paw Edema in rat
10. Studies of granulomata in rat
11. Studies of Hypersensitivity models
12. Splenectomy

Based on CCS-303 and CCS-304: Cell Biology special Papers

1. Isolation of DNA
2. Isolation of RNA
3. Estimation of DNA
4. Estimation 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. Study of eye lenses differentiation in chick embryo.
19. Study of nervous system development in chick embryo.
20. Study of Angiogenesis in chick embryo.
21. Study of Dorsal nerve root development in chick embryo
22. Effect of colchicines on development of dorsal nerve root in chick embryo
23. Demonstration of stem cells renewal by mitosis (liver cells Intestinal crypt cells. Bone marrow cells – demonstration of cell division by fFeulgen technique).
24. marrow cells – demonstration of cell division by fFeulgen technique).
25. Study of blastulation in amphioxus and frog
26. Study of gastrulation in amphioxus and frog
27. Study of partial hepatectomy in mice.
28. Any other experiments / practicals set by the Department.

Based on CCS-303 and CCS-304: Physiology special Papers

- 1) Study of histology and histochemistry of reproductive organs.
- 2) Vaginal smear technique.
- 3) Study of Uterine muscles.

- 4) Study of sperm count.
- 5) Capacitation and motility of sperm.
- 6) Study of placental type.
- 7) Contraceptive devices.
- 8) Gonadectomy in white rat
- 9) Estimation of lactate content of rat blood.
- 10) Estimation of calcium content of rat blood.
- 11) Determination of PEFr.
- 12) Study of physical fitness by Step Test method
- 13) Determination of Grip strength.
- 14) To study effect of work load on finger muscle by Finger Ergometry.
- 15) Absorption spectra of blood pigments.
- 16) Estimation of Chloride content in rat blood.
- 17) Visit to the industrial area to study man- machine environment.
- 18) Demonstration of principal of dialysis.
- 19) Demonstration of IVF procedure (Lab. visit).
- 20) Project work/ Review articles.
- 21) Study of bio-equipment's and their ergonomics features
- 22) Any other practical set by concern teacher.

Based on CCS-303 and CCS-304: Entomology special Papers

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. Pests of cereals.
10. Pests of pulses.
11. Pests of fiber crops.
12. Pests of fruit and fruit trees.
13. Pests of Oil seed crops.
14. Pests of Vegetable crops.
15. Other agricultural important insect pests
16. Field visit to study nature pest damage.
17. Any practical set by the concerned teacher

Based on CCS-303 and CCS-304: Aquaculture and Fisheries special Papers

1. Identification of important food fishes, prawns and molluscs 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, CO₂, Alkalinity, Inorganic nitrate and Phosphate from water sample
7. Qualitative analysis of digestive enzymes

8. Identification of diseased fish – Bacterial, fungal and viral infections (Slides)
9. Blood glucose estimation in fish
10. Sexual dimorphism and secondary sexual characters in fishes
11. Short term bioassay of LC50 determination (Demonstration)
12. Field trips and study tours to fish farms, fisheries institute, or national laboratory etc..
13. Any practical set by the concerned teacher / Department.
14. Allotment of project work which is to be submitted in semester IV
15. Any other experiment set by the teacher/ Department.

Based on CCS-303 and CCS-304: Sericulture special Papers

1. Morphology of egg, larva, pupa and adult of mulberry and non-mulberry silkworms
2. Dissection of silkworm for
 - Digestive system
 - Nervous system
 - Circulatory system
 - Reproductive system (Moth)
3. Demonstration of mulberry cultivation.
4. Preparation of mulberry saplings
5. Demonstration of pruning and application of chemical fertilizers
6. Preparation of herbarium of mulberry and non-mulberry host plants.
7. Study of anatomy of leaf, stem and petiole
8. Collection and preservation of mulberry pests
9. Study root and foliar diseases of mulberry
10. Study of *B. mori* silkworm rearing appliances.
11. Rearing of mulberry silkworm (*B. mori*)
12. Rearing of Tasar silkworm (*A. mylitta*)
13. Rearing of Eri silkworm (*P. ricini*)
14. Field visit to silkworm rearing at farmer's level and govt farm
15. Any other experiment set by the concerned teacher

M. Sc. Zoology
Choice Based Credit System
M. Sc.-II, Sem.- IV
CCPR- 406: Practical IV

Practical based on paper (CC-401, CBE-402, CCS-403, CCS-404)

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 CBE-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.

Based on CBE-402: Evolution and Behaviour

1. Effect prodigality of reproduction on Natural selection in paper creatures
2. Effect of mutations on Natural selection in paper creature.
3. The causes of evolution; Hardy-Weinberg equilibrium

4. Study of evolutionary evidences – vestigial organs, fossils and embryological evidences.
5. Study of monkey and human skull - A comparison to illustrate common primate and unique Hominin features
6. Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-adaptation and co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens
7. Sampling for discrete characteristics (dominant vs recessive) for discontinuous variations e.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe.
8. To study the effect of light and darkness on the chromatophores of fish.
9. Study of predation behaviour in spider.
10. To study the effect of light/darkness on development of insect (Spodoptera).
11. Study of Courtship Behaviour in house fly.
12. To study the median threshold concentration of sucrose solution in eliciting feeding responses of housefly.
13. Identification of various behaviours in animals- Altruistic, camouflage, feeding, courtship, social.
14. Identification and Making video clips of any one type of animal behaviour from surrounding.
15. To study Diurnal variations in human body temperature
16. Any experiment designed by a teacher.

Based on CCS-403 and CCS-404:Cell Biology special Papers

1. Histology of Lymphoid organ- Skin, 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. Study of unilateral renal necrosis
15. Study of histology of stressed kidney
16. Study of histology of necrotic kidney
17. Age related lipid peroxidation in various organs of rat / mouse.
18. Demonstration of lipofuscin granules in brain of aged (natural & induced) rat / mouse.
19. Drug induced lipid peroxidation in liver & kidney (CCl₄ / any suitable drug).
20. Any other practical / experiments set by the Department.

Based on CCS-403 and CCS- 404:Physiology special Papers

- 1) Study of blood indices.
- 2) Effect of toxicant / drug to the digestive/ reproductive cell/ glands (Histology and Histochemistry).
- 3) Qualitative test of Carbohydrate, Protein and fatty acids.
- 4) Determination of Oxygen Consumption in fish.
- 5) Effect of pH on Amylase activity.
- 6) Study of Electrocardiogram (ECG).
- 7) Study of Arterial blood pressure (BP).
- 8) Effect of Insulin on blood sugar level.
- 9) Effect of Adrenalin on blood sugar level.
- 10) Study of colour index from blood sample by using haemocytometer.
- 11) To study effect of temperature on enzyme activity
- 12) Effect of temperature on heartbeat.
- 13) Demonstration of role of brain hormones in developmental stage.
- 14) Determination of Calcium in given sample of blood plasma.
- 15) Separation of serum proteins by Electrophoresis.
- 16) Estimation of blood Cholesterol.
- 17) Tracheactomy in rat
- 18) Pancreactomy in rat

Based on CCS-403 and CCS-404:Entomology special Papers

1. Dissection of any pest to study digestive, nervous and reproductive system.
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. Qualitative estimation of nitrogenous waste products in the excreta of Cockroach.
9. Study of insecticide appliances.
10. Insect pest damage detection.
11. Study of economically important parasitoids (Biocontrol agents).
12. Study of economically important insect predators (Biocontrol agents).
14. Identification and economic importance of vertebrate biocontrol agents of insect pests.
15. Study of weed controlling insects.
16. Any practical set by concerned teacher.
17. Project work

Based on CCS-403 and CCS-404:Aquaculture and Fisheries special Papers

- 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. Identification and control measures of aquatic weeds and insects

6. Assessment of pollutants from farm water – heavy metals and pesticides
7. Estimation of primary productivity of water sample by light and dark bottle experiment.
8. Qualitative and quantitative study of zooplankton.
9. Method of fish preservation.
10. Project report / Review article.
11. Any other experiment set by the concerned teacher.

Based on CCS-403 and CCS-404:Sericulture special Papers

1. Visit to commercial grainage centre
2. Study of grainage building and grainage equipments
3. Identification of Seed Cocoons and pupal sex separation
4. Acid treatment for artificial hatching loose eggs and sheet eggs
5. Identification of defective cocoons and its percentage in a lot of cocoon
6. Determination of average filament length and average denier, single cocoon reeling
7. Study of different reeling machines
8. Characterisation of silkworm breeds/races BV & MV
9. Evolution of heterosis & over dominance of different combinations
10. Study of inbreeding depression
11. Identification of silkworm mutants
12. Study of morphology of mulberry /Characterisation of mulberry breeds
13. Preparation of temporary slide- demonstration of somatic chromosome number
14. Participation / to organise farmers meet
15. Incubation of silkworm eggs
16. Demonstration of cocoon Handicrafts
17. Value addition in sericulture – mulberry tea, Pakoda etc.
18. Cocoon storage/stiffening
19. Preservation of seed cocoons and its importance
20. Any practical set by concern teacher
21. Project work/Review article

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Choice Based Credit System
M. Sc. II, Sem.-IV
Generic Elective (GE) : Applied Zoology

UNIT I

15 hrs

Sericulture:

- ❖ Life cycle of Mulberry Silkworm,
- ❖ Rearing technology of mulberry silkworm,
- ❖ Value products from Sericulture

Apiculture:

- ❖ The honey bee and types,
- ❖ Social organization of honey bees,
- ❖ Life history of honey bees,
- ❖ Methods of bee keeping,
- ❖ Value added Products from Apiculture

UNIT II

15 hrs

Fisheries:

- ❖ Types of fisheries
- ❖ Fish culture
- ❖ Processing & packaging of fish and fish products
- ❖ Value added products from Fisheries
- ❖ Rearing of ornamental fishes

Aqua culture:

- ❖ Prawn culture
- ❖ Pearl culture
- ❖ Mussel culture
- ❖ Value added products from Aqua culture