



**UNIVERSITY OF MYSORE**

**M.Sc. in Sericulture & Seribiotechnology**

Credit Based, Choice Based Continuous Evaluation Pattern System  
(M.Sc. Sericulture & Seribiotechnology)  
96 credits course

**DEPARTMENT OF STUDIES IN SERICULTURE SCIENCE  
MANASAGANGOTRI  
MYSORE – 570 006**

2014 - 15

**University of Mysore**  
**Department of Studies in Sericulture Science**  
**Credit Based Choice Based Continuous Evaluation Pattern System**

**Eligibility for admission to the M.Sc. degree in Sericulture & Seribiotechnology**

- (1) The candidates having B.Sc. degree with sericulture as one the cognate subjects of the study or any Life Science/Biological Science/Agricultural Science subjects and
- (2) The candidate must have scored a minimum of 45% marks in aggregate at graduation. (Relaxable to 40% for SC & ST candidates or as per University Rules and Regulations).
- 3) Admission: As per University Rules & Regulations

**SCHEME**

**Credit Matrix for a P.G. Program in Sericulture & Seribiotechnology**

	Type of Course	M.Sc.				Total
		I	II	II	IV	
1.	Hard Core	16	12	12	12	<b>52</b>
2.	Soft Core	8	8	8	8	<b>32</b>
3.	Open Elective	-	4	4	4	<b>12</b>
	<b>Total</b>	<b>24</b>	<b>24</b>	<b>24</b>	<b>24</b>	<b>96</b>
<b>Grand Total</b>						<b>96</b>

**M.Sc. in Sericulture & Seribiotechnology**  
Credit based Choice Based continuous evaluation pattern System

**I Semester – 24 credits**

Sl. No.	Course Code	Title of the Course	Credit pattern (L:T:P)	Credit value
<b>Hard Core</b>				
1	SERBT - 1.1	Mulberry Biology and Production	3:0:1	4
2	SERBT - 1.2	Silkworm Biology and Egg Production	3:0:1	4
3	SERBT - 1.3	Silkworm Physiology and Biochemistry	3:0:1	4
4	SERBT - 1.4	Silkworm Rearing Technology	3:0:1	4
<b>Soft Core</b>				
5	SERBT - 1.5	Science of Sericulture	3:1:0	4
6	SERBT - 1.6	Computer Application and Biostatistics	3:1:0	4
			18:2:4	<b>24</b>

**II Semester – 24 credits**

Sl. No.	Course Code	Title of the Course	Credit pattern (L:T:P)	Credit value
<b>Hard Core</b>				
1	SERBT - 2.1	Silkworm Genetics and Breeding	3:0:1	4
2	SERBT - 2.2	Mulberry and Silkworm Crop Protection	3:0:1	4
3	SERBT - 2.3	Term Work (Minor Project)	0:1:3	4
<b>Soft Core</b>				
4	SERBT - 2.4	Molecular Biology and Immunology	3:1:0	4
5	SERBT - 2.5	Cell Biology and Genetics	3:1:0	4
<b>Open Elective</b>				
6	SERBT - 2.6	Mulberry Biology, Production and Protection	3:1:0	4
			15:4:5	<b>24</b>

**III Semester – 24 credits**

Sl. No.	Course Code	Title of the Course	Credit pattern (L:T:P)	Credit value
<b>Hard Core</b>				
1	SERBT – 3.1	Mulberry Physiology, Cytogenetics and Breeding	3:0:1	4
2	SERBT – 3.2	Proteomics, Genomics and Bioinformatics	3:0:1	4
3	SERBT – 3.3	Silk Technology, Sericulture Extension and Economics	3:0:1	4
<b>Soft Core</b>				
4	SERBT – 3.4	Entrepreneurship Development in Sericulture	3:1:0	4
5	SERBT – 3.5	Applied Entomology	3:1:0	4
<b>Open Elective</b>				
6	SERBT - 3.6	Silkworm Biology, Cocoon Production and Protection	3:1:0	4
			18:3:3	<b>24</b>

**IV Semester – 24 credits**

Sl. No.	Course Code	Title of the Course	Credit pattern (L:T:P)	Credit value
<b>Hard Core</b>				
1	SERBT - 4.1	Mulberry and Silkworm Biotechnology	3:0:1	4
2	SERBT - 4.2	Project Work	0:2:6	8
<b>Soft Core</b>				
3	SERBT - 4.3	Textile Technology	3:1:0	4
4	SERBT - 4.4	Vanya Sericulture	3:1:0	4
<b>Open Elective</b>				
5	SERBT – 4.5	Silk Technology and Entrepreneurship Development	3:1:0	4
			12:5:7	24

**Note:**

1. L = Lecture (1 Credit = 1 hr.); T = Tutorial (1 Credit = 2 hrs.); P = Practical (1 Credit = 2 hrs.).
2. A duration of two hours per week for each Hard core course will be allocated towards Field Work in addition to the credits (hours) assigned.

- Sd -

**(H.B. MANJUNATHA)**  
Chairman – BOS in Sericulture

## **PROGRAMME OUTCOMES**

**On successful completion of the programme, student will be able to**

1. Acquire sound knowledge on the basics and advances in various aspects of sericulture and seri-biotechnology.
2. Gain confidence with the practical training obtained during the course to undertake sericulture as an entrepreneur and/or guide farmers.
3. Get acquainted with the allied aspects of biological/agricultural sciences to prepare for competitive examinations.
4. Get exposed to various scientific equipments and learn their usage that was quite useful towards research.
5. Know through the project work undertaken - how to choose research topic of current interest and way to execute and compile it.

## I SEMESTER

### SERBT - 1.1: MULBERRY BIOLOGY AND PRODUCTION

#### Course Outcomes

On successful completion of this course, students will be able to

1. Gain knowledge on various aspects of growth and development of mulberry.
2. Know the climatic and soil conditions required for the cultivation of mulberry.
3. Acquire practical knowledge on production of mulberry leaves under different systems of cultivation.

#### Pedagogy

1. Presentation through power point slides, display of photos, charts, etc.
2. Field work: Preparation of mulberry nursery, grafting and layering.
3. Field work: Soil sampling and analysis, application of manures and fertilizers, irrigation, cultural operations, pruning and harvesting of mulberry leaves.

#### Theory

**3 Credits**

<b>Unit – I</b>		
1	Salient features, economic importance and affinity of the family Moraceae. Phytogeography and systematics of the genus <i>Morus</i> L. and its species. Botanical description of mulberry.	4hrs.
2	Reproductive biology of mulberry: Sexual polymorphism, development of anther, pollen and male gametophyte, development of ovary, megaspore and female gametophyte, pollination, fertilization, embryo and seed development; polyembryony, parthenocarpy and apomixis.	5hrs.
3	Anatomy of mulberry leaf, stem and root; secondary growth: structure and organization of shoot and root meristems.	3hrs.
<b>Unit-II</b>		
4	Botanical nomenclature; centers of origin of crop plants. Weeds of mulberry garden: Taxonomy and their characteristics.	2hrs.
5	Propagation of mulberry: Sexual and asexual methods – significance. Raising of nursery for production of seedlings and saplings.	3hrs.

6	Grafting and layering in mulberry - types and techniques.	2hrs.
7	Weather elements; influence of climatic factors on growth and productivity of mulberry, agro-climatic zones, agricultural applications of remote sensing.	3hrs.
8	Popular mulberry cultivars of tropical and temperate regions, rainfed and irrigated conditions. Assessment of mulberry leaf yield and quality.	2hrs.
<b>Unit – III</b>		
9	Basic principles of crop production; classification of crops; methods of crop production; farming systems; planting seasons.	2hrs.
10	Soils for mulberry cultivation: Soil profile and classification; physical, chemical and biological properties.	2hrs.
11	Concept of soil fertility and productivity: Soil organic matter and humus. Soil sampling and testing; problematic soils and their reclamation.	2hrs.
12	Irrigation management: Sources, methods and schedules; quality of irrigation water; conservation of soil moisture in dry land farming.	3hrs.
13	Plant nutrient management: Essential plant nutrients, organic manures, inorganic fertilizers and biofertilizers – importance, classification and application; integrated nutrient management.	3hrs.
<b>Unit-IV</b>		
14	Establishment and maintenance of mulberry gardens; package of practices for mulberry gardens under rainfed and irrigated conditions, gardens for rearing of young-age silkworms and silkworm seed crop.	4hrs.
15	Pruning of mulberry: Objectives and methods. Harvesting, transportation and preservation of mulberry.	2hrs.
16	Weed management in mulberry: Principles, methods and integrated management.	2hrs.
17	Farm management: Scope and concept, basic farm management decisions, cost computation procedures and maintenance of farm records.	3hrs.
18	By-products of mulberry and their utilization.	1hr.

**Practical**

**1 Credit**

1	Morphology of mulberry.
2	Anatomy of leaf blade of mulberry.
3	Anatomy of stem and root of mulberry.
4	Salient features of popular mulberry cultivars.

5	Raising of saplings - cutting preparation, planting and maintenance of nursery.
6	Grafting (bud, stem and root) and layering in mulberry.
7	Planting methods – row and pit systems and tree planting.
8	Characteristic features of important weeds of mulberry garden.
9	Soil sampling and preparation of soil samples for analysis.
10	Preparation of compost and vermicompost.
11	Application of organic manures and chemical fertilizers for mulberry.
12	Irrigation methods (surface, sprinkler and drip irrigation) for mulberry.
13	Estimation of leaf yield, leaf-shoot ratio and leaf area in mulberry.
14	Methods of pruning and harvesting of mulberry.

### SERBT - 1.2: SILKWORM BIOLOGY AND EGG PRODUCTION

#### Course Outcomes

On successful completion of this course, students will be able to

1. Acquire knowledge on various aspects of silkworm biology and development.
2. Understand the silkworm seed organization and grainage operations.
3. Gain scientific procedure involved in production of disease free layings.

#### Pedagogy

1. Presentation through power point slides, charts, etc.
2. Dissect and display of silkworm larvae, pupae and moths.
3. Visit to silkworm egg production centres.

#### Theory

**3 Credits**

Unit-I		
1	Classification of insects - general characteristic features of insects; classification of sericigenous insects; characteristic features of order Lepidoptera and families – Bombycidae and Saturniidae.	3hrs.
2	Metamorphosis in insects: Importance, types and hormonal influence.	2hrs.
3	Morphology and life cycle of the silkworm, <i>Bombyx mori</i> : Egg, larva, pupa and adult.	3hrs.
4	Classification of silkworms: Geographical distribution, moultnism, voltinism,	2hrs.



	cocoon colour and shape.	
5	Insect egg: Morphology and structure, oviparity, ovoviviparity and viviparity, polyembryony, parthenogenesis and pedogenesis.	2hrs.
	<b>Unit-II</b>	
6	Spermatogenesis and oogenesis in <i>Bombyx mori</i> .	3hrs.
7	Embryonic development in <i>Bombyx mori</i> .	3hrs.
8	Anatomical features of silkworm: Digestive, circulatory, excretory, nervous, and respiratory systems; silk gland of silkworm.	4hrs.
9	Reproductive systems of silk moths.	2hrs.
	<b>Unit-III</b>	
10	General account of silkworm egg production and demand.	1hr.
11	Silkworm seed organization: Importance of quality seed cocoon production – norms and procedure followed in P <sub>3</sub> , P <sub>2</sub> and P <sub>1</sub> levels; seed areas and selected seed rearers; seed legislation act.	4hrs.
12	Grainage: Location and capacity; model grainage; grainage equipments and their uses; disinfection and hygiene.	3hrs.
13	Seed cocoon markets, norms for purchase of bivoltine and multivoltine seed cocoons, procurement and transportation of seed cocoons.	2hrs.
14	Environmental requirements for silkworm egg production; planning for hybrid silkworm egg production.	2hrs.
	<b>Unit-IV</b>	
15	Grainage activities: Sorting, selection and preservation of seed cocoons, sex separation at pupal stage, preliminary examination of pupae, synchronization and emergence of moths, pairing and de-pairing, refrigeration of moths, oviposition – preparation of loose and sheet eggs, mother moth examination, surface disinfection and washing, packing and sale of eggs.	6hrs.
16	Cold storage of Dfls: Short and long term chilling, hibernation schedules for preservation of silkworm eggs. Artificial hatching of hibernating eggs – hot and cold acid treatment.	4hrs.
17	Byproducts of grainage and their utilization.	2hrs.

1	Morphology of the silkworm, <i>Bombyx mori</i> .
2	Life cycle of the mulberry silkworm.
3	Characteristic features of popular bivoltine and multivoltine races of silkworm.
4	Dissect and display the digestive and excretory systems in silkworm.
4	Dissect and display of nervous system and silk glands in silkworm.
5	Dissect and display of male and female reproductive systems of silk moths.
6	Ground plan of grainage building and equipments.
7	Disinfection and hygiene practices in grainage.
8	Sorting and processing of seed cocoons for egg production.
9	Sexing of pupae and moths.
10	Preparation of loose and sheet eggs.
11	Acid treatment (hot and cold) of hibernating silkworm eggs and mother moth examination.
12	Identification of different types of eggs and incubation of eggs.
13	Mounting of embryo – pin head and blue egg stages.
14	Visit to an egg production centre.

**SERBT - 1.3: SILKWORM PHYSIOLOGY AND BIOCHEMISTRY**

**Course Outcomes**

**On successful completion of this course,** students will be able to

1. Acquire knowledge on basics of biochemistry and physiological aspects of silkworm.
2. Know the nutritional requirements and preparation of artificial diet for silkworm.
3. Understand the role of bio-molecules and their metabolism in silkworm.

**Pedagogy**

1. Presentation through power point slides, display of charts, etc.
2. Hands on training in collection of silkworm tissues for bio-chemical analysis.
3. Analysis of bio-molecules in different tissues of silkworm strains.

<b>Unit-I</b>		
1	Muscle Physiology: Histology of insect muscles, flight muscles in insects, ultra structure of skeletal muscle, mechanism of muscle contraction.	3hrs.
2	Neurophysiology: Insect nervous system, structure of the neuron, nerve impulse, conduction, synaptic and neurotransmitters.	3hrs.
3	Receptor Physiology: Photoreceptors – compound eyes, mechanism of image formation, Chemoreceptors and Mechanoreceptors and their functions.	3hrs.
4	Endocrinology: Organisation of neuroendocrine system in insects, structure of endocrine glands, neurosecretion -chemistry and function of insect hormones.	3hrs.
<b>Unit-II</b>		
5	Nutritional physiology: Artificial diets, feeding apparatus, feeding behaviour – phagostimulants - feeding deterrents - nutritive requirements of the silkworm- midgut structure and function - midgut pH- potassium secretion.	4hrs.
6	Respiratory physiology: Insect respiratory system- tracheal system – spiracles - tracheal ventilation - tracheal diffusion.	4hrs.
7	Excretory physiology: Malpighian tubules – structure and function; modification of primary urine; problems of urination- role of hind gut in water regulation – water balance in silkworm.	4hrs.
<b>Unit-III</b>		
8	Carbohydrates: Structure and classification; properties of different classes of sugars and aminosugars. Isomerism - optical and stereoisomerism in sugars.	3hrs.
9	Metabolism of carbohydrates: glycolysis, glycogenolysis, gluconeogenesis - pathways and regulation.	4hrs.
10	Bioenergetics: First and second laws of thermodynamics. Concepts of entropy and free energy change in cellular reaction. Biological oxidation: Respiratory chain, redox potential and mechanisms of oxidative phosphorylation. Alternate pathways of carbohydrate metabolism - HMP / PPP.	5hrs.
<b>Unit-IV</b>		
11	Proteins and amino acids: Classification and structure - primary, secondary, tertiary and quaternary.	3hrs.
12	Biosynthesis of silk protein - mechanism and regulation of silk protein synthesis. X- ray diffraction studies, alpha keratin, collagen and fibroin.	3hrs.

13	Amino acids - chemical structure and function; essential and non essential amino acids; ketogenic and glucogenic amino acids; inborn errors of amino acid metabolism – phenylketoneuria, alkaptonuria; oxidative deamination and transaminations; biosynthesis of urea and uric acid in silkworm.	6hrs.
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### Practical

1 Credit

1	Estimation of amylase activity in silkworm gut fluid and haemolymph.
2	Determination of effect of adrenalin and atropine on the heart beat of silkworm.
3	Estimation of glycogen in fat body and ovary of <i>Bombyx mori</i> .
4	Estimation of total carbohydrates in the fat body of multivoltine and bivoltine silkworm races / breeds.
5	Estimation of total protein content in the fat body of male and female silkworm.
6	Estimation of succinate dehydrogenase activity level in the haemolymph of multivoltine and bivoltine silkworm races / breeds.
7	Estimation of aminotransferase activity levels in haemolymph of silkworm races / breeds.
8	Estimation of glucose level in haemolymph in different instars of silkworm.
9	Estimation of protein content in fat body / midgut tissue of silkworm.
10	Estimation of total carbohydrates in fat body and mid gut tissue of silkworm.
11	Estimation of haemolymph trehalose content in silkworm.
12	Estimation of cholesterol content in haemolymph of silkworm.
13	Estimation of uric acid content in silkworm litter.
14	Estimation of lactic acid content in hibernated and non-hibernated eggs of silkworm.

## SERBT – 1.4: SILKWORM REARING TECHNOLOGY

### Course Outcomes

On successful completion of this course, students will be able to

1. Acquire both theoretical and practical knowledge to undertake silkworm rearing.
2. Understand the factors and procedures involved in silkworm rearing.
3. Develop confidence to address the critical issues during silkworm rearing.

### Pedagogy

1. Presentation through power point slides, photos, etc.
2. Hands on training on large scale silkworm rearing.
3. Visit to chawki rearing centres and farmers field.

**Theory****3 Credits**

<b>Unit – I</b>		
1	Planning for silkworm rearing: Estimation of leaf yield and quality, brushing capacity; selection of silkworm races / breeds and hybrids.	4hrs.
2	Rearing houses: Types, location and orientation; rearing houses for young (chawki) and grown up (late-age) silkworms; rearing appliances and their uses.	4hrs
3	Disinfection and hygiene: Importance, types of disinfectants, preparation of spray solution, quantum of spray solution required, disinfection method, mode of action of disinfectants and hygiene practices in silkworm rearing.	4hrs.
<b>Unit-II</b>		
4	Environmental requirements for silkworm egg incubation, young and late-age silkworm rearing.	4hrs.
5	Egg transportation – time and devices; egg incubation – methods and black boxing; methods of brushing silkworms.	3hrs.
6	Qualitative and quantitative requirements of mulberry for young and late-age silkworms.	3hrs.
7	Harvesting, transportation and preservation of mulberry leaves.	2hrs.
<b>Unit – III</b>		
8	Chawki silkworm rearing: Rearing methods and operations; chawki rearing centres – importance and functions.	5hrs.
9	Late age silkworm rearing: Rearing methods and operations;	5hrs.
10	Moulting: Characteristic features - before, at and after moult; care during moulting.	2hrs.
<b>Unit-IV</b>		
11	Mounting - types of mountages, methods of mounting matured silkworms, environmental requirements during spinning and density of mounting.	4hrs.
12	Cocoon harvesting, sorting, packing, transportation and marketing, preparation of crop harvest report.	4hrs.
13	Artificial diet for silkworm rearing: Composition, merits and demerits.	2hrs.
14	By-products of silkworm rearing and their utilization.	2hrs.

1	Estimation of leaf yield in mulberry garden.
2	Silkworm rearing houses - model and plan
3	Silkworm rearing equipments and their uses.
4	Disinfection of rearing houses and equipments.
5	Incubation and black boxing of silkworm eggs.
6	Brushing of silkworms - methods
7	Selection of mulberry for feeding young and late-age silkworms.
8	Preservation of mulberry for feeding young and late-age silkworms.
9	Young – age silkworm rearing – methods and operations.
10	Late – age silkworm rearing – methods and operations
11	Moulting – identification of moulting larvae and care.
12	Mounting – mountages, identification and mounting of spinning larvae.
13	Harvesting and sorting of cocoons.
14	Preparation of crop report and other records in the rearing house.

### SERBT - 1.5: SCIENCE OF SERICULTURE

#### Course Outcomes

On successful completion of this course, students will be able to

1. Understand the insect and non-insect fauna producing silk.
2. Acquire knowledge on organization of sericulture industry in India.
3. Obtain knowledge on cultivation of mulberry and production of cocoons.

#### Pedagogy

1. Presentation through power point slides, display of charts, photos, etc.
2. Group discussion and one-to-one interaction.
3. Demonstration of mulberry and silkworm materials.

#### Theory

3 Credits

Unit-I		
1	Introduction to textile fibres; types – natural and synthetic fibres and their	2hrs.

	properties; importance of silk fibre.	
2	Insect and non-insect fauna producing silk; types of silk produced in India.	2hrs.
3	History, development and status of mulberry and non-mulberry sericulture in India. Silk production in India and other countries; export and import.	3hrs.
4	Characteristic features and advantages of sericulture; scope of sericulture in India vis-à-vis other agricultural crops - employment potential and income generation; role of women in sericulture.	3hrs.
5	Sericulture organization in India. Sericulture extension: Extension systems - Central Silk Board, state sericulture departments, universities and voluntary organizations.	2hrs
	<b>Unit-II</b>	
6	Host plants of mulberry and non-mulberry silkworms. Mulberry cultivars - tropical and temperate regions, irrigated and rainfed conditions.	1hrs.
7	Propagation of mulberry – sexual and asexual (cuttings, grafting and layering).	3hrs.
8	Establishment of mulberry garden: Selection of land / soil, preparation and planting.	2hrs.
9	Package of practices for mulberry cultivation under rainfed and irrigated conditions.	2hrs.
10	Pruning – objectives and methods; harvesting, transportation and preservation of mulberry.	2hrs.
11	Pests and diseases of mulberry and their management.	2hrs.
	<b>Unit-III</b>	
12	Silkworm seed organization and its significance; seed areas (bivoltine and multivoltine), selected seed rearers and silkworm seed legislation act. Silkworm races / breeds: Classification – geographical distribution, voltinism and moultnism, indigenous and exotic, multivoltine and bivoltine.	2hrs.
13	General account of silkworm egg production and demand. Grainage building and equipments, disinfection and hygiene, procurement and preservation of seed cocoons, sex separation, eclosion, pairing and depairing, oviposition – sheet and loose egg preparation, mother moth examination, acid treatment, surface sterilization, washing, packing and sale of eggs.	4hrs.
14	Life cycle of <i>Bombyx mori</i> . Rearing houses and equipments; disinfection and hygiene. Transportation, incubation and black boxing of silkworm eggs. Rearing operations - brushing, young and late-age silkworm rearing, moulting, mounting, spinning, cocoon harvesting and marketing.	4hrs.
15	Pests and diseases of silkworm and their management.	2hrs.

<b>Unit-IV</b>		
16	Physical and commercial characteristics of cocoons. Cocoon sorting, cocoon stifling – objectives and methods, cocoon preservation and cocoon cooking – objectives and methods.	4hrs.
17	Silk reeling: Charaka, cottage basin and multi-end; re-reeling and packing – objectives and operations. Properties of mulberry silk; silk testing and grading – objectives; silk exchanges; weaving and dyeing.	4hrs.
18	Biomedical importance of mulberry and silkworm.	2hrs.
19	Byproducts of sericulture industry and their utilization – mulberry cultivation, silkworm rearing, grainage and silk reeling.	2hrs.

**Tutorial (Demonstration)**

**1 Credit**

1	Silkworms and their host plants.
2	Propagation of mulberry.
3	Pruning and harvesting of mulberry.
4	Pests and diseases of mulberry.
5	Grainage equipments and operations.
6	Silkworm races and life cycle.
7	Rearing equipments and operations.
8	Pests and diseases of silkworm.
9	Silk cocoons and textile fibres.
10	Defective cocoons - identification and sorting.
11	Silk reeling devices and operations.
12	Sericulture byproducts and handicrafts.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.



## SERBT - 1.6: COMPUTER APPLICATIONS AND BIOSTATISTICS

### Course Outcomes

On successful completion of this course, students will be able to

1. Acquire knowledge on the computer and its use in support of their studies.
2. Gain knowledge on statistical tools and its application.
3. Gain knowledge on analysis and interpretation of biological data.

### Pedagogy

1. Presentation through power point slides, display of charts, etc.
2. Hands on training using computers.
3. Hands on training in collection, tabulation and analysis of data

### Theory

**3 Credits**

<b>Unit-I</b>		
1	Introduction to computers: Characteristics, history and evolution, generation and types of computers.	4hrs.
2	Computer architecture; Input and output devices; primary and secondary storage devices; central processing unit.	4hrs.
3	Operating system: Types, booting, DOS commands, Windows and its applications.	4hrs.
<b>Unit-II</b>		
4	M.S. Office: Word, Excel and Power Point.	5hrs.
5	Computer virus: Symptoms, detection and protection.	2hrs.
6	Introduction to internet: World Wide Web, database, e-mail and chat.	3hrs.
7	Role and use of computers in sericulture.	2hrs.
<b>Unit-III</b>		
8	Biostatistics: Introduction, importance and functions.	2hrs.
9	Frequency distribution: Preparation of frequency table, relative and cumulative frequencies. Measures of central tendency and dispersion.	3hrs.
10	Diagrammatic representations: Frequency distribution, frequency polygon, cumulative frequency curves (ogives), bar diagrams, rectangles, squares, circles / pie diagrams, pictograms and histograms.	4hrs.
11	Tests of significance – Student ‘t’, Chi-square and F-tests; tests of hypotheses - level	3hrs.

	of significance. Analysis of variance: One-way and two-way classification.	
<b>Unit-IV</b>		
12	Techniques for recording observations – mulberry and silkworm rearing.	3hrs.
13	Experimental designs: CRD, RCBD, LSD and factorial experiments.	4hrs.
14	Correlation and regression analysis,	2hrs.
15	Use of statistical packages in data analysis - Genstat and REML.	3hrs.

**Tutorial (Demonstration)**

**1 Credit**

1	MS-DOS commands.
2	Windows and its applications.
3	MS Word and its applications.
4	MS Excel and its application.
4	MS Power Point and its applications.
5	Antivirus and its applications.
6	Internet – browsing, surfing, e-mail and chat.
7	Uses and applications of computers in sericulture.
8	Applications of measures of central tendency.
9	Diagrammatic representation of data – bar, pie and histograms.
10	Analysis of data through Student ‘t’ and Chi square tests.
11	Record of observations on mulberry - growth, yield and quality parameters.
12	Record of observations on silkworm - rearing, cocoon and grainage parameters.
13	Analysis of data through CRD and RCBD.
14	Analysis of data through LSD and factorial experiments.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

## II SEMESTER

### SERBT 2.1 - SILKWORM GENETICS AND BREEDING

#### Course Outcomes

On successful completion of this course, students will be able to

1. Understand the concepts of genetics and racial characteristics of silkworm breeds.
2. Understand the genetical intricacies in silkworm.
3. Learn different methods and procedure involved in breeding of silkworm.

#### Pedagogy

1. Presentation through power point slides.
2. Display of charts, photos, etc.
3. Conduct of laboratory experiments.

#### Theory

3 Credits

Unit – I		
1	Hereditary traits of <i>Bombyx mori</i> - egg, larva, pupa and moth.	3hrs.
2	Genetics of cocoon colour: Inheritance of cocoon colour - white, flesh, green, pink and yellow.	2hrs.
3	Linkage and crossing over: Linkage groups in <i>Drosophila</i> and <i>Bombyx mori</i> . Classical linkage map of <i>B. mori</i> .	4hrs.
4	Genetics of voltinism, multivoltinism and maturity genes - maternal inheritance - voltinism studies in tropical and temperate races.	3hrs.
Unit – II		
5	Mosaicism - types and theories; induction of mosaics in silkworm.	2hrs.
6	Parthenogenesis in silkworm - types and induction.	2hrs.
7	Radiation and chemical mutagenesis in silkworm, measurement of mutation through specific locus test; dominant and autosomal recessive lethal; strain and stage sensitivity.	3hrs.
8	Introduction to toxicology of silkworm. Procedures used in toxicology studies, methods of administration of pesticides, toxic symptoms in silkworm, LC-50 and LD-50 values.	3hrs.
9	Silkworm breeding organization in India and China.	2hrs.

<b>Unit – III</b>		
10	Silkworm races: Distinct characters, classification based on voltinism, moultnism and geographical distribution. Characteristic features of temperate and tropical races. Germplasm and its importance in silkworm breeding.	3hrs.
11	Genotype - environmental interactions. Heritability studies in <i>Bombyx mori</i> - broad and narrow range of heritability for various economic traits in silkworm.	2hrs.
12	Silkworm breeding - scope and objectives; methods – inbreeding, out-breeding, mutation breeding - their merits and demerits; breeding plans.	3hrs.
13	New concepts of silkworm breeding: Biochemical genetics and breeding; inheritance of genes for amylases, esterases and phosphotases; breeding for thermotolerance, disease resistance, higher productivity, shorter larval duration and fine denier; voltinism breeding.	3hrs.
14	Quantitative genetics – Mendelian population – quantitative trait loci (QTL).	1hr.
<b>Unit – IV</b>		
15	Selection: Criteria, index and parameters - methods of selection for qualitative and quantitative traits, fixation of characters, inbreeding depression and evaluation index.	3hrs.
16	Hybridization: Polyhybrids - heterosis and hybrid vigour; theories of heterosis; combining ability - general and specific; line x tester and diallele analysis. Exploitation of heterosis in Indian sericulture.	3hrs.
17	Sex limited breeds - role of translocation in silkworm breeding, methods of evolving sex-limited breeds; sex limited breeds of China, Japan and India.	3hrs.
18	Race authorization system of India - a comparative analysis; release of races for commercial exploitation; authorized races / hybrids of India.	3hrs.

**Practical**

**1 Credit**

1	Racial characters of the silkworm, <i>Bombyx mori</i> : Egg, larva, cocoon (pupa) and adult stages (univoltine, bivoltine and multivoltine).
2	Estimation of fecundity and hatching percentage in bivoltine and multivoltine races / breeds.
3	Mutants of <i>Bombyx mori</i> : Larval (Ursa, Zebra and Knobbed), egg colour (pere), eye colour (white and red eye) and cocoon colour.
4	Study of adult life span (longevity) in <i>Bombyx mori</i> –multivoltine and bivoltine races /

	breeds and sexes.
5	Study of toxic symptoms in different stages of <i>Bombyx mori</i> .
6	Selection of cocoons for breeding and maintenance of breeding data.
7	Assessment of qualitative and quantitative traits of silkworm for breeding.
8	Calculation of inbreeding depression in silkworm.
9	Breeding plan for evolution of robust and productive breeds.
10	Study of larval and cocoon character / segregation in F <sub>1</sub> and F <sub>2</sub> progenies of multi x bi hybrids to observe Mendelian pattern of inheritance.
11	Evaluation of heterosis and over - dominance in F <sub>1</sub> silkworm hybrid.
12	Estimation of filament length and denier in cocoons for breeding by cold reeling.
13	Preparation of layings of double hybrids of silkworm (plan).

## SERBT – 2.2: MULBERRY AND SILKWORM CROP PROTECTION

### Course Outcomes

**On successful completion of this course, students will be able to**

1. Understand the biology and damage caused by the pests of mulberry and their management.
2. Gain knowledge on the diseases of mulberry and their management.
3. Acquire the knowledge on pests and diseases of silkworms and their management.

### Pedagogy

1. Teaching using black board and power point slides.
2. Explanation using pest and disease specimens of mulberry and silkworm.
3. Visit to fields and pest and disease management laboratories.

### Theory

**3 Credits**

Unit-I		
1	Pests of mulberry. Classification of important pests of mulberry based on their groups, feeding habits and status.	2hrs.
2	Major pests of mulberry: Life cycle, symptoms of attack, seasonal occurrence, nature of damage and management of Bihar hairy caterpillar, cutworm, leaf roller, wingless grasshopper and mealy bug (pink and papaya).	5hrs.

3	Minor pests of mulberry: Life cycle, symptoms of attack, seasonal occurrence, nature of damage and management of stem girdler beetle, stem borer, scale insect, jassid, thrips, root grub, termites, snails and mites.	3hrs.
4	Integrated pest management - concepts, principles and essential components. Pest forecasting and outbreak.	2hrs.
<b>Unit-II</b>		
5	Parasitism; host - parasitic interaction; disease cycle and development.	1hr.
6	Plant diseases – classification and status of important diseases of mulberry.	2hrs.
7	Major diseases of mulberry: Causal organism, symptomatology, seasonal incidence, disease cycle, yield and quality loss and management of leaf spot, leaf rust, powdery mildew, stem canker, root knot and root rot diseases.	4hrs.
8	Minor diseases of mulberry: Causal organism, symptomatology, seasonal incidence, disease cycle, yield and quality loss and management of fusarial leaf and stem blight, bacterial leaf blight, spot and wilt, sclerotial wilt / collar rot and Phoma stem blight; viral and mycoplasma diseases.	3hrs.
9	Integrated disease management - Concepts, principles and essential components. Disease forecasting and outbreak.	2hrs.
<b>Unit-III</b>		
10	Insect and non-insect pests of mulberry silkworm and their status.	2hrs.
11	Tachinid flies associated with <i>Bombyx mori</i> - classification, distribution, incidence, extent of damage and management strategies with reference to <i>Exorista bombycis</i> .	6hrs.
12	Dermeid beetles associated with <i>Bombyx mori</i> and their management.	2hrs.
13	Factors responsible for pest outbreak (with special reference to <i>Exorista bombycis</i> ) and pest forecasting.	2hrs.
<b>Unit-IV</b>		
14	Diseases of insects: Types, pathogenesis and predisposing factors.	1hr.
15	Diseases of <i>Bombyx mori</i> : Causal organism, mode of infection and transmission, symptomatology, incidence, extent of crop loss, cross infectivity and management of microsporidiosis (pebrine), virosis (NPV, CPV, IFV and DNV), bacteriosis (bacterial flacherie) and mycoses (muscardine and aspergillosis).	8hrs
16	Non-infectious diseases of <i>Bombyx mori</i> .	1hr.
17	Bioassay of pathogens: Determination of median lethal concentration (LC-50).	2hrs.

1	Study of leaf spot and leaf rust in mulberry.
2	Study of powdery mildew and stem canker in mulberry.
3	Study of root knot and root rot in mulberry.
4	Study of leaf eating pests of mulberry.
5	Study of shoot feeding pests of mulberry.
6	Study of root feeding pests of mulberry.
7	Life cycle of the uzi fly, <i>Exorista bombycis</i> and estimation of damage to silkworm.
8	Evaluation of uzicide and bleaching powder solution against uzi fly.
9	Evaluation of parasitoids against uzi fly.
10	Study of mass production of parasitoids.
11	Life cycle of dermestid beetles and assessment of cocoon damage.
12	Preparation of temporary mounts of pebrine spores of <i>Nosema bombycis</i> and polyhedra of nuclear polyhedrosis virus infecting <i>Bombyx mori</i> .
13	Preparation of temporary mounts of fungal pathogens infecting <i>Bombyx mori</i> .
14	Application of bed disinfectants for management of silkworm diseases.

### SERBT- 2.3: TERM WORK

#### Course Outcomes

On successful completion of this course, students will be able to

1. Explore the current problems and identify the topic in the field of sericulture.
2. Understand the protocol / procedure involved in conduct of minor project.
3. Learn about execution and compilation of minor project.

#### Pedagogy

1. Provide guidance for designing, planning and execution of experiments.
2. Provide guidance for presentation of research work through power point presentation
3. Provide guidance for preparation of report.

A topic for the major project will be assigned to each student and it shall be either from the syllabus or from any other topic in the field of Sericulture and Seribiotechnology as approved by the guide and department council.

### SERBT-2.4: MOLECULAR BIOLOGY AND IMMUNOLOGY

#### Course Outcomes

On successful completion of this course, students will be able to

1. Acquire basic knowledge on molecular biology.
2. Understand the mechanism of protein synthesis in prokaryotes and eukaryotes.
3. Gain knowledge on immunological techniques.

#### Pedagogy

1. Presentation through power point slides, photos, etc.
2. Demonstration of molecular biology based experiments.
3. Demonstration of immunology based experiments.

#### Theory

3 Credits

Unit-I		
1	Introduction to nucleic acids: Chemical and physical properties of DNA and RNA, helical structure of DNA and RNA, types of RNA, DNA organization in chromosomes and extra chromosomal DNA.	3hrs.
2	DNA replication in prokaryotes and eukaryotes: Semi - conservative synthesis of DNA, enzymes in DNA replication.	3hrs.
3	Transcription: Biosynthesis of RNA from DNA, RNA polymerase, initiation, elongation and termination of transcription, RNA processing in prokaryotes and eukaryotes.	3hrs.
4	Translation: Factors and enzymes involved in protein synthesis; initiation, elongation and termination of translation in prokaryotes and eukaryotes. Wobble hypothesis, aminoacylation of t-RNA and inhibitors of protein synthesis.	3hrs.
Unit-II		
5	Gene regulation in prokaryotes: Lac operon, repressor protein, promoters, structural genes, fine structure of gene.	3hrs.
6	Gene organization in eukaryotes: Repetitive sequence, satellite DNA, jumping genes and transposons. Retrovirus and cellular oncogenes.	3hrs.
7	Model organisms for molecular biology - bacteriophage, bacteria, yeast, fruit fly, silkworm, mice and <i>Arabidopsis</i> .	2hrs.
8	Molecular biology of floral development – genetic regulation, phytochrome and signal transduction.	2hrs.
9	Cell death – necrosis and apoptosis, death signals, factors that oppose apoptosis.	2hrs.
Unit-III		
10	History, scope and applications of immunology.	3hrs.



11	Immunity: Types – innate, acquired, active and passive; organs associated with immunity	2hrs.
12	Antigens and their features; immunoglobulins (antibodies) - structure, types, biological properties and functions; monoclonal antibodies.	2hrs.
13	Antigen – antibody reactions : Salient features, immune complex, specificity, binding sites, binding forces, intermolecular forces; cross reaction; types and detection of antigen – antibody reaction - ELISA; immunoblotting, radio-immuno assay.	3hrs.
14	Complement system: Salient features, sources of origin, complement activation - classical and alternate pathways and complement fixations; biological functions.	2hrs.
<b>Unit-IV</b>		
15	Cells associated with immune system: Origin of cells, types of cells – lymphocytes, null cells, monocytes, polymorphonuclear leucocytes, mast cells, antigen presenting cells, platelets.	3hrs.
16	Hypersensitivity and immune deficiencies.	1hr.
17	Autoimmune diseases: Pathogenesis, classification, common autoimmune diseases – autoimmune haemolytic anaemia, rheumatoid arthritis, thyrotoxicosis, Addison’s disease, Hashimoto’s disease; diagnosis and treatment of autoimmune disease.	4hrs.
18	Major histocompatibility complex (MHC): MHC molecules – H2 complex and human leucocyte antigen and their functions. Transplantation – graft retention and rejection.	3hrs.
19	Immune system in insects with special reference to <i>Bombyx mori</i> .	1hr.

**Tutorial (Demonstration)**

**1 Credit**

1	Colorimetric estimation of DNA in silk gland.
2	Colorimetric estimation of RNA in silk gland.
3	Extraction of DNA from plant and animal sources.
4	Quantification of DNA by spectrophotometry.
5	Separation of amino acids by thin layer chromatography.
6	Separation of amino acids by paper chromatography.
7	Model organisms – Fruit fly, silkworm and Arabidopsis.
8	Purification of DNA – RAPD technique.
9	Determination of LC-50 values for silkworm using viral pathogens.
10	Isolation and purification polyhedral inclusion bodies of <i>BmNPV</i> .
11	Counting of polyhedral inclusion bodies of <i>BmNPV</i> .
12	Identification of blood groups.
13	Identification and counting of blood cells.
14	Identification of different types of haemocytes in <i>Bombyx mori</i> .
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

## SERBT - 2.5 - CELL BIOLOGY AND GENETICS

### Course Outcomes

On successful completion of this course, students will be able to

1. Learn basics of cell biology and the techniques involved.
2. Acquire knowledge on cell and chromosomal behavior and dynamics during cell division.
3. Gain knowledge on genetic expression of different traits in plants and animals.

### Pedagogy

1. Presentation through power point slides, photos, etc.
2. Demonstration of cell biology based experiments.
3. Demonstration of genetics based experiments.

### Theory

3 Credits

Unit-I		
1	Techniques in cell biology: Light and electron microscopy. Fixation and staining: Cytochemical methods, cell culture, autoradiography, micromanipulation techniques, cell fractionation and ultra centrifugation.	4hrs.
2	Structure, organization and functions of plasma membrane; membrane models.	2hrs.
3	Organization and functions of cytoskeleton; microfilaments, microtubules and intermediate filaments; organization of cytoskeleton.	2hrs.
4	Ultrastructural organization and functions of cell organelles: Endoplasmic reticulum, Golgi complex, nucleus and nuclear envelope, mitochondria, chloroplast, lysosomes and ribosomes.	4hrs.
Unit-II		
5	Types of chromosomes – eukaryotic chromosomes. Structure and organization of chromatin and synoptenemal complex. Special chromosomes: polytene, lampbrush and B-chromosomes.	3hrs.
6	Cell cycle: Chromosome dynamics during mitosis and meiosis; achromatic apparatus and cytokinesis; evolution of mitotic spindles.	3hrs.
7	Cytology of gamatogenesis: Spermatogenesis and oogenesis in animals with special reference to the silkworm, <i>Bombyx mori</i> .	3hrs.

8	Germ cells and fertilization – biochemical events and ultra structural aspects of fertilization in animals with special reference to the silkworm, <i>Bombyx mori</i> .	3hrs.
<b>Unit-III</b>		
9	Life and work of Mendel: Mendel's laws.	2hrs.
10	Interaction of genes: Epistasis and complementary factors. Polygenic inheritance - skin colour in man. Lethal genes - coat colour in mice.	3hrs.
11	Allelism: Multiple alleles, isoalleles and pseudoalleles; blood groups and Rh factor in man.	3hrs.
12	Linkage and crossing over: Linkage groups in <i>Drosophila</i> and <i>Bombyx mori</i> – construction and map.	4hrs.
<b>Unit-IV</b>		
13	Fine structure of a gene: Classical concept - Benzer's work on rII-locus in T4 phage; split genes and mobile genes.	4hrs.
14	Genetic code: Nature of genetic code, codons and anticodons, triplet code and evidences for triplet code.	2hrs.
15	Chromosomal aberrations - spontaneous and induced; deletion, duplication, translocation and inversion; numerical variations in chromosomes.	4hrs.
16	Introduction to eugenics – genetic counseling.	2hrs.

**Tutorial (Demonstration)**

**1 Credit**

1	Cytological techniques: Pre-treatment, fixation and preservation of specimens.
2	Preparation of different stains for cytological studies.
3	General morphology and life cycle of <i>Drosophila melanogaster</i> .
4	Identification of mutants of <i>Drosophila melanogaster</i> (white eye, red eye and bar eye).
5	Identification of mutants of <i>Drosophila melanogaster</i> (sepia, vestigial wing and yellow body).
6	Preparation and staining of salivary gland chromosomes of <i>Drosophila melanogaster</i> .
7	Genetic problems on Mendel's first law using experimental results of <i>Drosophila melanogaster</i> .
8	Genetic problems on Mendel's first law using silkworm.
9	Study of mitosis in onion root tip.
10	Study of meiosis in the testes of grasshopper.
11	Study of meiosis in the testes of silkworm.

12	Study of mitosis and meiosis in uzi fly.
13	Study of salivary gland chromosome in uzi fly.
14	Problems on Mendel's law of independent assortment using Chi-square test
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

**SERBT – 2.6: MULBERRY BIOLOGY, PRODUCTION AND PROTECTION  
(Credit pattern – 3:1:0 = 4)**

**Course Outcomes**

**On successful completion of this course, students will be able to**

1. Acquire knowledge on the botanical aspects of mulberry.
2. Gain knowledge on cultivation aspects of mulberry.
3. Know about the pests and diseases of mulberry and their management.

**Pedagogy**

1. Presentation through point slides, charts, photos, etc.
2. Demonstration of materials related to mulberry.
3. Demonstration of pest and disease specimens of mulberry.

**Theory**

**3 Credits**

<b>Unit – I</b>		
1	Phytogeography, taxonomy and systematics of mulberry. Distribution and economic importance of primary and secondary host plants of tasar, eri and muga silkworms.	3hrs.
2	Reproductive biology of mulberry: Sexual polymorphism; male and female flowers, pollination, fertilization, embryo and seed of mulberry; polyembryony and parthenocarpy.	4hrs.
3	Anatomy of root, stem and leaf of mulberry; secondary growth –structure and organization of shoot and root meristems.	3hrs.
4	Botanical nomenclature; centers of origin of crop plants. Weeds of mulberry garden and their management.	2hrs.
<b>Unit-II</b>		
5	Weather elements, climatic factors on growth and productivity of mulberry,	2hrs.

	applications of remote sensing in agriculture and sericulture.	
6	Propagation of mulberry: Sexual and asexual methods (cuttings, grafting and layering) - types and techniques – significance.	2hrs.
7	Raising of nursery for large scale production of saplings (Kisan nursery) and its economics.	2hrs.
8	Popular mulberry cultivars of India. Assessment of mulberry leaf yield and quality and its importance.	2hrs.
9	Soils for mulberry cultivation: Soil profile and classification; physical, chemical and biological properties; soil sampling and testing; problematic soils and their reclamation.	4hrs.
<b>Unit – III</b>		
10	Irrigation management: Sources, methods and schedule. Conservation of soil moisture in dry land farming.	2hrs
11	Plant nutrient management: Essential nutrients, organic manures, inorganic fertilizers and biofertilizers – importance, classification and application; integrated nutrient management.	4hrs
12	Establishment and maintenance of mulberry gardens; package of practices for mulberry gardens under rainfed and irrigated conditions, gardens for rearing of young-age silkworms and silkworm seed crop.	4hrs.
13	Pruning of mulberry: Objectives and methods; harvesting, transportation and preservation of mulberry.	2hrs.
<b>Unit-IV</b>		
14	Pests and diseases of mulberry - classification and status.	2hrs
15	Major and minor pests of mulberry: Life cycle, symptoms of attack, seasonal occurrence, nature of damage and their management.	3hrs
16	Major and minor diseases of mulberry: Causal organism, symptomatology, seasonal incidence, disease cycle, yield and quality loss and their management.	4hrs
17	Integrated pest and disease management - concepts, principles and essential components. Pest and disease forecasting and outbreak.	2hrs.
18	By-products and medicinal importance of mulberry.	1hr.

**Tutorial (Demonstration)****1 Credit**

1	Host plants of mulberry and non-mulberry silkworms.
2	Anatomy of root, stem and leaf blade of mulberry.
3	Field observations of popular mulberry cultivars.
4	Soil sampling and preparation of soil sample for analysis.
5	Visit to composting and vermicomposting units.
6	Observations of organic manures, chemical fertilizers and biofertilizers.
7	Raising of saplings - cutting preparation, planting and maintenance of nursery.
8	Grafting and layering in mulberry.
9	Planting methods – row and pit systems and tree planting.
10	Irrigation systems (surface, sprinkler and drip irrigation).
11	Characteristic features of important weeds of mulberry garden.
12	Estimation of leaf yield, leaf-shoot ratio and leaf area.
13	Methods of pruning and harvesting of mulberry.
14	Study of leaf, stem and root feeding pests of mulberry.
15	Study of leaf, stem and root diseases of mulberry.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

### III SEMESTER

#### SERBT - 3.1 : MULBERRY PHYSIOLOGY, CYTOGENETICS AND BREEDING

#### Course Outcomes

**On successful completion of this course, students will be able to**

1. Understand the physiological aspects in relation to growth and development of mulberry.
2. Acquire the knowledge on genetic resources and cytological aspects of mulberry.
3. Gain the knowledge on breeding and evaluation techniques for improvement of mulberry.

#### Pedagogy

1. Presentation through point slides, charts, photos, etc.
2. Field work: Hybridization techniques in mulberry
3. Visit to tissue culture laboratory.

#### Theory

**3 Credits**

<b>Unit-I</b>		
1	Crop growth and development - crop development stages, physiological growth components, leaf growth, tillering and branching; growth analysis; yield analysis – biological and economic yield.	3hrs.
2	Plant and water relations: concept of water potential. Absorption of water – active and passive absorption; absorption of minerals; translocation of solutes; Munch hypothesis, source and sink relationship.	4hrs.
3	Transpiration: Significance, types; mechanism of stomatal opening and closing: Anti transpirants; guttation, factors affecting rate of transpiration.	2hrs.
4	Photosynthesis: History, significance and outline of the process: Photosynthetic pigments and their characteristics. Mechanism of electron transport: Calvin cycle; Kranz anatomy: C <sub>4</sub> cycle; CAM pathway. Factors affecting photosynthesis, Photorespiration – site, mechanism and significance.	3hrs.
<b>Unit-II</b>		
5	Mineral nutrition: Macro and micronutrients, uptake, physiological role, deficiency symptoms in mulberry, mineral toxicity.	3hrs.
6	Plant growth regulators: Distribution and physiological role of auxins, gibberellins, cytokinins, abscisic acid and ethylene. PGRs in moriculture.	2hrs.
7	Biological nitrogen fixation – types, mechanism and genetics: Role of nif genes, huf genes and leg haemoglobin.	2hrs.
8	Physiology of flowering: Photoperiodism and vernalization. Phytochrome – concept. Senescence, dormancy and seed germination.	2hrs.
9	Stress physiology: Biotic and abiotic stresses in crops, effects on mulberry: Mechanism of resistance to drought, salinity, mineral toxicity. Disease resistance in crop plants with special reference to mulberry.	3hrs.

<b>Unit-III</b>		
10	Yield and quality of mulberry leaf: Variations in relation to irrigated and rainfed systems, varieties - scope for improvement.	2hrs.
11	Cytogenetics: chromosome number (basic, somatic and gametic). Karyotype; chromosome banding; meiotic irregularities, chromosome associations during meiosis in polyploids.	3hrs.
12	Cytology of mulberry – chromosome number, ploidy, polysomaty, karyotype, meiosis in mulberry.	2hrs.
13	Objectives of mulberry breeding; reproductive systems- parameters associated with yield and quality of mulberry leaf; problems in breeding of asexually propagated crops. Variability in economic traits of mulberry.	2hrs.
14	Genetic resources of mulberry; Germplasm - collection, characterization, conservation and utilization; cryopreservation, genetic erosion.	2hrs.
15	Plant introduction - purpose, agencies, procedures; quarantine. Achievements, merits and demerits. Acclimatization.	1hr.
<b>Unit-IV</b>		
16	Selection techniques - mass, pure line and clonal selections. Hybridization: Objectives, types and procedure. Pollen viability, pollen storage, stigmatic receptivity. Selection of parents, production of F <sub>1</sub> progeny, selection among F <sub>1</sub> .	2hrs.
17	Mutation breeding in mulberry - chimeras; achievements and limitations.	2hrs.
18	Breeding for drought, salinity and alkalinity: Sources, genetics and methods.	2hrs.
19	Breeding for disease and pest resistance: Sources, genetics and methods.	2hrs.
20	Polyploidy breeding: Types of heteroploids and their importance. Induction of tetraploids and evolution of triploids in mulberry and their importance.	2hrs.
21	Evaluation techniques of selected mulberry genotypes - PYT, FYT & MLT; Plot experimentation; multiplication and authorization of variety.	2hrs.

**Practical**

**1 Credit**

1	Determination of water potential of potato tuber.
2	Study of mineral deficiency symptoms in mulberry.
3	Separation of chloroplast pigments by paper chromatography.
4	Extraction of chloroplast pigments by solvent wash method.
5	Use of micrometers - measurement of pollen and stomata size.
6	Mitotic chromosomes of onion – karyotype; comparison with mulberry chromosomes.
7	Meiosis in <i>Allium</i> / <i>Chlorophytum</i> ; meiotic chromosomal associations in diploid, triploid and tetraploid mulberry.
8	Hybridization techniques – experiment with mulberry and determination of seed setting percentage.
9	Colchicine treatment – induction of tetraploidy in mulberry.
10	Stomatal size, frequency and index and pollen fertility in mulberry varieties.
11	Estimation of total chlorophyll, chlorophyll a & b contents in mulberry leaf.
12	Estimation of protein in mulberry leaf.



13	Estimation of carbohydrate in mulberry leaf.
14	Determination of moisture content and moisture retention capacity of mulberry leaf in popular cultivars.

### SERBT - 3.2 : PROTEOMICS, GENOMICS AND BIOINFORMATICS

#### Course Outcomes

On successful completion of this course, students will be able to

1. Know the concepts of genome and proteome and how these are linked in the process of biological functions.
2. Understand the genome projects, genome organization, proteome of an organism and learn different methods of protein analysis.
3. Acquire knowledge on bioinformatics aspects to keep pace with the recent advances in technologies.

#### Pedagogy

1. Presentation through point slides, photos, etc.
2. Demonstration in handling and use of scientific equipments.
3. Conducting wet and dry lab experiments individually.

#### Theory

**3 Credits**

Unit-I		
1	Genome analysis: Genomic DNA - extraction and preparation from bacteria, plants and animals. Genome size and diversity in different organisms. Construction and Screening of cDNA and genomic DNA libraries (Plasmid, Cosmid and BACs). Methods of DNA sequencing - Maxam and Gilbert's, Sanger, Ligation mediated PCR and automated methods.	8hrs.
2	Whole Genome Sequence of the silkworm, <i>Bombyx mori</i> – Sequence method and strategies, genome features, genomic resources and application. Mulberry chloroplast genome – method and properties.	4hrs.
Unit-II		
3	Genome mapping: Molecular markers and their application in genome analysis. Molecular linkage and genetic map – construction based on RFLP, RAPD, AFLP, SSR and ISSR. Physical map – construction based on clone (BAC-FISH), ESTs, STSs. Long range restriction mapping (with special reference to silkworm).	6hrs.
4	Comparative and functional genomics: A brief account on <i>Bombyx</i> , <i>C. elegans</i> , <i>Drosophila</i> , human and rice genome projects and their relationship. Gene variation and SNPs, SNPs and disease associations, repetitive and coding	6hrs.

	sequences, transcriptome, DNA chip and micro array in functional genomics.	
<b>Unit-III</b>		
5	Proteome analysis: Different methods of protein separation (1-DE and 2-DE), purification, quantification, immunoblot assay; amino acid sequencing - chemical and enzymatic methods and mass spectrometry - MALDI-TOF, MS-MS, LC-MS and ion trap.	6hrs.
6	Silkworm proteome analysis: Protein identification and analysis by various methods. Proteome analysis in different tissues of silkworm (silk glands, midgut, fat bodies, haemolymph, ovaries, and Malpighian tubules). Heat shock proteins and their importance in silkworm strain improvement program.	6hrs.
<b>Unit-IV</b>		
7	Overview of Bioinformatics: Origin and definition, historical background, scope, importance and applications.	2hrs.
8	Bioinformatics tools and techniques: Genome sequence alignment and analysis programs; protein sequence alignment and analysis programs; protein structure prediction tools and techniques.	5hrs.
9	Biological databases: Scope and objectives, construction of a database, different types of databases. Sequence search tools and properties. Major sequence repositories- NCBI, DDBJ, EMBL nucleotide sequence database, GenBank, genome sequence database (GSDB), STACK, TIGR gene indices and UniGene. Gene expression databases – ASDB, FlyView, GXD, BodyMap, EpoDB, etc. Genetic and physical maps – DRESH, GB4-RH, GDB, GenAtlas, GeneMap, etc. Genomic databases – AceDB, CropNet, FlyBase, GOLD, HIV sequence Database, INE, Mendel database, MGD, TIGR microbial database, TAIR, ZFIN, and ZmDB. Protein databases - SWISS-PROT, MSDB, PIR, DAtA, GenProtEC, HUGE, TIGRFAMs, trEST, trGEN, PROSITE, ProtoMap, SBASE, and SMART. Proteome resources – Aaindex, proteome analysis database, REBASE, SWISS-2DPAGE and YPD. Major RNA sequence databases. Mulberry and silkworm databases and their composition.	5hrs.

### Practical

**1 Credit**

1	Preparation of metaphase and pachytene chromosome spreads for mapping from silkworm larvae and uzifly.
2	Preparation of chromosome spreads from uzifly and silkworm larvae for differential banding.
3	Estimation of genome size by cytophotometry and flowcytometry.
4	Quantitative estimation of DNA from silkworm by spectrophotometry.
5	Isolation of genomic DNA from silkworm and estimation by spectrophotometry and flurometry.
6	Isolation and qualitative estimation of DNA from silkworm by electrophoresis.
7	Gene analysis by PCR.
8	Isolation genomic DNA from mulberry and estimation by spectrophotometry,

	flurometry and electrophoresis.
9	Quantitative estimation of protein from silkworm eggs and different tissues by calorimetric method.
10	Protein profile studies in silkworm eggs, whole organism and different tissues of silkworm by single and two dimensional electrophoresis.
11	Analysis of heat shock proteins expression in silkworm.
12	Western blot analysis of protein.
13	Database Access and data retrieval from databases.
14	Construction of database – Home page and other supporting WebPages.
15	Studies of structure and composition of major databases.
16	DNA and protein sequence alignment and comparison by both manual and bioinformatics tools.

### **SERBT – 3.3 : SILK TECHNOLOGY, SERICULTURE EXTENSION AND ECONOMICS**

#### **Course Outcomes**

**On successful completion of this course, students will be able to**

1. Acquire knowledge on pre, true and post reeling process.
2. Understand the extension services in sericulture industry.
3. Work out the economics of mulberry, cocoon and silk reeling.

#### **Pedagogy**

1. Presentation through power point slides, charts, photos, etc.
2. Hands on training on silk reeling, preparation of leaflets and flash cards.
3. Visit to sericulture extension and economics division and silk factory.

#### **Theory**

**3 Credits**

<b>Unit-I</b>		
1	Physical and commercial characteristics of multivoltine and bivoltine cocoons. Cocoon markets – organization and functions; cocoon sorting – objectives and procedure; defective cocoons.	3hrs.
2	Cocoon stifling: Objectives and methods – sun drying, steam stifling, hot air drying, Yamato hot air driers - advantages and disadvantages. Preservation of cocoons.	2hrs.
3	Cocoon cooking: Objectives and methods - open pan, three-pan, pressurized, floating and sunken systems - merits and demerits.	2hrs.
4	Reeling water: Sources and quality, importance in cocoon cooking and raw silk quality; factors influencing water quality; corrective measures.	2hrs.
5	Silk reeling: Evolution of silk reeling. Reeling units – charaka, cottage basin,	3hrs.

	multi-end and automatic reeling devices. Comparative account on the performance of different reeling units; components and their functions in silk reeling devices.	
<b>Unit-II</b>		
6	Re-reeling and packing: Objectives, reeling, hank preparation, lacing, skeining, booking, bale making and bundling.	2hrs.
7	Raw silk properties - physical, chemical and microscopic. Factors influencing the properties of raw silk. Silk exchanges – structure and function.	2hrs.
8	Raw silk testing and grading – objectives: Raw silk testing – conditioned weight, visual and mechanical tests. Raw silk grading - international standards (ISA) and Bureau of Indian Standards (BIS).	3hrs.
9	Degumming, bleaching and silk dyeing – objectives and methods.	2hrs.
10	Silk throwing; silk weaving - hand and power loom; fabric examination.	2hrs.
11	Byproducts of silk reeling industry and their utilization.	1hr.
<b>Unit-III</b>		
12	Extension education: Objectives and importance; principles, concepts and functions of extension education; teaching and learning process.	2hrs.
13	Communication: Functions, models, elements, concepts and implications.	2hrs.
14	Extension programme management; sericulture development through plans; major programmes in sericulture.	2hrs.
15	Extension teaching methods adopted in sericulture. Use of audio-visual aids in sericulture. Training: meaning, principles, methods and training programmes in sericulture.	2hrs.
16	Adoption and diffusion of innovations. TOT: meaning and systems; role of extension in TOT.	2hrs.
17	Sericulture extension system: Extension systems of CSB, state governments, voluntary organizations and Universities. Extension services in sericulture.	2hrs.
<b>Unit-IV</b>		
18	Economics: Principles of economics, micro and macro economics; classification of costs – explicit and implicit, fixed, variable, marginal, average; profits – gross and net.	2hrs.
19	Advantages and characteristics of sericulture. Scope of sericulture in India – vis-à-vis other agricultural crops - income and employment generation.	2hrs.
20	Economics of mulberry production under rainfed and irrigated systems; comparative economics of mulberry production under traditional and improved practices.	3hrs.
21	Economics of silkworm egg production in government and private grainages. Economics of cocoon production for commercial purpose; comparative economics of cocoon production under traditional and improved methods of silkworm rearing.	3hrs.
22	Economics of raw silk production in charaka, cottage basin and multi-end reeling units.	2hrs.

### Practical

**1 Credit**

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	Sorting of cocoons – identification of good and defective cocoons.

4	Cocoon stifling and cooking.
5	Determination of alkalinity and hardness of reeling water by titration methods.
6	Reeling techniques: Epprouvette, Charaka, Cottage basin, Multi-end and Automatic reeling devices.
7	Estimation of degumming loss in multivoltine and bivoltine cocoons and raw silk.
8	Estimation of bleaching loss in multivoltine silk.
9	Dyeing of multivoltine and bivoltine silk using acid, basic and compound dyes.
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	Preparation of leaflets and flash cards on various activities of sericulture.
14	Visit to museum of Extension Division of CSRTI, Mysore.
15	Visit to field and farmers rearing house to study sericulture technologies adopted.

### SERBT - 3.4: ENTREPRENEURSHIP DEVELOPMENT IN SERICULTURE

#### Course Outcomes

On successful completion of this course, students will be able to

1. Understand the entrepreneurial opportunities in sericulture.
2. Acquire knowledge on project formulation.
3. Gain knowledge to become an entrepreneur in various aspects of sericulture.

#### Pedagogy

1. Presentation through power point slides, charts, etc.
2. Hands on training in formulation of projects.
3. Visit to sericulture based EDP units.

#### Theory

3 Credits

Unit-I		
1	Entrepreneurship development programme (EDP): Emergence and objectives of EDP, essential qualities to become an entrepreneur; selection of a potential entrepreneur.	2hrs.
2	Planning for EDP: Objectives, selection of a centre, purpose of pre-training promotional work.	2hrs.
3	Follow-up for EDP: Need, extent and mechanism; facilitating follow-up; approach to competence development.	2hrs.

4	Project formulation (project appraisal): Meaning and purpose, personnel / agencies interested in project appraisal, market feasibility of the project, technical and market analysis, means of finance, profitability, risk analysis and liquidity management; agencies supporting sericulture projects.	4hrs.
5	Marketing: Approach and essence; market assessment – demand; steps involved in market study.	2hrs.
<b>Unit-II</b>		
6	Insectary facilities and equipments: Location, building specification, air conditioning and environmental control, furnishings and equipment, sanitation and equipment, subsidiary facilities.	2hrs.
7	Mass production of insect pathogens: Culturing of hosts / preparation of culture substrates, inoculation, collection of diseased/dead hosts; isolation, purification and storage of pathogens.	4hrs.
8	Mass production of parasitoids: Culturing of host insects, oviposition of parasitoids, emergence of parasitoid adults from hosts, collection of parasitoid adults, feeding and storage of parasitoid adults.	3hrs.
9	Mass production of insect predators: Culturing of prey insects, release of adults of predators on the colony of prey insects for oviposition, collection and feeding of predator adults, storage of predator adults.	3hrs.
<b>Unit-III</b>		
10	EDP in raising mulberry saplings (Kisan nursery) and vermicomposting.	2hrs.
11	EDP in organization of chawki rearing centres.	2hrs.
12	EDP in silkworm egg production and rearing.	2hrs.
13	EDP in silk reeling – charaka, cottage basin and multi-end reeling units.	3hrs.
14	EDP in mass production of parasitoids and predators.	3hrs.
<b>Unit-IV</b>		
15	Mechanization: Objectives, principles, technology and productivity, characteristic features, advantages and limitations.	2hrs.
16	Mechanization in mulberry cultivation, silkworm egg production and silkworm rearing - activities, scope and economics.	4hrs.
17	Advances in silk reeling technology - activities, scope and economics.	2hrs.
18	Contract farming and its scope in sericulture.	2hrs.
19	Occupational health hazards in sericulture.	2hrs.

### **Tutorial (Demonstration)**

**1 Credit**

1	Planning the facilities required for establishment of insectary.
2	Observations on insect pathogens and symptoms.
3	Observations on insect parasitoids and predators.
4	Planning for raising mulberry saplings (Kisan nursery) and vermicomposting.
5	Planning for establishment of chawki rearing centers.
6	Planning for establishment of silkworm egg production centres.

7	Planning for establishment silk reeling - charka, cottage basin and multi-end reeling units.
8	Assessment of Benefit – Cost ratio under traditional and mechanized systems of mulberry cultivation.
9	Assessment of Benefit – Cost ratio under traditional and mechanized systems of silkworm egg production.
10	Assessment of Benefit – Cost ratio under traditional and mechanized systems of silkworm rearing.
11	Assessment of Benefit – Cost ratio under traditional and mechanized systems of silk reeling units.
12	Visit to units for mass production of parasitoids and predators.
13	Visit to grainage / silk reeling units to study the health related problems among the concerned personnel.
14	Visit to chawki rearing centres.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

### SERBT 3.5: APPLIED ENTOMOLOGY

#### Course Outcomes

On successful completion of this course, students will be able to

1. Acquire knowledge of insects and their behavior.
2. Gain knowledge on harmful, beneficial and social insects.
3. Gain knowledge on management of insect pests.

#### Pedagogy

1. Presentation through power point slides, photos, pictures, videos, etc.
2. Explanation using insect specimens.
3. Hands on training in collection and preservation of insects.

#### Theory

3 Credits

Unit-I		
1	General characteristic features of insects – salient features of insect orders with special reference to Lepidoptera, Diptera, Hymenoptera, Coleoptera, Homoptera and Neuroptera.	4hrs.
2	Metamorphosis in insects - ametabola, hemimetabola and holometabola.	2hrs.
3	Insect age, abundance and adaptations; insects as the most successful organisms on earth.	2hrs.
4	Beneficial insects - silkworm, honeybee and lac insect – products and their uses; parasitoids and predators and their role in pest suppression; pollinators and their role in crop production.	4hrs.

<b>Unit-II</b>		
5	Harmful insects: (a) Agricultural pests -cereals, pulses, vegetables, oilseeds and stored grains.	4hrs.
6	(b) Veterinary insects and other pests -blood sucking flies, lice, fleas and arachnids.	4hrs.
7	(c) Pests of public health importance - mosquito, house fly, louse, bed bug and rat flea.	4hrs.
<b>Unit – III</b>		
8	Collection and preservation of insects - collection methods - baits, killing, preservation, mounting, labeling and identification of a few insects using keys.	4hrs.
9	Insect pests and their control: (a) Definition and origin of pests. (b) Categories and types of pests. (c) Symptoms and injuries caused by pests. (d) Insect vectors. (e) Economic threshold and economic injury level. (f) Pest control: General considerations – different methods – IPM.	8hrs.
<b>Unit – IV</b>		
10	Insects as human food: Commonly eaten insects, nutritional value and advantages of eating insects.	2hrs.
11	Insects as important laboratory tools for scientific research - silkworm, fruit fly, house fly and mosquito.	2hrs.
12	Social insects - termites, honeybees, wasps and ants.	2hrs.
13	Mass production of biocontrol agents: (a) Insectary – Models and facilities (b) Mass production of parasitoids (egg, larval and pupal) (c) Mass production of predators (d) Mass production of pathogens (e) Storage, packaging, transportation and release of biocontrol agents	6hrs.

### **Tutorial (Demonstration)**

**1 Credit**

1	Collection and identification of insects belonging to important orders of class Insecta: Lepidoptera, Coleoptera and Orthoptera.
2	Collection and identification of insects belonging to important orders of class Insecta: Diptera, Hymenoptera and Homoptera.
3	Collection and methods of insect preservation.
4	Studies on beneficial insects – silkworm, honeybee and lac insect.
5	Studies on identification of harmful insects: Bihary hairy caterpillar, cutworm, leaf roller chaffer beetle and termites.
6	Studies on identification of harmful insects: Scale insect, leaf hoppers, thrips and jassid.
7	Studies on identification of silkworm pests: Uzi fly and dermestid beetle.
8	Study of insects for scientific research - silkworm, fruit fly, house fly and mosquito.



9	Study of social insects - termites, honeybees, wasps and ants.
10	Planning the facilities required for establishment of insectary.
11	Observations on insect pathogens and symptoms.
12	Observations on insect parasitoids and predators.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

### **SERBT – 3.6: SILKWORM BIOLOGY, COCOON PRODUCTION AND PROTECTION**

#### **Course Outcomes**

**On successful completion of this course, students will be able to**

1. Understand the life cycle and classification of silkworm races.
2. Acquire knowledge on procedure involved in production of cocoons.
3. Gain knowledge on protection of silkworm from pests and diseases.

#### **Pedagogy**

1. Presentation through power point slides, photos, etc.
2. Demonstration of silkworm rearing equipments and silkworms.
3. Demonstration of pests and diseases of silkworm.

#### **Theory**

**3 Credits**

<b>Unit – I</b>		
1	Classification of insects - general characteristic features of insects; characteristic features of the order Lepidoptera; detailed study of the families – Saturniidae and Bombycidae; classification of sericigenous insects.	3hrs.
2	Metamorphosis in insects. Morphology and life cycle of mulberry and non-mulberry silkworms - egg, larva, pupa and adult.	3hrs.
3	Anatomical features of silkworm: Digestive, circulatory, excretory, nervous and respiratory systems and silk gland; reproductive systems of silk moth.	3hrs.
4	Classification of silkworm races / breeds – geographical distribution, voltinism, moulting, indigenous and exotic, multivoltine and bivoltine. Characteristics of temperate and tropical voltine groups of silkworm.	3hrs.
<b>Unit-II</b>		
5	Planning for silkworm rearing: Estimation of leaf yield and quality, brushing capacity, selection of silkworm races / breeds and hybrids.	3hrs.
6	Rearing houses: Selection of building site, orientation of the building, rearing houses for young (chawki) and grown up (late-age) silkworms; rearing appliances and their uses.	3hrs.
7	Disinfection and hygiene: Importance, types of disinfectants, preparation of spray solution and quantum of spray solution required, disinfection method, mode of	4hrs.

	action of disinfectants; hygiene practices in rearing.	
8	Egg transportation - time, methods and devices, egg incubation, black boxing; brushing – methods.	2hrs.
	<b>Unit – III</b>	
9	Young age silkworm rearing: Environmental requirements, rearing methods and operations. Care during moult; chawki rearing centres.	4hrs.
10	Grown-up silkworm rearing: Environmental requirements, rearing methods and operations.	3hrs.
11	Artificial diet for silkworm rearing: Composition, merits and demerits.	2hrs.
12	Mounting, harvesting and marketing: Types of mountages, methods of mounting, environmental requirements, density of mounting, cocoon harvesting, sorting, packing, transportation and marketing, preparation of crop harvest report; byproducts of silkworm rearing and their utilization.	3hrs.
	<b>Unit-IV</b>	
13	Insect and non-insect pests of mulberry silkworm and their status.	2hrs.
14	Tachinid flies and dermestid beetles associated with <i>Bombyx mori</i> and their management.	3hrs.
15	Diseases of <i>Bombyx mori</i> : Causal organism, mode of infection and transmission, symptomatology, incidence, extent of crop loss, cross infectivity and management of Microsporidiosis (pebrine), Virosis (NPV, CPV, IFV and DNV), Bacteriosis (bacterial flacherie) and Mycoses (muscardine and aspergillosis) diseases.	6hrs.
16	Non-infectious diseases of <i>Bombyx mori</i> .	1hr.

**Tutorial (Demonstration)**

**1 Credit**

1	Morphology and life cycle of the silkworm, <i>Bombyx mori</i> .
2	Morphology and life cycle of the non-mulberry silkworms.
2	Characteristic features of popular bivoltine and multivoltine races/breeds of silkworm.
3	Dissect and display the digestive system and silk glands in silkworm.
4	Dissect and display of male and female reproductive system of silkworm.
5	Rearing houses and equipments.
6	Disinfection of rearing houses and equipments.
7	Incubation of silkworm eggs and brushing of silkworms.
8	Selection and preservation of mulberry for feeding of young and late-age silkworms.
9	Young and late-age silkworm rearing.
10	Method of application of bed disinfectants for management of silkworm diseases.
11	Moulting – identification of moulting larvae.
12	Mounting – mountages, identification and mounting of spinning larvae.
13	Harvesting and sorting of cocoons.
14	Preparation of crop report and other records in the rearing house.

A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.
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## IV SEMESTER

### SERBT – 4.1: MULBERRY AND SILKWORM BIOTECHNOLOGY

#### Course Outcomes

**On successful completion of this course,** students will be able to

1. Understand the concepts and components of biotechnology.
2. Acquire knowledge on biotechnological techniques which can be applied for improvement of mulberry plant.
3. Gain knowledge on biotechnological tools for improvement of silkworm.

#### Pedagogy

1. Presentation through power point slides, photos, videos, etc.
2. Conduct of mulberry and silkworm based biotechnology experiments.
3. Visit to biotechnology and tissue culture laboratories.

#### Theory

**3 Credit**

<b>Unit-I</b>		
1	Introduction: Scope and importance of plant biotechnology.	1hr.
2	Plant cell and tissue culture techniques: Introduction and historical background of plant morphogenesis and tissue culture, laboratory requirements for plant tissue culture, culture media; applications of cell and tissue culture in mulberry.	3hrs.
3	Growth in relation to morphogenesis: Cell and organ differentiation; de-differentiation and re-differentiation; cell competence; concept of totipotency; regeneration.	2hrs.
4	Micropropagation; somatic embryogenesis, multiple shoot formation, somaclonal variations, synthetic seeds in mulberry.	2hrs.
5	Production and uses of haploids: Anther culture, pollen culture, ovule culture, bulbasum technique; detection of haploids; applications of haploids in mulberry breeding.	2hrs.
6	Somatic hybridization: Isolation of protoplast; viability and plating density of protoplasts; protoplast culture; isolation of sub-protoplast; regeneration of plants; protoplast fusion and uses of somatic hybrids; genetic modification of protoplast.	2hrs.
<b>Unit – II</b>		
7	Preservation and screening of germplasm for drought, salinity and disease resistance in mulberry. Embryo and endosperm culture; bioreactors.	2hrs.
8	Recombinant DNA technology: Cloning vectors for recombinant DNA, cloning and expression of vectors.	2hrs.
9	Gene transfer methods in plants; target cells for transformation; gene transfer techniques using <i>Agrobacterium</i> ; selectable and scorable markers; agro infection and	2hrs.

	gene transfer in mulberry.	
10	Transgenic plants and their role in crop improvement; molecular farming and regulated gene expression.	2hrs.
11	Transformation of chloroplast genome (Cg) in higher plants using <i>Agrobacterium</i> and particle gun; targeting of foreign protein into chloroplast and mitochondria.	2hrs.
12	Patenting transgenic organisms and isolated genes and DNA sequences; Plant breeder's rights (PBRs) and farmers' rights.	2hrs.
	<b>Unit – III</b>	
13	Animal cell and tissue culture: History, scope, advantages and disadvantages. Insect cell and tissue culture and their applications; media preparation and culturing procedures; somatic cell fusion.	4hrs.
14	Silkworm cell culture – establishment of primary and secondary cell lines, composition and preparation of media and maintenance of cultures.	2hrs.
15	Tissue and organ culture; whole embryo culture; tissue grafting.	2hrs.
16	Polymerase chain reaction (PCR): Gene amplification, application of PCR in silkworm biotechnology.	2hrs.
17	Principles and fundamentals of biotechnology; Application of biotechnology in silkworm – new textile fibres, improvement of silkworm strains and marker assisted breeding.	2hrs.
	<b>Unit – IV</b>	
18	A brief account of transgenic animals: Insect transgenesis – silkworm transgenesis, application of silkworm transgenesis, piggy bac transposon, red fluorescent protein expression in <i>Bombyx mori</i> .	3hrs.
19	Genetic resistance of the silkworm, <i>Bombyx mori</i> , to bacterial and viral diseases. Immune response against bacterial and viral diseases in silkworm; regulation of host gene expression, inducible anti-bacterial and anti-viral proteins in silkworm. Molecular triggering of anti bacterial proteins – antibacterial protein gene expression.	3hrs.
20	<i>BmNPV</i> vector – life cycle – genomic organization of <i>BmNPV</i> , biotechnological application for large - scale synthesis of recombinant proteins (valuable proteins) using <i>BmNPV</i> in different stages of <i>Bombyx mori</i> .	3hrs.
21	Preservation of endangered non-mulberry silkworms through biotechnological approaches.	1hrs.
22	IPR, patenting, WTO-GATT and bioethics.	2hrs.

### Practical

1Credit

1	Estimation of protein in mulberry leaf.
2	Separation and identification of amino acids by chromatography.
3	Procedure for sterilization and preparation of culture media.
4	Study of callus, embryogenesis and organogenesis in mulberry – <i>in vitro</i> .
5	Studies on isozyme polymorphism through PAGE in mulberry
6	Studies on protein polymorphism through PAGE in mulberry leaf.
7	Preparation of synthetic seeds in mulberry.
8	Media preparation for silkworm cell lines.

9	Selection of tissue for establishment of silkworm cell lines.
10	Protein profile in haemolymph and fat body tissues in silkworm through PAGE.
11	Polyacrylamide gel electrophoresis – esterases in silkworm.
12	Polyacrylamide gel electrophoresis – phosphatases and dehydrogenases in silkworm.
13	Estimation of protease enzyme in the mid gut tissue of silkworm through calorimetric method.
14	Demonstration of Northern blotting techniques.
15	Calorimetric estimation of RNA in silk gland of silkworm.

### **SERBT - 4.2: PROJECT WORK**

#### **Course Outcomes**

**On successful completion of this course,** students will be able to

1. Ignite students for right choice of research topic and understand its relevance.
2. Acquire knowledge in planning and execution of project work.
3. Gain experience for conduct of research independently.

#### **Pedagogy**

1. Provide guidance for designing and execution of project work.
2. Provide guidance for presentation of research work through power point presentation.
3. Provide guidance for preparation of project report.

#### **8 Credits**

A topic for the major project will be assigned to each student and it shall be either from the syllabus or from any other topic in the field of Sericulture and Seribiotechnology as approved by the guide and department council.

### **SERBT – 4.3 : TEXTILE TECHNOLOGY**

#### **Course Outcomes**

**On successful completion of this course,** students will be able to

1. Understand the classification and properties of textile fibers.
2. Understand the weaving, dyeing and printing techniques of textile materials.
3. Gain knowledge in the field of apparel technology.

## Pedagogy

1. Presentation through power point slides, photos, etc.
2. Demonstration of textile based materials.
3. Visit to textile industries.

## Theory

**3 Credits**

<b>Unit-I</b>		
1	Introduction and history of textiles; classification of fibres – natural and manmade fibres.	2hrs.
2	Yarn formation: Types and characteristics of yarns; staple, filament and integrated multi-component yarns; textured, stretch and bulk yarns.	2hrs.
3	Weaving: Preparation for weaving, essential weaving operations, selvages, construction of cloth designs, thread count, classification of weaves and their characteristics, fabric defects.	3hrs.
4	Felted and non-woven fabric formation: Process, types, properties and uses of felted fabrics and non-woven fabrics.	2hrs.
5	Decorative fabric construction: Braiding, knitting, lace and embroidery; finishing processes: Types and effects.	3hrs.
<b>Unit-II</b>		
6	Dyeing: Selection of dyes, types of dyes, dyeing methods, identifying dyeing defects, tests to determine colourfastness.	3hrs.
7	Printing and flocking: Dyes used for printing, methods of printing and flocking.	2hrs.
8	Major natural fibres (cotton, linen, wool, hair and silk) : History, types, manufacturing process, finishing and blending process.	5hrs.
9	Minor natural fibres : Vegetable and mineral fibres.	2hrs.
<b>Unit-III</b>		
10	Major manmade fibres (rayon, acetate, triacetate, nylon, aramid, polyester, acrylic, modacrylic, spandex, polypropylene and glass) : History, methods of production, types, finishing, evaluating and blending process.	8hrs.
11	Minor manmade fibres: Polymers, saran, novoloid and polybenzimidazole fibres.	4hrs.
<b>Unit-IV</b>		
12	Comparative characteristics of natural and manmade fibres.	3hrs.

13	Consumer goods for apparels – composition, properties and uses.	2hrs.
14	Consumer goods for home finishing – curtains, pillows, blankets, terry towels, table clothes, carpets and rugs.	3hrs.
15	Fabric care: Permanent care and labeling.	2hrs.
16	Testing of fabric: Non-technical and technical tests.	2hrs.

### **Tutorials (Demonstration)**

**1 Credit**

1	Microscopic and physical properties of natural fibres.
2	Chemical properties of natural fibres
3	Microscopic and physical properties of manmade fibres.
4	Chemical properties of manmade fibres.
5	Types of yarns – staple and filament.
6	Samples of weave patterns.
7	Types of decorative fabrics.
8	Fabric dyeing.
9	Different types of printed fabrics.
10	Samples of consumer goods.
11	Fabric testing.
12	Care of fabrics.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

## **SERBT 4.4: VANYA SERICULTURE**

### **Course Outcomes**

**On successful completion of this course,** students will be able to

1. Understand the distribution and status of vanya silk production.
2. Know the procedure involved in cultivation of host plants of vanya silkworms.
3. Learn the techniques involved in rearing of vanya silkworms.

### **Pedagogy**

1. Presentation through power point slides, photos, etc.
2. Hands on training in establishment and maintenance of vanya silkworm host plants.
3. Hands on training in rearing of vanya silkworms.

**Theory****3 Credits**

<b>Unit-I</b>		
1	Insect and non-insect fauna producing silk and their distribution in world and India.	2hrs.
2	Status of vanya silks in India – characteristic features, advantages, income and employment, production and demand.	4hrs.
3	Host plants of vanya silkworms: State-wise distribution in India, area and economic importance.	3hrs.
4	Botanical description of primary host plants of vanya silkworms.	3hrs.
<b>Unit-II</b>		
5	Establishment of primary host plants of vanya silkworms and package of practices for their cultivation.	4hrs.
6	Pests and diseases of primary host plants of vanya silkworms and their management.	3hrs.
7	Planning for vanya silkworm egg production and rearing; grainage and rearing equipments.	3hrs.
8	Disinfection and hygiene practices in grainages and silkworm rearing houses / premises.	2hrs.
<b>Unit-III</b>		
9	Breeding, eco-races / races, morphology and life cycle of vanya silkworms.	3hrs.
10	Egg production technology of vanya silkworms.	3hrs.
11	Rearing technology of young and late-age vanya silkworms.	3hrs.
12	Pests and diseases of vanya silkworms and their management	3hrs.
<b>Unit-IV</b>		
13	Tasar and muga cocoon reeling: Selection, cooking and reeling; eri cocoon spinning.	3hrs.
14	Economics of tasar, eri and mugaculture.	3hrs.
15	Byproducts of vanya sericulture and their utilization.	2hrs.
16	Constraints (inherent and man-made) in vanya silk production; strategies for improvement of vanya sericulture (host plants and vanya silkworms) in India.	4hrs.

**Tutorial (Demonstration)****1 Credit**



1	Host plants of eri silkworms.
2	Host plants of tasar silkworms.
3	Host plants of muga silkworms.
4	Pests and diseases of primary host plants of eri silkworms.
5	Pests and diseases of primary host plants of tasar silkworms.
6	Pests and diseases of host plants (primary) of muga silkworms.
7	Morphology and life cycle of eri silkworm.
8	Morphology and life cycle of tasar silkworm.
9	Morphology and life cycle of muga silkworm.
10	Egg production technology of vanya silkworms.
11	Rearing technology of vanya silkworms.
12	Pests and diseases of vanya silkworms.
13	Cooking and spinning technology of eri cocoons.
14	Cooking and reeling technology of tasar and muga silk cocoons.
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

## SERBT – 4.5: SILK TECHNOLOGY AND ENTREPRENEURSHIP DEVELOPMENT

### Course Outcomes

On successful completion of this course, students will be able to

1. Understand the properties of cocoon and silk.
2. Know the procedure involved in reeling of silk on different machines.
3. Gain knowledge on entrepreneurial aspects and opportunities in sericulture.

### Pedagogy

1. Presentation through power point slides, photos, etc.
2. Demonstration of silk materials.
3. Visit to sericulture based EDP units.

### Theory

3 Credits

Unit-I		
1	Physical and commercial characteristics of multivoltine and bivoltine cocoons. Cocoon markets – organization and functions; cocoon sorting – objectives and procedure; defective cocoons.	3hrs.
2	Cocoon stifling: Objectives and methods – sun drying, steam stifling, hot air drying, Yamato hot air driers - advantages and disadvantages. Preservation of cocoons.	3hrs.
3	Cocoon cooking: Objectives and methods - open pan, three-pan, pressurized, floating and sunken systems - merits and demerits.	3hrs.
4	Reeling water: Sources and quality, importance in cocoon cooking and raw silk quality; factors influencing water quality; corrective measures.	3hrs.
Unit-II		
5	Silk reeling: Evolution of silk reeling. Reeling units – charaka, cottage basin, multi-end and automatic reeling devices. Comparative account on the performance of different reeling units; components and their functions in silk reeling devices.	4hrs.
6	Re-reeling and packing: Objectives, grant reeling, hank preparation, lacing, skeining, booking, bale making and bundling.	2hrs.
7	Raw silk properties - physical, chemical and microscopic. Factors influencing the properties of raw silk. Silk exchanges – structure and function.	2hrs.
8	Raw silk testing and grading – objectives: Raw silk testing – conditioned weight, visual and mechanical tests. Raw silk grading - international standards (ISA) and Bureau of Indian Standards (BIS).	4hrs.
Unit-III		
9	Degumming, bleaching and silk dyeing – objectives and methods.	3hrs.
10	Silk throwing; silk weaving - hand and power loom; fabric examination.	3hrs.
11	Byproducts of silk reeling industry and their utilization.	2hrs.

12	Entrepreneurship development programme (EDP): Emergence and objectives of EDP, essential qualities to become an entrepreneur, selection of a potential entrepreneur.	2hrs.
13	Planning for EDP: Objectives, selection of a centre, purpose of pre-training promotional work.	2hrs.
<b>Unit-IV</b>		
14	EDP in raising mulberry saplings (Kisan nursery) and vermicomposting.	2hrs.
15	EDP in organization of chawki rearing centres.	2hrs.
16	EDP in silkworm egg production and rearing.	3hrs.
17	EDP in silk reeling – charaka, cottage basin and multi-end reeling units.	3hrs.
18	EDP in mass production of parasitoids and predators.	2hrs.

**Tutorial (Demonstration)**

**1 Credit**

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	Sorting of cocoons – Identification of good and defective cocoons.
4	Determination of filament length and denier by single cocoon reeling.
5	Practicing of cocoon cooking and brushing.
6	Estimation of degumming loss in multivoltine and bivoltine cocoons and raw silk.
7	Estimation of bleaching loss in multivoltine silk.
8	Dyeing of multivoltine and bivoltine silk.
9	Study of different types of silk wastes.
10	Preparation of garlands / handicrafts using silk waste and pierced cocoons.
11	Planning for raising mulberry saplings (Kisan nursery) and vermicomposting.
12	Planning for establishment of chawki rearing centers.
13	Planning for establishment of silkworm egg production centres.
14	Planning the facilities required for establishment of insectary
	A consolidated report shall be submitted at the end of the course for evaluation towards C-2 component.

## REFERENCES

- Agrios, G.N. (1997) *Plant Pathology*. 4<sup>th</sup> Edn., Academic Press, New York.
- Akira Nakamura (2000) *Fiber Science and Technology*. Oxford & IBH Publications, New Delhi.
- Alex Fraser (1966) *Heredity, Genes and Chromosomes*. McGraw Hill Book Company, New York.
- Allard, R.W. (1976) *Principles of Plant Breeding*. John Wiley & Sons, New York.
- Anonymous (1997) *Silkworm Egg Production*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Anonymous (1998) *Illustrated Textbook on Sericulture*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Anonymous (2000) *International J. Wild Silkmoth and Silk*. International Society for Wild Silkmoths, Japan and CSB, India.
- Anonymous (2000) *Silk Dyeing and Finishing Handbook*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Anonymous (2002) *Silk Weaving*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Anonymous (2002) *Colours from Nature – Silk Dyeing Using Natural Dyes*. Vol. I and II, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Aruga, H. and Tanaka, Y. (1971) *Cytoplasmic Polyhedrosis Virus of the Silkworm*. University of Tokyo Press, Japan.
- Ather H. Siddiqi (1982) *Experimental Physiology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- 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.
- Beck, S.D. (1963) *Animal Photoperiodism*. Holt, Holt Library of Science Series, New York.
- Beck, S.D. (1980) *Insect Photoperiodism*. Academic Press, New York.
- Beebec, T. and Burke, J. (1992) *Gene Structure and Transcription*. Oxford University Press, Oxford.
- Bernard P. Corbman (1983) *Textiles: Fiber to Fabric*. 6<sup>th</sup> Edition, Mc. Graw – Hill International Editions, Home Economic Series, Singapore, p. 594.
- Bhojwani, S.S. and Bhatnagar, S.P. (1999) *The Embryology of Angiosperms*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Bilgrami, K.S. and Dube, H.C. (1997) *A Textbook of Modern Plant Pathology*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Biotol Series (1993) *Analysis of Amino Acids, Proteins and Nucleic Acids*. Butterworth – Henmann.
- Biotol Series (1993) *Cellular Interactions and Immunobiology*. Butterworth - Heinemann.
- Biotol Series (1993) *Technological Applications of Immunochemicals*. Butterworth-Heinemann.
- Bhojwani, S.S. and Bhatnagar, S.P. (1999) *The Embryology of Angiosperms*. Vikas Publishing House Ltd., New Delhi.
- Bhojwani, S.S. and Razdan, M.K. (1998) *Plant Tissue Culture: Theory and Practice*. 2<sup>nd</sup> Edn., Elsevier, Amsterdam.
- Boraiah, G. (1994) *Lectures on Sericulture*. SBS Publishers, Bangalore.
- Borror, D. J and Delong, D. M. (1960) *Introduction to of Insects*. Holt, New York.

- Branden, C. and Tooze, J. (1991) *Introduction to Protein Structure*. Garland Publishing Inc., New York & London.
- Brown, T.A. (1983) *Gene Cloning - An Introduction*. Chapman and Hall.
- Brown, T.A. (1992) *Genetics a Molecular Approach*. 2<sup>nd</sup> Edn., Chapman and Hall, London.
- Bruce A.; Dennis B.; Jullian L.; Martin R.; Keith R. and James W. (1983) *Molecular Biology of the Cell*. Garland Pub. Inc., New York & London.
- Cantor, C.R. and Schimmel, P.R. (1980) *Biophysical Chemistry*. Vols. I, II and III, W.H. Freeman and Co., New York.
- Chapman, R.F. (1998) *The Insects-Structure and Function*. Cambridge University Press, UK.
- Charles J. Huber (1929) *The Raw Silk Industry of Japan*. The Silk Association of America, Inc., New York.
- Chaudhuri, H.K. (1971) *Elementary Principles of Plant Breeding*. Oxford and IBH Pub., New Delhi.
- Chaudhury, S.N. (1981) *Muga Silk Industry*. Directorate of Sericulture & Weaving, Govt. of Assam, Gouhati, Assam.
- Chaudhury, S.N. (1982) *Eri Silk Industry*. Directorate of Sericulture & Weaving, Govt. of Assam, Gouhati, Assam.
- Chinnaswamy, K.P.; Govindan, R.; Krishnaprasad, N.K. and Reddy, D.N.R. (2000) *Moriculture in Tropics. Vol. 1 – Proceedings of NSTS – 1999*, UAS, Bangalore.
- Chinnaswamy, K.P.; Govindan, R.; Krishnaprasad, N.K. and Reddy, D.N.R. (2000) *Silkworm Management in Tropics. Vol. 2 – Proceedings of NSTS – 1999*, UAS, Bangalore.
- Dandin, S.B. and Gupta, V.P. (2002) *Advances in Indian Sericulture Research*. CSR&TI, Mysore.
- Dandin, S.B.; Jayant Jayaswal and Giridhar, K. (Eds.) (2003) *Handbook of Sericulture Technologies*. CSB, Bangalore.
- Darlington, C.D and La Cour, L.F. (1976) *Handling of Chromosomes*. 6<sup>th</sup> Edn., Rev. by L.F. La cour, London, Allen and Unwin.
- Darlington, C.D and Lewis, K.R. (1969) *Chromosomes Today*. Oliver & Boyd, Edinburgh.
- Datta, R.K. (1996) *Global Silk Scenario – 2001. Proceedings of the International Conference on Sericulture – 1994*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Dent, D.R. and Walton, M.P. (Eds.) (1997) *Methods in Ecological and Agricultural Entomology*. CAB International, Cambridge.
- De Robertis and De Robertis (1988) *Cell and Molecular Biology*. Lea & Febiger, Hong kong.
- Devaiah, M.C.; Narayanaswamy, K.C. and Maribashetty, V.G. (1999) *Advances in Mulberry Sericulture*. CVG Publications, Bangalore.
- Dilip De Sarkar (1998) *The Silkworm – Biology, Genetics and Breeding*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Doerfler, W. and Bohm, P. (1986) *Current Topics in Microbiology and Immunology*. Springer – Verlag, New York and London.
- Dube, H.C. (1992) *A Textbook of Fungi, Bacteria and Viruses*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Eikichi Hiratsuka (2000) *Silkworm Breeding*. Oxford & IBH Publications, New Delhi.
- Elcio P. Guimaraes, John Ruane, Beate D. Scherf, Andrea Sonnino and James D. Dargie (2007) *Marker-Assisted Selection*, FAO, Rome.
- Falconer, D.S. (1972) *Introduction to Quantitative Genetics*. Oliver & Boyd, Edinburgh.
- Fatima, D.; Mani, A.; Narayanan, L.M.; Selvaraj, A.M. and Armugama, N. (1997) *Immunology and Microbiology*. Saras Publication, Nagercoil.

- Foth, H.D. (1984) *Fundamentals of Soil Science*. 7<sup>th</sup> Edn., John Wiley & Sons, New York.
- Gardner, E.J. (1981) *Principles of Genetics*. 5<sup>th</sup> Edn., John Wiley & Sons, New York, Chichester Toronto, Singapore.
- Gautam, R.D. (1994) *Biological Pest Suppression*. Westvill Publishing House, New Delhi.
- Ghosh, M.R. (1989) *Concepts of Insect Control*. New Age International Publishers, New Delhi.
- Giese, A.C. (1973) *Cell Physiology*. 4<sup>th</sup> Edn., Philadelphia, Saunders.
- Gilmour, D. (1961) *Biochemistry of Insects*. Academic Press, New York.
- Goldsmith, M.R. and František Marec (2010) *Molecular Biology and Genetics of the Lepidoptera*, CRC Press Taylor & Francis Group, Broken Sound Parkway NW, USA.
- Gopalaswamy, N. (1994) *Agricultural Meteorology*. Rawat Publications, Jaipur.
- Gopal Chandra De (1989) *Fundamentals of Agronomy*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Govindaiah, Gupta, V.P., Sharma, D.D., Rajadurai, S. and Nishitha Naik (2005) *Mulberry Crop Protection*. Central Silk Board, Bangalore.
- Govindan Bhaskaran, Stanley Friedman and Rodriguez, J.G. (1981) *Current Topics in Insect Endocrinology and Nutrition*. Plenum Press, New York and London.
- Govindan, R.; Bharathi, V.P., Sannappa, B. and Ramakrishna Naika (2005) *Growth Regulators and Hormones in Sericulture*. Seri Scientific Publishers, Bangalore.
- Govindan, R.; Chinnaswamy, K.P.; R.; Krishnaprasad, N.K. and Reddy, D.N.R. (2000) *Non-Mulberry Sericulture, Silk Technology and Sericulture Economics and Extension*. Vol. 3 – *Proceedings of NSTS – 1999*, UAS, Bangalore.
- Govindan, R.; Chinnaswamy, K.P.; R.; Krishnaprasad, N.K. and Reddy, D.N.R. (2000) *Advances in Tropical Sericulture*. Vol. 4 – *Proceedings of NSTS – 1999*, UAS, Bangalore.
- Govindan, R.; Devaiah, M.V.; Rangaswamy, H.R. (1978) *Reshme Vyavasaya (Kannada)*. UAS, Bangalore.
- Govindan, R.; Narayanaswamy, T.K. and Devaiah, M.C. (1998) *Principles of Silkworm Pathology*. Seri Scientific Publishers, Bangalore.
- Govindan, R.; Ramakrishna Naika and Sannappa, B. (2004) *Advances in Disease and Pest Management in Sericulture*. Seri Scientific Publishers, Bangalore.
- Govindan, R.; Ramakrishna Naika and Sannappa, B. (2004) *Progress of Research on Disease and Pest Management in Sericulture*. Seri Scientific Publishers, Bangalore.
- Govindan, R.; Ramakrishna Naika and Sannappa, B. (2005) *Objective Sericulture for Competitive Examinations*. Seri Scientific Publishers, Bangalore.
- Hames, B.D.; Hooper, N.M. and Haughtan, I.D. (1997) *Instant Notes in Biochemistry*. Viva Books Pvt. Ltd., Chennai.
- Harper, H.A. (1967) *Review of Physiological Chemistry*. Los Altos, Lange Medical Publications.
- Hartmann, H.T. and Kaster, D.E. (1961) *Plant Propagation: Principles and Practices*. N.J. Englewood Cliffs, Prentice Hall, New York.
- Hiroo and Sibuya-ku (1975) *Textbook of Tropical Sericulture*. Japan Overseas Corporation Volunteers, Tokyo, Japan.
- Holborow, E.J. (1973) *An ABC of Modern Immunology*. The Lancet Ltd., London.
- Huang, E. (2003) *Protection of Mulberry Plants*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Huang, G. R. (1998) *Silk Reeling*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Imms, A.D. (1961) *General Text Book of Entomology*. 9<sup>th</sup> Edn., Rev. by O.W. Richards & R.G. Davies, Bombay.

- Ingram, D.S. and Halgeson, J.P. (1980) *Tissue Culture Methods for Plant Pathologists*. Blackwell Scientific Publication, London.
- John, P.; Donald, A.; Prescott, L.M.; Harley and Klein (1999) *Microbiology*. 4<sup>th</sup> Edn., WCB, McGraw-Hill Companies.
- Johri, B.N. and Bhattacharya, S.P. (1994) *Taxonomy and Phylogeny of Angiosperms*. Narosa Publishers, New Delhi.
- Jolly, M.S. (1987) *Appropriate Sericulture Techniques*. Published by International Centre for Training and Research in Tropical Sericulture, Mysore.
- Jolly, M.S.; Sen, S.K.; Ahsan, M.M. (1974) *Tasar culture*. Ambika Publishers, Bombay.
- Jolly, M.S.; Sen, S.K.; Sonwalkar, T.N. and Prasad, G.K. (1979) *Sericulture Manual - 4 – Non-Mulberry Silks*. Agriculture Service Bulletin, FAO, Rome.
- Joshi, P. (2000) *Genetic Engineering and its Application*. Agrobios Pvt. Ltd.
- Kerkut, G.A. and Gilbert, L.I. (1985) *Comprehensive Insect Physiology, Biochemistry and and Biochemistry - Vol.1-12*. Pergamon Press, Oxford, New York and Toronto.
- Kichisaburo M. (1997) *Moriculture – Science of Mulberry Cultivation*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Kolay, A.K. (1996) *Basic Concepts of Soil Science*. New Age International Pvt. Ltd., New Delhi.
- Konhar, S.L. (1981) *Economic Botany in the Tropics*. Mcmillan India Ltd., Delhi.
- Koshy, T.D. (1990) *Silk Exports and Development*. Ashish Publishing House, New Delhi.
- Kovalev, P.A. (1970) *Silkworm Breeding Stocks*. Central Silk Board, Bangalore.
- Krame, P.J. (1969) *Plant and Soil Water Relationships: Modern Synthesis*. McGraw-Hill New York.
- Krishnamoorthy, H.N. (1975) *Gibberellins and Plant Growth*. Wilsy Eastern, New Delhi.
- Krishnaswami, S.; Madhava Rao, N.R.; Suryanarayan, S.K and Sundaramurthy, T.S. (1972) *Sericulture Manual - 3 - Silk Reeling*. Agriculture Service Bulletin, FAO, Rome.
- Krishnaswami, S.; Narasimhanna, M.N.; Suryanarayan, S.K and Kumararaj, S. (1973) *Sericulture Manual-2 - Silkworm Rearing*. Agriculture Service Bulletin, FAO, Rome.
- Kumaresan, P. and Srinivasa, G. (2005) *Sericulture Extension Management and Economics*. Central Silk Board, Bangalore.
- Larnar, M.F. and Donald, H.P. (1969) *Modern Developments in Animal Breeding*. Academic Press, London.
- Lawrence, G.H.M. (1960) *Taxonomy of Vascular plants*. Macmillan & Co., New York.
- Lehninger, A.L. (1978) *Biochemistry, Molecular Basis of Cell Structure and Function*. 2<sup>nd</sup> Edn., Ludhiana, Kalyani.
- Lewin, B. (1999) *Gene VII*. Oxford University Press, Oxford.
- Livine, L. (1969) *Biology of the Gene*. Saint Louis, Mosby.
- Mackenzie, A.; Ball, A.S. and Virdee, S.R. (1999) *Instant Notes in Ecology*. Viva Book Pvt. Ltd., New Delhi, Mumbai and Chennai.
- Madan Mohan Rao, M. (1999) *Comprehensive Sericulture Manual*. PS Publications, Hyderabad.
- Mahadevappa, D.; Halliya, V.G.; Shankar, D.G. and Ravindra Bhandiwad (2000) *Mulberry Silk Reeling Technology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Malgavkar, P.B. (1987) *Technologies for Economic Development*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Mathews, C.K. and Van Holde, K.E. (1995) *Biochemistry*. 2<sup>nd</sup> Edition, Benjamin Cumings, Redwood City, C.A.
- Mehta, S.S. and Vinod Shanbhag (1990) *Indian Textiles – An Intersectoral Perspective*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.

- Metcalf, C.L.; Flint, W.P. and Metcalf, R.L. (1962) *Destructive and Useful Insects*. MacGraw-Hill Book Co. Inc., New York and London.
- Misra, R.D. and Ahmed, M. (1993) *Manual on Irrigation Agronomy*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay and Calcutta.
- Morohoshi, S. (2000) *Development Physiology of Silkworms*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Murray, D.R. (1991) *Advanced Methods in Plant Breeding Biotechnology*. CAB, International, Wallingford, Oxon, United Kingdom.
- Narasimhanna, M.N. (1998) *Manual on Silkworm Egg Production*. CSB, Bangalore.
- Narayanaswamy, K.C. and Devaiah, M.C. (1998) *Silkworm Uzi Fly*. Zen Publishers, Bangalore.
- Nataraju, B., Sathyaprasad, K., Manjunath, D. and Aswani Kumar, C. (2005) *Silkworm Crop Protection*. Central Silk Board, Bangalore.
- Natesh, S.; Chopra, V.L. and Ramachandran, S. (Eds.) (1989) *Biotechnology in Agriculture*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Nielsen, S.S. (1994) *Introduction to the Chemical Analysis of Foods*. Jones and Bartlett Publishers, Boston.
- Nobumasa, H. (2000) *Structure of the Silk Yarn*. Oxford and IBH Publications, New Delhi.
- Odum, E.F. (1971) *Fundamentals of Ecology*. Philadelphia, Saunders.
- Omura, S. (1973) *Silkworm Rearing Techniques in Tropics*. Overseas Technical Co-operation Agency, Tokyo, Japan.
- Pandey, S.N. and Chada, A. (1996) *Economic Botany*. Vikas Publishing House Pvt. Ltd., New Delhi.
- Pandey, S.N. and Sinha, B.K. (1995) *Plant Physiology*. Vikas Pub. House Pvt. Ltd., New Delhi.
- Paul, W.E. (1990) *Fundamental Immunology*. Raven Press. New York.
- Prescott, M.L.; Harley, J.P. and Klein, D.A. (1999) *Microbiology*. Wmc Brown Publishers's, USA.
- Raghavarao (1983) *Statistical Techniques in Agricultural and Biological Research*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Bombay and Calcutta.
- Rajan, R.K. and Himantharaj, H.T. (2005) *Silkworm Rearing Technology*. Central Silk Board, Bangalore.
- Rajanna, L., Das, P.K., Ravindran, S., Bhogेशa, K., Mishra, R.K., Singhvi, N.R., Katiyar, R.S. and Jayaram, H. (2005) *Mulberry Cultivation and Physiology*. Central Silk Board, Bangalore.
- Ramakrishna Naika; Govindan, R. and Sannappa, B. (2002) *Organic Sericulture*. Seri Scientific Publishers, Bangalore.
- Rangaswami, G. (1996) *Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.
- Rangaswami, G.; Narasimhanna, M.N.; Kasiviswanathan, K., Sastry, C.R. and Jolly, M.S. (1976) *Sericulture Manual-1- Mulberry cultivation*. Agriculture Services Bulletin, FAO, Rome.
- Reddy, D.N.R. and Narayanaswamy, K.C. (2003) *Pests of Mulberry*. Zen Publishers, Bangalore.
- Reddy, D.N.R.; Narayanaswamy, K.C. and Jayaramaiah, M. (2000) *The Eri Silkworm Egg..* Zen Publishers, Bangalore.
- Reinert, J. and Bajaj, Y.P.S. (1977) *Fundamental and Applied Aspects of Plant Cell, Tissue and Organ Culture*. Springer, New York.



- Robert, P.W. (1975) *Genes and Proteins*. Dowden, Hutchinson & Ross Inc., Stroudsburg, Pennsylvania.
- Roger Y. Stainer, John L. Ingraham, Mark L. Wheelis, Page R. Painter (1998) *General Microbiology*. Macmillan Education Ltd., London.
- Sandhya Rani, G. (1998) *Sericulture and Rural Development*. Discovery Publishing House, New Delhi.
- Sanjay Sinha (1990) *The Development of Indian Silk*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Sankaran, S. and Subbaiah Mudaliar, V.T. (1997) *Principles of Agronomy*. Pub. BAPPCO, Bangalore.
- Sannappa, B.; Jayaramaiah, M.; Govindan, R. and Chinnaswamy, K.P. (2002) *Advances in Ericulture*. Seri Scientific Publishers, Bangalore.
- Sarkar, D.C. (1980) *Ericulture in India*. Central Silk Board, Bangalore.
- Saxena, A.B. (1996) *Development of Behaviour in Insects*. Anmol Publications Pvt. Ltd., New Delhi.
- Saxena, A.B. (1996) *Hormones of Insects*. Anmol Publications Pvt. Ltd., New Delhi.
- Saxena, A.B. (1996) *Principles of Insect Morphology*. Anmol Publications Pvt. Ltd., New Delhi.
- Saxena, A.B. (1996) *Ecology of Insects*. Anmol Publications Pvt. Ltd., New Delhi.
- Schlegel, H.G. (1993) *General Microbiology*, 7<sup>th</sup> Edn., Cambridge University Press, Cambridge, U.K.
- Sengupta, K.; Kumar, P.; Baig, M. and Govindaiah (1990) *Handbook on Pest and Disease Control of Mulberry and Silkworm*. ESCAP, UN, Thailand.
- Shankar, M.A. (1997) *Hand Book of Mulberry Nutrition*. UAS - Multiplex, Bangalore.
- Sharma, P.D. (1994) *Ecology and Environment*. 6<sup>th</sup> Edition, Rastogi Publication, Meerut.
- Simon R. Charlslley (1982) *Culture and Sericulture*. Academic Press Inc. London.
- Singh, B.D. (1998) *Biotechnology*. Kalyani Publishers, New Delhi.
- Singh, B.D. (2000) *Plant Breeding - Principles and Methods*. Kalyani Pub., New Delhi.
- Singh, R.N.; Samson, M.V. and Datta, R.K. (2000) *Pest Management in Sericulture*. Indian Publishers, Delhi.
- Singh, S.S. (1996) *Principles and Practices of Agronomy*. Kalyani Publishers, New Delhi.
- Sinnott, E.W.; Dunn, L.C. and Dobzhansky, T. (1958) *Principles of Genetics*. Tata McGraw Hill Pub. Co. Ltd., New York.
- Sivarama Sastry. K.; Padmanabhan, G. and Subramanyam, C. (1994) *Textbook of Molecular Biology*. Macmillan India Ltd., New Delhi.
- Smith, R. L. (1974) *Ecology and Field Biology*. 2<sup>nd</sup> Edn., Harper & Row, New York.
- Smith and Kaary, P.F. (1975) *Genetic Structure and Function*. Macmillan, London.
- Smith, D.W. (1994) *Biocomputing: Informatics and the Genome Project*. Academic Press.
- Sreerama Reddy, G. (Ed.) (1998) *Silkworm Breeding*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Steinhaus, E.A. (1963) *Insect Pathology: An Advanced Treatise* – Vol. 1-2. Academic Press, New York and London.
- Stent, G.S. and Calender, R. (1986) *Molecular Genetics*. CBS Publishers, New Delhi.
- Strayer, U. L. (1995) *Principles of Biochemistry*. 4<sup>th</sup> Edition, W.H. Freeman, New York.
- Strickberger, M.W. (1976) *Genetics*. Macmillan, New York.
- Sturnikov, V.A. (1976) *Control of Silkworm Development and Sex*. MIR Publishers, Moscow.
- Sukumar, J.; Dandin, S.B. and Bongale, U.D (1994) *Mulberry Disease and Management*. KSSRDI, Bangalore.

- Swanson, C. P. (1968) *Cytology and Cytogenetics*. Macmillan Co., Bombay.
- Sybenga, J. (1992) *Cytogenetics in Plant Breeding*. Springer – Verlog, New York.
- Tanaka, Y. (1964) *Sericology*. Central Silk Board, Bangalore.
- Tazima, Y. (1964) *Genetics of Silkworm*. Academic Press, London.
- Tazima, Y. (1972) *Handbook of Silkworm Rearing*. Fuji Pub.Co. Ltd., Tokyo, Japan.
- Tazima, Y. (1978) *The Silkworm: An Important Laboratory Tool*. Kodansha Ltd., Tokyo.
- Thangavelu, K.; Chakraborty, A.K.; Bhagawati, A.K. and Isa, Md. (1998) *Handbook of Mugaculture*. CSB, Bangalore.
- Tortara, G.J.; Funke, B.R. and Case, C.L. (1998) *Microbiology: An Introduction*. 6<sup>th</sup> Edn., The Benjamin – Cumings Pub. Co., Redwood City, C.A.
- Trigiano, R.N. and Gray, D.J. (2000) *Plant Tissue Culture Concepts and Laboratory Exercises*. 2<sup>nd</sup> Edn, CRC Press, New York.
- Tripurari Sharan (1984) *Sericulture and Silk Industry*. Published by Y.K. Sharma, Consortium on Rural Technology, Delhi.
- Trivedi, P.C. (Ed.) (2001) *Plant Pathology*. Pointer Publishers, Jaipur, India.
- Twyman, R.M. (1998) *Advanced Molecular Biology*. Viva Book Pvt. Ltd., New Delhi.
- Ullal, S.R. and Narasimhanna, M.N. (1981) *Handbook of Practical Sericulture*. CSB, Bangalore.
- Venkatachalam, S. (1999) *The Computer Revolution*. Pitamber Pub. Co. Pvt. Ltd., New Delhi.
- Verma, P.S. and Agarwal, V.K. (2004) *Cell Biology, Genetics, Evolution and Ecology*. Published by S. Chand & Co., New Delhi.
- Watson, J.D.; Gilman, M.; Witkowski, J. and Zooleym (1992) *Recombinant DNA*. 2<sup>nd</sup> Edn., WH Freeman and Co., New York.
- Weir, D.M. (1977) *Immunology*. 4<sup>th</sup> Edn., The English Language Book Society and Chrchill Livingstone, Singapore.
- White, M.J.D. (1973) *Animal Cytology and Evolution*. 3<sup>rd</sup> Edn., C.U.P, London.
- Wigglesworth, V.B. (1956) *Insect Physiology*. 5<sup>th</sup> Edn., Rev. Methuen, London.
- William J. Shull (1964) *Mutations*. Ann. Arbor, The University of Michigan Press.
- Wilson, K. and Walker, J. (1994) *Practical Biochemistry – Principles and Techniques*. Cambridge University Press, Cambridge.
- Winchester, A.M. (1974) *Genetics*. Oxford & IBH Pub. House, New Delhi.
- Yasuji Hamamura (2001) *Silkworm Rearing on Artificial Diet*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi and Calcutta.
- Yellamanda Reddy, T. and Shankara Reddi, G.H. (1995) *Principles of Agronomy*. Publishers, New Delhi.
- Yokoyama (1954) *Synthesised Science of Sericulture*. Published by CSB, Bombay.
- Yonemura, M. and Rama Rao, N. (1925) *Handook of Sericulture*. Mysore Government Branch Press.

## JOURNALS

1. Bulletins of Sericultural Experimental Station - Suginami, Tokyo, Japan.
2. Journal of Sericultural Science of Japan - Sericultural Experimental Station, Wade, Soginami-ku, Tokyo, Japan.
3. Annual Report of National Institute of Genetics - Misima, Sizioka-Kan, Japan.
4. Japan Journal of Genetics - Published by the Genetics Society of Japan.

5. Sericologia - Jacques Rousseau, 69350, La Mulatiere, France.
6. Indian Journal of Sericulture - Published by CSR & TI, Mysore.
6. Journal of Sericulture and Technology - Published by NASSI, Bangalore.
7. Indian Silk - Published by Central Silk Board, Bangalore.
8. Bulletin of Indian Academy of Sericulture - Bhubaneshwar, Orissa.
9. Reshme Krishi (Kannada) - Published by Department of Sericulture, Government of Karnataka, Bangalore.
10. Current Science – Published by Indian Institute of Science, Bangalore.

**(H.B. MANJUNATHA)**  
Chairman – BOS in Sericulture

**PATTERN OF QUESTION PAPER FOR THE THEORY (EXTERNAL) EXAMINATION**

**M.Sc. Sericulture and Seribiotechnology  
(Semester Scheme - CBCS Pattern)**

Time: 3 Hours

Max. Marks: 70

**Instructions:** Answer all the questions. All questions carry equal marks

I. Define / explain **any seven** of the following: 7 x 2 = 14  
(Questions from all the Units of the Syllabus)

- a)
- b)
- c)
- d)
- e)
- f)
- g)
- h)
- i)
- j)

II. Main question (Question from Unit- I of the Syllabus) 1 x 14 = 14

OR

Write explanatory note on the following:

- a)
- b)

III. Main question (Question from Unit- II of the Syllabus) 1 x 14 = 14

OR

Write explanatory note on the following:

- a)
- b)

IV. Main question (Question from Unit- III of the Syllabus) 1 x 14 = 14

OR

Write explanatory note on the following:

- a)
- b)

V. Main question (Question from Unit- IV of the Syllabus) 1 x 14 = 14

OR

Write explanatory note on the following:

- a)
- b)