

Formulation of Fish Feed

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Formulation of Fish Feed	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on identification of various indigenous ingredients for formulation of fish feed.
- To gather knowledge on the nutritional requirements of the cultivable species.
- To gain knowledge on the impact of formulated feeds on fish growth.
- To enhance the quality of aquacrops and increase the production.

Learning Outcomes

By the end of the course, the students will be able to:

- Identify the useful ingredients for fish feed formulation.
- Learn to prepare fish feed using locally available ingredients.
- Start the Fish feed production industry.
- Initiate entrepreneurship on Fish feed production.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own fish feed production industry.

SYLLABUS:

Practical

Unit I: Selection of ingredients

20 Hours

Identification of various types of non-conventional ingredients for fish feed formulation. Evaluation of their nutritional quality. Preparation of fish feed and feeding of the prepared feeds to the cultivable fishes and prawns. The study of impact of the prepared feeds on the performances of fishes and prawns.

Exercises:

1. Identification of various types of locally available ingredients (*viz.* macrophytes, oil-cakes, plants etc.) for fish feed formulation.

2. Evaluation of the nutritional values (*viz.* protein, lipid, carbohydrates, ash, amino acids, fatty acids) of these ingredients.
3. Assay of presence of anti-nutritional factors (*viz.* tannin, saponin, phytic acid, oxalic acid etc.) in these ingredient

Unit II: Formulation of Fish Feed

20 Hours

Preparation of fish feed using traditional method and computerized soft ware. Evaluation of quality of prepared feed for the cultivable species.

Exercises:

1. Formulation of fish feed using “Pearson Square” method.
2. Formulation of fish feed using computerized soft ware.
3. The assay of biochemical composition of formulated feed: protein, lipid, carbohydrate, ash, amino acids, fatty acids.

Unit III: Feeding of Fish

20 Hours

The feeding of the prepared feeds to the cultivable fishes and prawns. The study of impact of the prepared feeds on the performances of fishes and prawns. Evaluation of nutritional value of fishes for human consumption.

Exercises:

1. The feeding of the prepared feeds to the cultivable fishes and prawns.
2. Evaluation of impact of the prepared feeds on the survival, growth and production of fishes and prawns.
3. Assessment of Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE) of the feed.
4. Assay of nutritional value of the produced fishes/ prawns for human consumption.
5. Evaluation of impact of prepared feed on the water quality of the culture system.
6. Visit to a Fish feed preparation facility/ industry.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2017. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.

- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Fish Breeding and Larviculture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fish Breeding and Larviculture	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on various aspects of brood stock maintenance of carps and air breathing fishes.
- To understand the breeding techniques for carps and air breathing fishes.
- To understand the larviculture techniques for carps.
- To gain experience on the larviculture techniques of air breathing fishes.
- To gather knowledge in the management of optimum water quality for larviculture.
- To gather knowledge on the nutritional requirements of the cultivable species.
- To gain knowledge on the impact of live food in larviculture.

Learning Outcomes

By the end of the course, the students will be able to:

- Produce seeds of carps and air breathing fishes.
- Start the Fish hatchery business.
- Start fish-food production.
- Initiate entrepreneurship in fish seeds production.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own entrepreneurships in fish farming.

SYLLABUS:

Practical

Unit I: Breeding of Economically Important Fishes

20 Hours

Breeding of various fishes in the captivity and production of quality fish seeds for aquaculture.

Exercises:

1. Management of brood stock units and breeding of carps.
2. Maintenance of brood stock units and breeding of air breathing fishes.

3. Estimation of major water quality parameters *viz.*, temperature, pH, dissolved oxygen, conductivity etc. in the fish breeding units.

Unit II: Culture of Important Live Food Organisms

15 Hours

Culture of various live food organisms using organic manures and feeding of different fish larvae produced.

Exercises:

1. Culture of live food organisms *viz.*, rotifers, cladocerans, copepods, chironomid larva etc. using organic manures (like cattle manure, poultry wastes and mustard oil-cake).
2. Evaluation of major water quality parameters *viz.*, temperature, pH, dissolved oxygen, ammonia etc. in the live food culture units.
3. The enrichment of live food organisms (with vitamin C, DHA, EPA etc.) to enhance the nutritional value of the live food for fish larvae.

25 Hours

Unit II: Larviculture

Culture of larvae of carps and air breathing fishes and production of healthy seeds for stocking ponds.

Exercises:

1. Culture of fish larvae in the static water/ Recirculating Aquaculture Systems (RAS).
2. Measurement of water quality parameters (*viz.*, temperature, pH, dissolved oxygen, ammonia etc.) in the larvae culture unit regularly.
3. Feeding of fish larvae with live food thrice daily.
4. The study of morphological and physiological changes in the larvae during ontogenic development.
5. Visit to a fish farm.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2017. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New

Delhi, India.

- Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Ornamental Fish Culture: Opportunity and Scope

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Ornamental Fish Culture: Opportunity and Scope	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on Aquarium preparation and decoration.
- To gain hands-on training on breeding and culture of various Ornamental fishes.
- To gain experience in the management of optimum water quality in the fish aquarium.
- To gather knowledge on the nutritional requirements of the cultivable species.

Learning Outcomes

By the end of the course, the students will be able to:

- Prepare and decorate ornamental fish aquarium.
- Identify the suitable and economically important Ornamental fish species.
- Initiate entrepreneurship on Aquarium making and Ornamental fish production.

Skill development and job opportunities

After completion of this course students will be

- Fully equipped to start own entrepreneurship in **aquarium making and its decoration.**
- Aware about the requirements to start their own **Ornamental fish industry.**

SYLLABUS:

Practical

Unit I: Preparation of Aquarium and Its Decoration

20 Hours

Preparation of glass aquaria of various shapes and their decoration using locally available materials. The impact of aquatic plants in the maintenance of healthy environment in the aquarium.

Exercises:

1. Construction of glass aquaria of various shapes (rectangular, square, round etc.).
2. Identification and culture of useful aquatic plants for the decoration of fish aquarium.

3. Decoration of aquarium with plants and locally available materials.

Unit II: Breeding of Ornamental Fishes and Culture of Plants **20 Hours**

Identification of economically important cultivable Ornamental plants and fishes for culture.

Exercises:

1. Identification of economically important Ornamental fishes and their breeding.
2. Culture of young larvae and feeding them live food.
3. Regular monitoring of water quality parameters viz. temperature, pH, conductivity, dissolved oxygen, ammonia etc. in the fish aquarium.
4. Culture of zooplankton (rotifers, cladocerans, copepods etc.) using organic manures for the feeding of fish larvae.
5. Production of plants for the decoration of aquarium.

Unit III: Production of Marketable Ornamental Fishes

20 Hours

Culture of compatible fishes together and feeding them with live food and prepared diets. Keep them ready for local market.

Exercises:

1. Maintenance of aquarium.
2. Feeding of ornamental fishes with various natural foods and prepared diets.
3. Evaluation of their growth rate and colour development.
4. Development of marketing strategy for the produced ornamental fishes in well decorated aquaria.
5. Visit to any Aquarium Facility.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2019. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.
- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.

- Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.
- Swain, S. K., Sarangi, N. and Ayyapan, S. 2010. Ornamental Fish Farming. DIPAS, Indian Council of Agricultural Research, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Bio-floc Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Bio-floc Technology	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn about the basics of Bio-floc technology and it's important as a skill for self-sustainable and self-employment
- To learn production of fish in the larger scale with minimum use of water source and land to help in the total production of fish for human consumption in India.
- To learn about how to set-up the technology looking into the different conditions and availability of space and training.
- To teach fundamental concept of running this system with the biological knowledge of bacteria culture, water quality management
- To learn the types of fish species, types of feed and feeding, density of fish to be maintain in the particular volume of water etc.

Learning Outcomes

The Learning Outcomes of this course are as follows:

- After studying this course, students will be able to gain insight into fish culture using minimum amount of water, land, fish feed and with high biosecurity.
- After studying this course, students will be able to learn and explain about the bio-floc technology and they can set up bio-floc tanks for themselves and for others in the form of industries and entrepreneurship as well as for stat-up with the help of existing Government funding and self funding.
- After studying this course, students will be able to understand and implement bio-floc system and this can be an alternative skill for earning, self-employment, job generation and contribute in large scale fish production which are hygienic, organic and good protein source for human health.

SYLLABUS:

Practical

Unit-I

12 Hours

Introduction to basics of Bio-floc technology and its applications in aquaculture industry, Standard operating procedure, Microbial Role in Bio-floc System, Design Set-up and installation of Bio-floc system, Biosecurity, Advance over pond aquaculture, basic equipment's and necessary items .

Exercises

1. Inoculation of bacteria and its role in Bio-floc technology.
2. Plankton and microbial analysis of bio-floc.
3. Set-up and Installation of Bio-floc system.

Unit-II

12 Hours

Optimum water quality parameters and its management. Floc water preparation and floc volume measurement. Monitoring and management of dissolved oxygen, pH, conductivity, temperature, salinity, ammonia, nitrate, nitrite, TDS. Measurement of floc volume and its control. Role of bacteria in management of water quality.

Exercises

1. Analysis of following water quality parameters in Bio-floc culture tanks using kits: temperature, pH, conductivity, salinity, TDS, ammonia, nitrate, nitrite.
2. Water preparation for Bio-floc system.
3. Measurement of floc volume using imhoff cone.

Unit-III

12 Hours

Suitable species selection, Pre-stocking and post stocking management, Food and feeding management, Production performance, Nursery rearing days, Survival (%), Average body weight at harvest, feed conversion ratio.

Exercise

1. Identification of suitable fish, feeding habits, stocking capacity, growth rate and duration of culture.
2. The study of Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE).

Unit-IV

12 Hours

C: N ratio management, Nutritional requirements and protein levels in the food. Source of carbon, calculation of carbon and nitrogen ratio, suitable C:N ration management in the initial floc preparation and during culture days. Selection of species-specific food with optimum protein level, food size, quantity of feed according to per cent body weight, feeding rate.

Exercise

1. Calculation of C: N ratio and its management from the TAN content in the floc water.
2. Mouth size and food size and growth study.

Unit-V

12 Hours

Disease management and prophylactic treatment, Economics values of fish and its marketing strategies. Common disease in bio-floc, identification of disease its causes, species-specific disease, stress management and treatment. Steps for prevention and protections of possible disease, possible control measures with setup systems by controlling light, temperature etc. Sludge management. Economics values of fish and its marketing strategies. Production capacity and requirements, start-up and entrepreneurship opportunities, funding and grants for setting up from Government.

Exercise

1. Fungal, bacterial, parasitic and viral disease commonly found in bio-floc fish culture system.
2. Identification and economically important fish species for culture in bio-floc system like prawn, other new economic species etc.
3. Write a Project for start-up or entrepreneurship and governmental grants.
4. Visit to hatcheries with super-intensive models.

Recommended Readings:

- Avnimelech, Y. 2015. Bio-floc Technology- a Practical Guidebook. 3rd ed. World Aquaculture Society, USA.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Aquaculture Entrepreneurship

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Aquaculture Entrepreneurship	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To give first-hand training on traditional and technology-based Aquaculture.
- To understand the importance of different types of ponds required for aquaculture.
- To understand the requirement of advanced technology for sustainable development of aquaculture in India.
- To gain experience in the management of optimum water quality in the fish production systems.
- To enhance the quality of aquacrops and increase the production.

Learning Outcomes

By the end of the course, the students will be able to:

- Identify the useful aquaculture systems for sustainable aquaculture development.
- Recognize the suitable and economically important aquacultural species.
- Understand the importance of aquaculture in nutrition security, poverty elevation and employment generation.

Skill development and job opportunities

After completion of this course students may be

- Employed in various aquaculture related business including prawn and fish farms.
- Fully equipped to start own entrepreneurship in fish farming.

SYLLABUS:

Practical

Unit I: Pond-based Traditional Aquaculture

20 Hours

Introduction to indigenous pond-based fish culture systems and identification of economically important cultivable finfishes and shellfishes. The impact of aquatic organisms in the production of aquacrops.

Exercises:

1. Designing (layout) and drawing of a self-sustainable Aquaculture farm showing different ponds.
2. Selection and identification of cultivable finfishes and shellfishes (prawns, mussels, crabs).
3. Collection and identification of various freshwater aquatic plants. Understanding of the role of different aquatic plants in aquaculture.

4. Identification of harmful aquatic insects and their remedial measures.
5. The study of diurnal fluctuations of major water quality parameters (*viz.*, temperature, pH, dissolved oxygen, ammonia etc.) in a pond.

Unit II: Recirculating Aquaculture System (RAS)

20 Hours

Application of advance technology like, Recirculating Aquaculture System (RAS) for the sustainable development of Aquaculture in India.

Exercises:

1. Designing of a land-based Recirculating Aquaculture System (RAS).
2. Evaluation of various types of filters like, mechanical, chemical and biological filters in the maintenance of water quality in the RAS.
3. The study of role of flow rate and duration of circulation in the maintenance of water quality in the RAS.
4. The monitoring of temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, phosphate etc. at different hours of water circulation.
5. Culture of various fishes and prawns in the RAS.
6. Visit to a Recirculating Aquaculture System.

Unit III: Aquaponics System

20 Hours

Application of Aquaponics System to grow multiple crops simultaneously and thereby, increases the production of aquacrops in per unit area in a sustainable manner. Thus, enhances the earning of Fish farmers.

Exercises:

1. Designing of an Aquaponics System.
2. Evaluation of role of various types of edible (lettuce, tomato, water spinach etc.) and ornamental plants in the maintenance of ammonia levels in the fish culture units.
4. Identification of microorganisms functioning in the Aquaponics System.
5. Culture of various fishes and prawns in the Aquaponics System.
6. The monitoring of temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, phosphate etc. in the fish culture units.
7. Visit to an Aquaponics System.

Recommended Readings:

- AOAC, Association of Official Analytical Chemists. 2019. Official Methods of Analysis. Washington, DC: Association of Official Analytical Chemists Inc.
- APHA, American Public Health Association. 2017. Standard Methods for the Examination of Water and Wastewater. 23rd ed. Washington DC, USA: American Public Health Association, American Water Works Association, Water Environment Federation.
- Chakrabarti, R. and Sharma, J. G. 2008. Aquahouse. New Dimension of Sustainable Aquaculture. DIPAS, Indian Council of Agricultural Research, New Delhi, India.

- Holt, G. J. 2021. Larval Fish Nutrition. Willey-Blackwell, UK.
- ICAR, Indian Council of Agricultural Research. 2013. Handbook of Fisheries and Aquaculture. Directorate of Knowledge Management in Agriculture, Indian Council of Agricultural Research, New Delhi, India.
- Pillay, T. V. R. 2005. Aquaculture. Principles and Practices. Blackwell Publishing, New Delhi, India.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Pearl Culture

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Pearl Culture	2	0	0	2	XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

- To learn the basics of Pearl culture and it's important as a skill for self-sustainable and self-employment.
- To impart a comprehensive knowledge regarding morphology, anatomy, physiology, food and feeding behaviour, related diseases and its control measures of the mother Pearl Oyster.
- To gather a comprehensive knowledge of various types of implantations in Oyster and also the technique of insertion of beads for the formation of Pearl.
- To gather experience of post-operative care.
- To learn the techniques of harvesting, processing, sorting and marketing of the Pearl produced.

The Learning Outcomes:

By the end of the course, the students will be able to:

- Gain overall idea about Pearl oyster - its biology, morphology especially the histology of mantle, pearl formation etc.
- Recognize the suitable species of oyster for pearl culture in India.
- Set up a pearl culture system in pond/ tanks.
- Start entrepreneurship on Pearl culture.
- Start-up with the help of existing Government funding.

Skill development and job opportunities

After completion of this course students may be

- Employed in various pearl farming related businesses.
- Fully equipped to start own entrepreneurship in **pearl farming**.
- Completely aware about the requirements to start their own **Pear processing industry**.

SYLLABUS:

Practical

Unit-I

20 Hours

Introduction to pearl culture. Morphology and anatomy of pearl culture. Structure and histology of mantle. Origin of pearls, mussels producing pearls. Identification of species capable of producing pearl.

Exercises:

1. Set-up and Installation of culture system (sac culture, raft culture) for sustainable production.
2. Identification of suitable species capable to produce pearl.
3. The study of morphology and growth rate of the pearl oyster.
4. Measurement of major water quality parameters.
5. Feeding of the pearly oyster.

Unit-II**20 Hours**

Implantation of foreign particles for pearl formation and post operation care.

Exercise:

1. Preparation of the graft tissue for insertion.
2. Pearl oyster surgery and insertion technique of bead.
3. Post-operational care.
4. Culture of the pearl oyster using natural food .
5. Regular monitoring of the water quality parameters.

Unit-III**20 Hours**

Harvesting of Pearl and its processing. Sorting of Pearl. Marketing and economics concerned.

Exercises:

1. Bleaching and collection of pearls.
2. Cleaning of pearls.
3. Sorting of pearls.
4. Marketing of pearl.
5. Visit to a pear production site.

Recommended Readings:

- Srivastava, C.B.L. 2014. Fishery Science and Indian Fisheries.
- Far, A. E. 1986. Pearls. Butterworth Heinemann publications.
- Beveridge, M.C.M. 1987. Cage aquaculture. Fishing News.
- Bardach, J.E.W . 1972. Aquaculture farming and husbandry of freshwater and Sorting of Pearl. Marketing and economics concerned with Pearl Culture. Generation marine organisms
- Dobilet, D. 199. Pearl Farming. Australia: Nat Geographic Mag publication.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Sericulture I: Mulberry Silkworm Rearing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture I: Mulberry Silkworm Rearing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

1. Sericulture is multi-disciplinary activity consists of mulberry leaf production, silkworm rearing (cocoon production), silkworm egg production, silk reeling (yarn production), twisting, Warp and weft making, printing and dyeing, weaving, finishing, garment designing, marketing etc.
2. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth.
3. This course will generate entrepreneurs in this field. Sericulture offers gainful employment not only the rural masses but also for the educated youth in semi-urban and urban areas.

4. Effective utilization of waste generated in the industry will help in making the sericulture sector more viable, stable and create more employment opportunities.
5. Sericulturists fall under the category of primary activities. They usually find employment in sectors like government and research development centres.

SYLLABUS

Introduction to sericulture. Life cycle of silkworm and its characteristic features, Rearing of mulberry silk worm
(60 hours)

Practical

1. Study of models of rearing houses, appliances used in silkworm rearing
2. Preparation and application of disinfectants in rearing house and appliances
3. Technique for hot and cold acid treatment of silkworm eggs, its advantages and disadvantages
4. Rearing Techniques: Harvesting and preservation technique; leaf selecting for different instants; mulberry leaf estimation; Identification of moulting larva, care during moulting, mounting and mounting density, types of mountages; Harvesting of cocoons, assessment of cocoons.
5. Selection of moth, pairing and despairing, preparation of eggs (loose and sheet, surface sterilization of eggs)
6. Visit to seed cocoon markets, commercial grainage and cold storage centre to know activities of cocoon markets, preparation of laying and cold storage of eggs.
7. Mulberry Crop Cultivation: Preparation of nursery beds, Different propagation methods – grafting and layering, Planting System and Intercultural Operations: - pit and row system, mulching, irrigation.
8. Visit to Sericulture research institute

Essential Readings

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yip-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Sericulture II: Eri Silkworm Rearing

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture II: Eri Silkworm Rearing	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

Sericulture mainly focuses on silkworms rearing with the main aim of silk production. There are several applications of this:

1. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth. This course will generate entrepreneurs in this field.
2. . Sericulture by-products have remarkable application in the preparation of compost. Sericulture waste upon enrichment can be converted to high value manures.
3. Silk consists of two types of proteins, silk fibroin and sericin.

- a. Sericin contributes about 20-30 per cent of total cocoon weight. It is characterized by its high content of serine and 18 amino acids, including essential amino acids. Sericin has wide applications in pharmaceuticals and cosmetics such as, wound healing, bioadhesive moisturizing, antiwrinkle and antiaging properties.
- b. Silk fibroin, has a variety of applications in pharmaceutical, food, and fodder industries. Silk fibroin is used for bone formation, silk thread in surgery, and drug delivery system. Silk fibroin has unique properties including good adherence with flexibility to wound bed, absorption of exudates, biocompatibility, biodegradability, minimal inflammatory reaction and in skin grafting due to its outstanding mechanical properties.
4. Mulberry, the sole food plant of silkworm has also the potential to be used in pharmaceutical and food industry.

SYLLABUS

Introduction to non-mulberry sericulture (Eri, Tassar, Muga). Morphology of Eri silkworm, Propagation of host plant. **(60 hours)**

Practical

1. Propagation of castor food plant
2. Study of models of rearing houses, appliances used in Eri silkworm rearing
3. Preparation and application of disinfectants in rearing house and appliances
4. Rearing techniques of Eri silkworm, Eri mother moth examination, mounting method and storage of cocoons.
5. Incubation of eri eggs and its egg hatching ratio

Essential Readings

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yup-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.
- Hisao Aruga, Principles of Sericulture, Oxford & IBH Publications
- Eikichi Hiratsuka, Silkworm Breeding, Oxford & IBH Publications
- P.K. Pandey, S.K. Sharan, Silk Culture, APH Publishing Corp.
- Dr. P.K. Rajan, Silkworm Rearing Technology, Central Silk Board
- R.K. Goel, Laboratory Techniques in Sericulture, APH Publishing Corp.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Sericulture III: Silk Technology

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture III: Silk Technology	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

Sericulture mainly focuses on silkworms rearing with the main aim of silk production. There are several applications of this:

1. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth. This course will generate entrepreneurs in this field.
2. Sericulture by-products have remarkable application in the preparation of compost. Sericulture waste upon enrichment can be converted to high value manures.
3. Silk consists of two types of proteins, silk fibroin and sericin.
 - a. Sericin contributes about 20-30 per cent of total cocoon weight. It is characterized by its high content of serine and 18 amino acids, including essential amino acids. Sericin has wide

- applications in pharmaceuticals and cosmetics such as, wound healing, bioadhesive moisturizing, antiwrinkle and antiaging properties.
- b. Silk fibroin, has a variety of applications in pharmaceutical, food, and fodder industries. Silk fibroin is used for bone formation, silk thread in surgery, and drug delivery system . Silk fibroin has unique properties including good adherence with flexibility to wound bed, absorption of exudates, biocompatibility, biodegradability, minimal inflammatory reaction and in skin grafting due to its outstanding mechanical properties.
 4. Mulberry, the sole food plant of silkworm has also the potential to be used in pharmaceutical and food industry.

SYLLABUS

Introduction to Silk Technology

(60 hours)

Practical

1. Introduction to different textile fibres.
2. Cocoon stifling- different methods and determination of degree of drying.
3. Determination of commercial characters of cocoon: average cocoon weight, shell weight, shell percentage, average filament length, reelability, raw silk recovery percentage, renditta and denier.
4. Identification of silk, cotton, wool and synthetic fibres by various tests.
5. Raw silk testing and grading by mechanical tests like winding test, seriplane test and cohesion test.
6. Study of silk manufacturing unit.

Essential Readings

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House Yupp-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.
- Hisao Aruga, Principles of Sericulture, Oxford & IBH Publications
- Eikichi Hiratsuka, Silkworm Breeding, Oxford & IBH Publications
- P.K. Pandey, S.K. Sharan, Silk Culture, APH Publishing Corp.
- Dr. P.K. Rajan, Silkworm Rearing Technology, Central Silk Board
- R.K. Goel, Laboratory Techniques in Sericulture, APH Publishing Corp.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

Sericulture IV: Application of Sericulture in Therapeutic and Cosmetic Industry

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Sericulture IV: Application of Sericulture in Therapeutic and Cosmetic Industry	2	0	0	2	Class XII	NA

Learning Objectives

The Learning Objectives of this course are as follows:

1. To make the students aware about the significance of sericulture as a profit-making enterprise.
2. To help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk.
3. To give an understanding about the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits.
4. To help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Learning Outcomes

Upon completion of the course, students should be able to:

1. Learn about the history of sericulture and silk route.
2. Recognize various species of silk moths in India, and exotic and indigenous races.
3. Be aware about the opportunities and employment in sericulture industry- in public, private and government sector.
4. Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.
5. Develop entrepreneurial skills necessary for self-employment in mulberry and seed production and be apprised about practicing sericulture as a profit-making enterprise.
6. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Skill Development and Job Opportunities

1. Sericulture is multi-disciplinary activity consists of mulberry leaf production, silkworm rearing (cocoon production), silkworm egg production, silk reeling (yarn production), twisting, Warp and weft making, printing and dyeing, weaving, finishing, garment designing, marketing etc.

2. The demand for silk is bound to increase in the coming years This course will therefore help in generating employment, economic development and improvement in the quality of life of unemployed youth.
3. This course will generate entrepreneurs in this field. Sericulture offers gainful employment not only the rural masses but also for the educated youth in semi-urban and urban areas.
4. Effective utilization of waste generated in the industry will help in making the sericulture sector more viable, stable and create more employment opportunities.
5. Sericulturists fall under the category of primary activities. They usually find employment in sectors like government and research development centres.

SYLLABUS

Sericulture as a tool for rural development. Uses of different by-products of sericulture in pharmaceuticals and Cosmetics **(60 hours)**

Practical

1. Identify and collection of different waste materials of mulberry, silkworm rearing and silk reeling
2. Prepare different useful products of mulberry leaf waste and sticks.
3. Silkworm sericin in- medical textiles, regenerative drugs, and tissue engineering, cosmeceuticals, food additives, and manufacturing of valuable biomaterials.
4. Silkworm pupa in the field of therapeutics, cosmetics, animal feed, fertilizer, etc.
5. Sericulture wastes in sustainable applications for biofuels generation.
6. Entrepreneurial ideas to convert waste material of sericulture into raw material for other industries.
7. IT/ non IT based projects of sericulture.

Essential Readings

- Manual on Sericulture (1976); Food and Agriculture Organisation, Rome Ullal, S.R. and Narasimhanna M.N. (1987) Handbook of Practical Sericulture; 3rd Edition, CSB, Bangalore

Suggested Readings

- Yonemura, M. and Rama Rao, N. (1951) A Handbook of Sericulture. I. Rearing of silk-worms. Government Branch Press, Mysore.
- Ananthanarayanan, S. K. (2008) Silkworm Rearing. Daya Publishing House
- Aruga, H. (1994). Principles of Sericulture. CRC Press
- Sathe, T. V. and Jadhav, A. (2002) Sericulture and Pest Management. Daya Publishing House
- Yup-Lian, L. (1991) Silkworm Diseases. Food and Agricultural Organization.

Examination scheme and mode:

Evaluation scheme and mode will be as per the guidelines notified by the University of Delhi

PART- 9

Theme - 7

Isolation and Characterisation of Plasmid DNA

1. Teaching Methodology/Activities in the classroom

1. Mostly hands-on training either individually or in groups of 3-4 students.
2. A show and tell competition to be organized to explain the concept for either solution based method or spin column method of plasmid isolation.
3. Discard methods to be strictly followed — dry and wet discard

2. Assessment Pattern for each Unit/practical. Component of Attendance in the Assessment of 1 credit theory course

Unit I assessment based on:

1. Individual assessment on micro pipetting - 10 marks
2. Each student should prepare a streaked and a spread plate for assessment - 10marks

Unit II assessment based on:

1. Antibiotic resistance marker plates preparation and analysis — 10marks

Number of colonies to be mentioned	E. coli with plasmid	E. coli without plasmid
LB plate		
LB-amp plate		

2. Show and tell to explain the concept for either solution based method or spin column method of plasmid isolation - 10 marks

Unit III assessment based on:

1. Loading of samples on agarose gel for every student - 10 marks
2. Quality check of isolated plasmid on agarose gel: based on intensity of supercoiled vs linear band on the gel - 10 marks

Overall assessment based on:

- Timely submission of records (recording to be completed before the start of next experiment) - 10 marks

Viva voice — written or oral (after completion of each unit : 3+3+4) - 10 marks

3. Suggestions/Insertion/Deletions/Editing in the syllabus, Book Recommendation etc.

Additions - Highlighted in yellow

Deletions — Strikethrough-off

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical / Practice		
Isolation and Characterisation of Plasmid DNA	2	-	-	2	Class XII	NIL

Learning Objectives:

Students of this course should be able to learn:

- Fundamentals of nucleic acid molecules.
- Handling and growing of non-pathogenic bacterial strains of E. coli for recombinant DNA work.
- Basics of Plasmids and its isolation from the culture using different methods.
- Basics of electrophoresis techniques employed for the separation of Nucleic acid molecules.

Learning Outcomes:

At the end of this course, students should be able to learn and perform in Hands-on mode:

- Fundamentals of operation of different types of centrifuges, Electrophoresis, Spectrophotometer and about Good Laboratory Practices and working environment of Genomic Laboratory.
- Use of micropipettes, preparation of solutions, media and sterilisation.
- Basics of different types of nucleic acids
- Handle bacterial strains of E. coli for the isolation of single colony and growth in liquid media.
- Isolate Plasmids using different methods and characterise by agarose gel electrophoresis.

Unit 1: Basic microbiological techniques for culturing and growth of bacteria (16 hours)

Information on general and molecular biology laboratory practices including Biosafety, Information about important strains of E. coli used in recombinant DNA work; chemical composition of media used for growing E. coli both on solid and in liquid media.

Practical:

- 1.1 Pipetting using macro and micro pipettes, macro and micro weighing, ~~measurement of pH preparation of buffers and other solutions.~~ Preparation of media and reagents used in molecular biology.
- 1.2 Preparation of solid and liquid media for growing E. coli, sterilization using autoclave and use of Biosafety cabinet.
- 1.3 Pouring of Petri plates with solid agar media and streaking of E. coli to isolate single colonies.
- 1.4 Inoculation of E. coli from streaked plate/spread plate to obtain broth culture.

Unit 2: Plasmids: Characteristics and Isolation (32 hours)

Definition and Features of a plasmid, Comparative description of different plasmids in respect of copy number, plasmid compatibility, antibiotics resistance markers, plasmid curing, various plasmid isolation methods, ~~Gel electrophoresis for nucleic acids.~~ Technology for isolation of nucleic acids

using column, principle of binding and elution of DNA from column. Chromatographic techniques for isolation of nucleic acids.

Practical:

- 2.1 Culturing of E. coli (sensitive and resistant strains) to understand the concept of antibiotic resistance marker.
- 2.2 Isolation of plasmid DNA using the available culture by alkaline lysis (solution based) method: Mini, midi, and maxi preparation (any two), ethanol vs isopropanol precipitation, and use of phenol:chloroform extraction in the maxi preparation.
- 2.3 Isolation of plasmid DNA using self-grown broth culture by column (chromatography) method

Unit 3: Isolation and characterization of plasmid DNA by use of column, Plasmid characterization and quantification (16 hours)

~~Technology for isolation of nucleic acids using column, principle of binding and elution of DNA from column. Chromatographic techniques for isolation of nucleic acid. Gel electrophoresis for nucleic acids. Concept of DNA staining procedures (methylene blue and Ethidium bromide), spectrophotometric estimation of plasmid DNA.~~

Practical:

- ~~3.1 Isolation of plasmid DNA Using the self-grown culture by spin column method.~~ 3.1 Preparation of agarose gel, electrophoresis and visualization of plasmid DNA on the gel using transilluminator/Gel Documentation System, characterisation of different forms of plasmid DNA.
- ~~3.2 Documentation of the gel using gel documentation system.~~
- 3.2 Handling and discard of EtBr stained agarose gel.
- 3.3 Quantification of plasmid DNA using UV-Visible spectrophotometer and calculation of number of the plasmids in the given amount of isolated plasmid DNA.

Essential/ Recommended Readings:

1. Sambrook J, Fritsch EF & Maniatis T. Molecular Cloning. A laboratory Manual. 3rd Edition. Cold Spring Harbor Laboratory Press. New York.

Suggestive Reading:

1. Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA, Struhl K. Current Protocols in Molecular Biology. (eds.) John Wiley & Sons, Inc. New York.

Isolation and characterisation of Plasmid DNA

4, Next Suggestive courses where skills obtained in this 'Theme' would be highly useful:

1. Medical Diagnostics Laboratory
2. Cloning of Biotherapeutic Products
3. Metagenomic analysis of soil based on changing climatic conditions
4. DNA Barcoding of medicinally important plants
5. Informatics and Statistics for Biology and Allied Sciences
6. Biostatistics and Bioinformatics for Plant Sciences
7. Plant / Animal Biotechnology

8. Genetic Engineering

5. Prospective Job Roles after a particular course

1. Scientists at Pharmaceutical Industries
2. Technicians and Scientists at Medical Lab setting
3. Scientist at government approved Food Research Labs