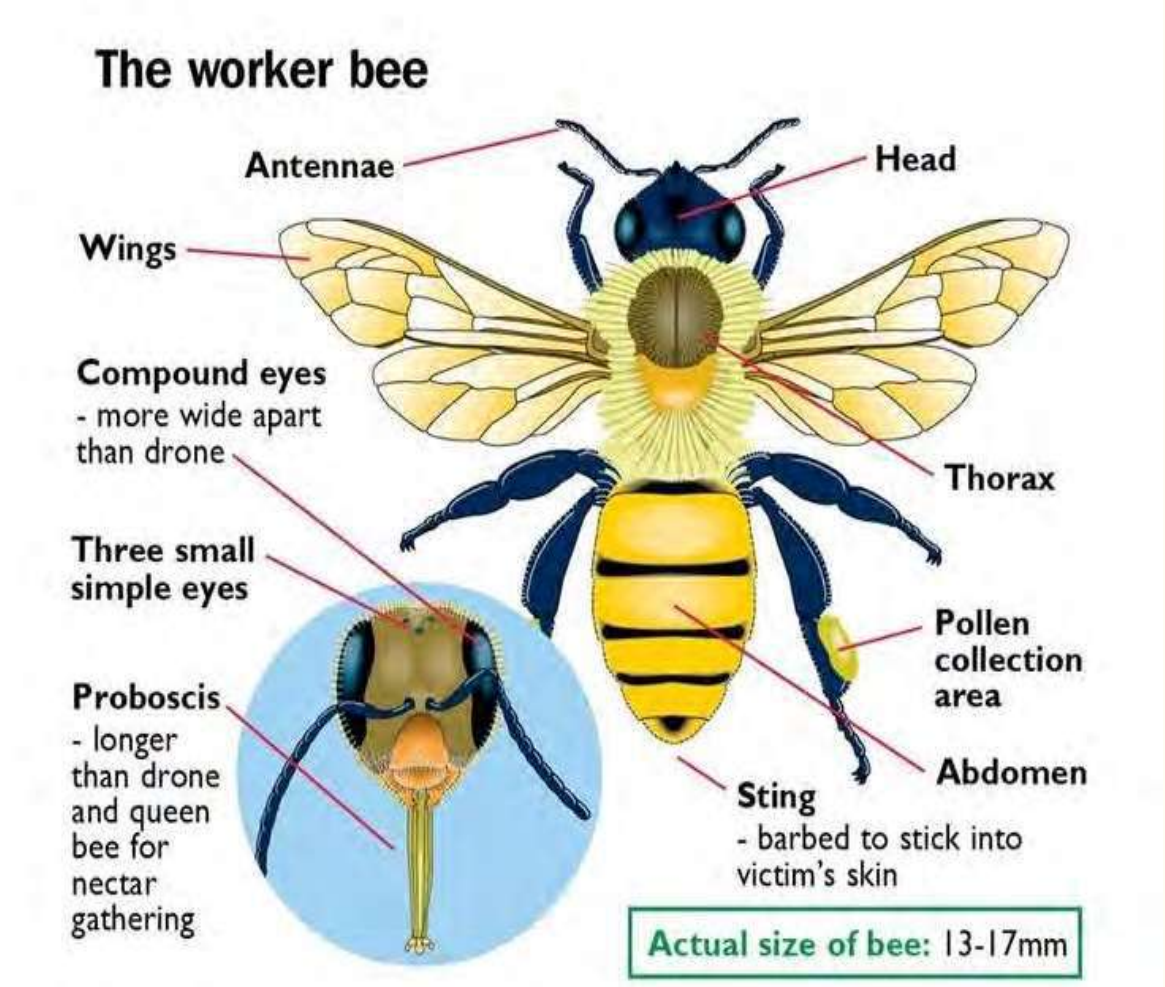
# Beekeeping (Apiculture)

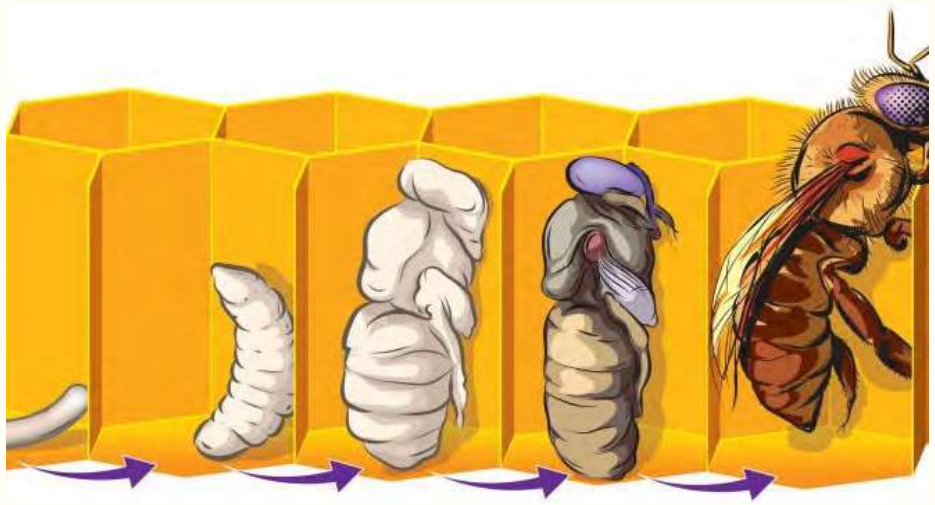
Grade 10 Plant Science •
Industrial Agriculture and Fish Culture

**Unit 1 • Section A**



# Learning Objectives

Define apiculture/beekeeping and explain its derivation.
Describe the history and development of beekeeping in Nepal.
Explain major beekeeping terminologies used in hive management.
List the importance and scope of beekeeping in Nepal.
Practice objective, short-answer and long-answer questions.

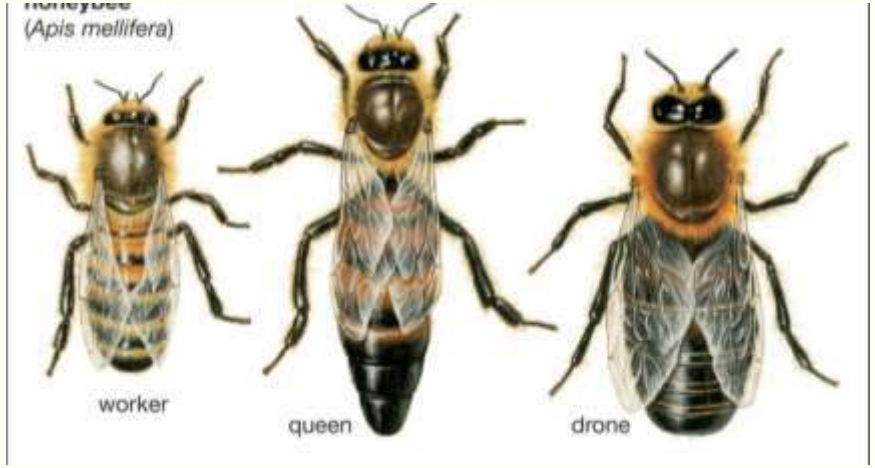


**Key idea: Beekeeping is both a science and an art because it needs technical knowledge, careful management and practical skill.**

# 1.1 Introduction: Meaning of Apiculture

Apiculture or beekeeping is the science and art of managing honey bee colonies.
It is done to produce honey, beeswax, pollen, royal jelly and other valuable products.
It plays a crucial role in pollination.
Pollination contributes directly to agricultural productivity.
In simple words: taking care of bees for honey, wax and other useful products is called beekeeping or apiculture.

**Exam definition**
**Apiculture = scientific and skillful management of honeybee colonies for honeybee products and pollination.**



# Word Origin: Apiculture

**“Apis”**
**Latin word meaning bee**

**“Cultura”**
**Latin word meaning cultivation, care or management**

**Apiculture**
**= care / cultivation / management of bees**

## Honey terminology

Honey is a sweet golden liquid loved by people for a very long time.
In Sanskrit, honey is called “Madhu”.
In Nepali, honey is called “Maha”.

**Memory trick**
**Apis = Bee**
**Cultura = Care**
**Apiculture = Bee care**

# Honey in Ancient Nepal and Religious Texts

In ancient times, people in Nepal knew about honey and how bees made it.
The importance of honey was mentioned in ancient scriptures like the Rig Veda.
Honey was considered a divine substance.
It was used for different purposes, including medicine.
People believed that honey could heal wounds, relieve cough and improve overall human health.
Our ancestors recognized honey not only as a sweet food but also as a medicinal and nutritional resource.

**Honey has food value, medicinal value and religious value.**

**Important terms**
**Madhu = Sanskrit**
**Maha = Nepali**

# Traditional Beekeeping in Nepal

People in Nepal have kept bees for many years.
In ancient times, people depended on wild bees to collect honey.
They climbed tall trees and cliffs to find beehives.
Nepali people collected honey from bees living in forests and hills.
This practice is connected to Nepali religious and cultural traditions.
Later, people started rearing bees in locally made wooden log hives and box hives.
At present, modern hives are popular for commercial honey production.

**Development sequence**
**Wild honey collection → log and box hives → modern hives → commercial honey production**

**Class discussion:**
**Why did people shift from wild honey collection to managed beekeeping?**

# Rana Era and Modernization of Beekeeping

During the Rana era, Nepal saw a renewed interest in beekeeping.
This was likely due to the influence of Western culture and increasing awareness of the benefits of honey.
Places such as Godavari and Nagarjun became centers of beekeeping activity because of natural beauty and diverse flora.
During this time, honey was valued for its nutritional properties and cosmetic uses.
In the mid-20th century, around 2000 BS, the Government of Nepal started efforts to modernize beekeeping.
The Small and Cottage Industries Department played a key role in promoting beekeeping as a cottage industry.

**Key places**
**Godavari**
**Nagarjun**

**Key institution**
**Small and Cottage Industries Department promoted beekeeping as a cottage industry.**

# Godavari Beekeeping Centre and Future Growth

The Godavari Beekeeping Centre was established under the direction of the late King Birendra Bir Bikram Shah Dev in 1942 BS.
The centre was a crucial step in the institutionalization and modernization of beekeeping in Nepal.
Beekeeping in Nepal has improved a lot, but there is still room for more growth.
By using new methods, building better facilities and conducting research on bees, Nepal can improve beekeeping further.
Improved beekeeping can help farmers' economy and protect the environment.

**Timeline memory**
**1942 BS: Godavari Beekeeping Centre**
**Around 2000 BS: Government effort to modernize beekeeping**

**Future formula**
**New methods + facilities + bee research = better income + environmental protection**

# Important Terminologies – Part 1

Beekeeping (Apiculture): Taking care of bees for honey, wax and other useful products.

Hive: A structure where bees live and make honey.

Colony: A group of bees living together in a hive.

Queen Bee: The main female bee who lays all the eggs in the hive.

Worker Bee: Female bees that do all the work like collecting food, feeding babies, cleaning and protecting the hive.

Drone: Male bees that only mate with the queen and do not have stingers.

Brood: The eggs, larvae and pupae inside the hive.

# Important Terminologies – Part 2

Comb: Structure of wax built by bees inside the hive where they store honey and raise baby bees.

Wax (Beeswax): A natural substance produced by bees to build the comb where honey is stored and brood is raised.

Royal Jelly: A special nutrient-rich secretion produced by worker bees and fed to queen larvae, helping them develop into queens.

Nectar: A sweet liquid produced by flowers and collected by bees to make honey.

Pollen: Flower powder collected by bees; rich in protein and nutrients.

Honey: A sweet substance made by bees from nectar and stored in the comb.

Apiary: A place where many beehives are kept together.

# Important Terminologies – Part 3

Swarming: Leaving the hive by bees with a new queen to start a new colony somewhere else.

Stinger: A sharp part used by bees to sting and protect the hive.

Foraging: The process of collecting nectar, pollen and water by bees.

Bee Suit: Special clothing worn by beekeepers to protect themselves from bee stings.

Gloves: Protective gear worn on hands to prevent bee stings while working with the hive.

Bee Veil: A hat with a net worn over the head to protect the face and neck from bee stings.

Smoker: A tool that blows smoke into the hive to calm the bees during inspection.

# Important Terminologies – Part 4

Hive Tool: A flat metal tool used to open hives, remove frames and scrape wax or propolis.

Bee Brush: A soft brush used to gently remove bees from combs or frames.

Frame: A wooden or plastic structure that holds the comb inside the hive box.

Extractor: A machine that spins honey out of the comb without breaking it.

Queen Excluder: A metal or plastic grid placed in the hive to keep the queen out of the honey area.

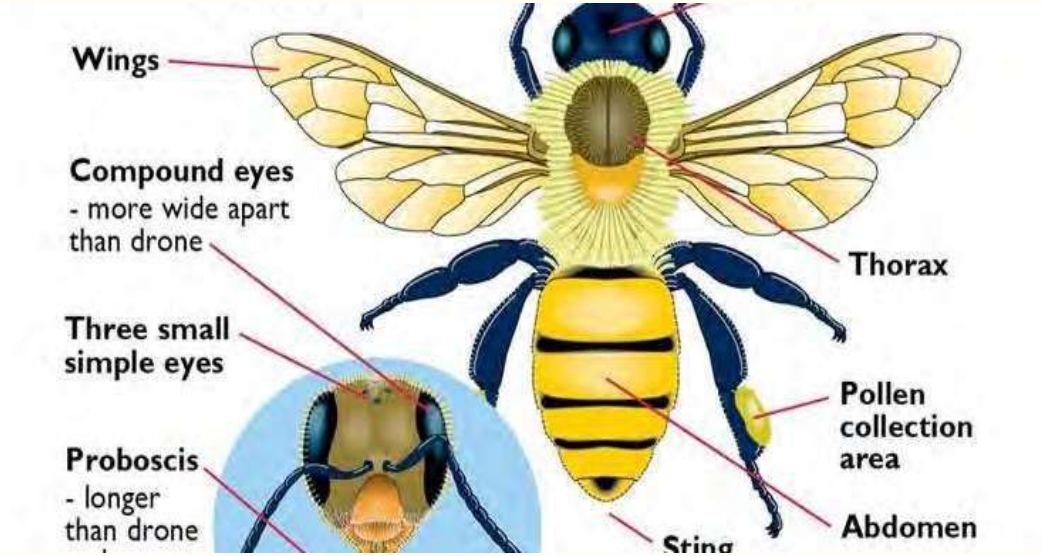
Feeder: A container placed inside the hive to give sugar water to bees during dry period.

Propolis: Resin collected by bees from trees and used to seal cracks in the hive and protect it from pathogens.

# Important Terminologies – Part 5

Bee bread: A fermented mixture of pollen and honey or nectar stored by bees in the hive; it is a vital food source for larvae and worker bees.

Queen cage: A small enclosed container used for keeping a queen bee temporarily.



# 1.2 Importance and Scope: Overview

Beekeeping contributes to both the economy and the environment.

Honey bees play a crucial role in pollination, which is essential for better crop yield.

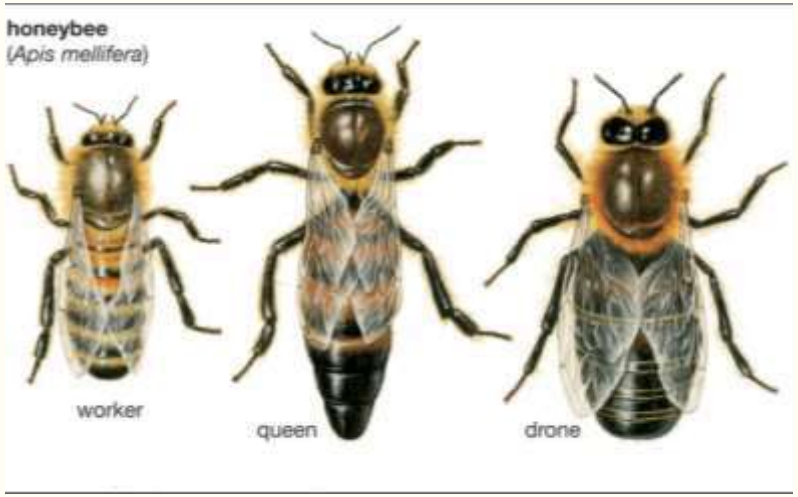
Beekeeping helps to produce different valuable products.

These valuable products help generate handsome income for farmers.

**Core connection**

**Bees → Pollination → Better crop yield**

**Bees → Honeybee products → Farmer income**



# Importance of Beekeeping – Part 1

1. Natural pollinators: Bees are known as the best pollinators for plants; they support agriculture and ecosystems.
2. Nutritional value: Honey and pollen are rich in nutrients and help improve human health.
3. Religious and cultural value: Honey has religious and traditional significance in many cultures.

Example: honey is one of the five elixirs of Panchamrit, offered to God and served as Prasad.

Buddhist and Christian communities use candles made from beeswax in rituals.

# Importance of Beekeeping – Part 2

4. Economic value: Hives produce high-value products such as honey, pollen, wax and royal jelly.
5. Employment and self-employment: Beekeeping can offer sustainable jobs and self-employment opportunities.
6. Medicinal value: Honey is widely used in Ayurveda, homeopathy and modern medicine for its healing properties.
7. Tourism value (Api-tourism): Beekeeping farms can attract tourists and create awareness about bees.

**Products to remember**
**Honey • Pollen • Beeswax • Royal jelly**

**Employment chain**
**Hive management → Honey extraction → Processing → Packaging → Marketing**

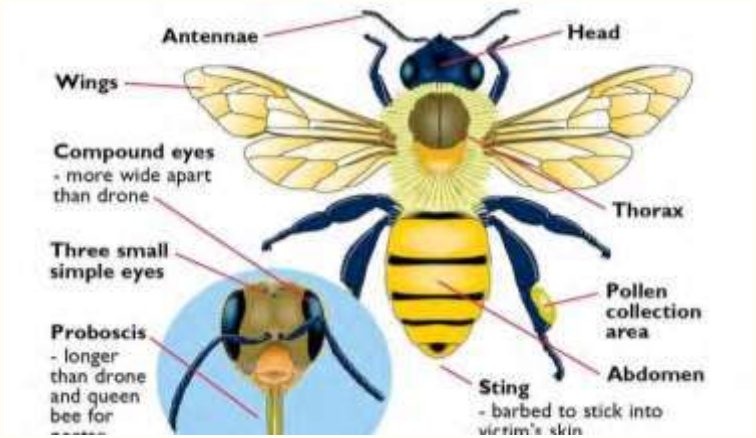
# Importance of Beekeeping – Part 3

8. Environmental indicators: Bees are sensitive to environmental changes and act as indicators of ecological health.
9. Symbol of unity and hard work: Bees represent teamwork and dedication.

This can inspire humans to work hard and chase their goals.

Overall, beekeeping has economic, environmental, nutritional, medicinal, cultural and educational importance.

**Memory line**
**Bee = Pollination + Honey + Medicine + Income + Environment + Teamwork**



# Scope of Beekeeping – Part 1

1. Increased demand for natural products: People in Nepal are becoming more health conscious.
There is growing interest in natural products like honey, wax and pollen.
The demand for bee products is increasing, which offers profitable opportunity for beekeepers.
2. Support for livelihoods: Beekeeping can provide an additional source of income for farmers.
It helps farmers diversify their income and improve their economic condition.

# Scope of Beekeeping – Part 2



3. Boosting yield: Bees are essential for pollinating different crops.
By enhancing better pollination, beekeeping helps improve crop yield.
Beekeeping directly supports agricultural productivity and food security.
4. Employment opportunities: Beekeeping creates job opportunities for people.
Employment is available in beekeeping, honey extraction, packaging and marketing.

# Scope of Beekeeping – Part 3

5. Promoting api-tourism: Beekeeping farms in Nepal can attract tourists interested in honey production and the importance of bees.
Api-tourism helps promote beekeeping and contributes to the growing eco-tourism industry in Nepal.
6. Expanding market access: Nepalese honey and bee products have potential to be sold in global markets as high-value commodities.
Sufficient production of honeybee products in Nepal can be sold both locally and internationally.

# Summary Table: Importance and Scope

| Aspect | Key points |
| --- | --- |
| **Importance** | Pollination, nutrition, religious-cultural value, economic value, employment, medicinal value, api-tourism, environmental indicator, unity and hard work. |
| **Scope** | Natural product demand, livelihood support, crop yield boosting, employment opportunity, api-tourism, local and international market access. |
| **Core message** | Beekeeping improves crop production, farmer income, health, culture, tourism and environmental awareness. |

# Classroom Activities

Brainstorming: Ask students to list bee products and uses of honey.
Terminology cards: Write terms on one card and definitions on another; students match them.
Group discussion: “How does beekeeping support agriculture and farmers?”
Picture study: Show honeybee parts, hive and colony members; students identify terms.
Local observation: Ask students to observe flowering crops and possible bee forage around school/community.
Quick revision game: One student says a term; another explains the meaning in one sentence.

# Practice Questions: Multiple Choice

1. The word “Apis” means:  A) Honey  B) Bee  C) Hive  D) Wax
2. The main female bee that lays eggs is called:  A) Worker  B) Drone  C) Queen  D) Larva
3. A place where many beehives are kept together is called:  A) Apiary  B) Colony  C) Comb  D) Frame
4. Which product is produced by bees to build comb?  A) Nectar  B) Beeswax  C) Pollen  D) Water
5. The process of collecting nectar, pollen and water by bees is called:  A) Swarming  B) Foraging  C) Feeding  D) Extracting

# Practice Questions: True / False and Fill in the Blanks

## True / False

1. Honeybees play a crucial role in pollination.
2. Drone bees have stingers and protect the hive.
3. Honey has religious and medicinal value.
4. Api-tourism means tourism related to beekeeping farms.

## Fill in the blanks

1. Honey is called _____ in Sanskrit and _____ in Nepali.
2. A tool that calms bees by blowing smoke is called _____.
3. A metal or plastic grid that keeps the queen out of the honey area is called _____.
4. The fermented mixture of pollen and honey stored by bees is called _____.

**Answer key: 1 True, 2 False, 3 True, 4 True • Madhu/Maha • Smoker • Queen excluder • Bee bread**

# Practice Questions: Matching

| Column A | Column B |
| --- | --- |
| 1. Hive | a. Main egg-laying female bee |
| 2. Queen bee | b. Sweet liquid from flowers |
| 3. Nectar | c. Structure where bees live |
| 4. Extractor | d. Machine that spins honey out of comb |
| 5. Propolis | e. Resin used to seal cracks and protect from pathogens |

**Answers: 1-c, 2-a, 3-b, 4-d, 5-e**

# Practice Questions: Short Answer

1. Define apiculture in one or two sentences.
2. Write the derivation of the word “Apiculture”.
3. Write any four products obtained from honeybee colonies.
4. What is the difference between queen bee, worker bee and drone?
5. What is swarming?
6. Write any five important beekeeping tools.
7. Why are bees called natural pollinators?
8. Write any four scopes of beekeeping in Nepal.

# Practice Questions: Long Answer and Creative Tasks

1. Explain the importance and scope of beekeeping in Nepal.
2. Describe the historical development of beekeeping in Nepal.
3. Explain important terminologies used in beekeeping with examples.
4. Discuss how beekeeping supports agriculture, farmer income and environment.
5. Draw and label a honeybee or hive structure.
6. Prepare a short classroom presentation on “Beekeeping as a cottage industry in Nepal”.

# Final Revision Memory Sheet

**Definition**
**Apiculture = science and art of managing honey bee colonies for products and pollination.**

**Origin**
**Apis = bee**
**Cultura = cultivation/care/management**

**Products**
**Honey • Beeswax • Pollen • Royal jelly • Propolis • Bee bread**

**Importance**
**Pollination • Nutrition • Culture • Economy • Employment • Medicine • Tourism • Environment • Teamwork**

**Scope**
**Natural products • Livelihood • Yield boosting • Jobs • Api-tourism • Global market access**

**Nepal timeline**
**Traditional wild honey → log/box hives → Godavari Beekeeping Centre → modern commercial beekeeping**

# End of Beekeeping Introduction, Terminologies, Importance and Scope

# Varieties / Types of Bees

## and Life Cycle of Honey Bee

Plant Science Grade 10

Teaching PowerPoint

# Hive-managed honey bees

These species can be managed by beekeepers in suitable hives.

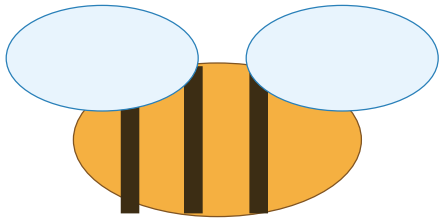
## Apis cerana/Asian

Smaller than Western honey bee
Adapts to different climates
Can survive harsh environments
Produces honey and pollinates crops

## Apis mellifera/European

Common commercial species worldwide
Builds multiple parallel combs
Produces honey, beeswax and royal jelly
Excellent crop pollinator

# Beekeeping: Life Cycle, Colony Management, Hives, Pests & Foraging



# Lesson Coverage

**1.4 Life cycle of honey bee**
**1.5 Bee colony and management**
**1.6 Selection of hive and baiting**
**1.7 Colonization and stocking**
**1.8 Swarming**
**1.9 Combs and their management**
**1.10 Pests, predators and diseases**
**1.11 Hives, their types and selection**
**1.12 Foraging of bees**
Exercise: MCQs, short answers, long answers and project work

# Key Terminologies for This Part

**Life cycle:** Series of developmental stages through which a honeybee passes.
**Egg:** First stage laid by the queen bee in honeycomb cells.
**Larva:** Worm-like feeding stage; food decides whether it becomes queen, worker or drone.
**Pupa:** Resting transformation stage where wings, legs and eyes develop.
Metamorphosis: Transformation from larva/pupa into adult bee.
**Colony**: Group of bees working together in a hive.

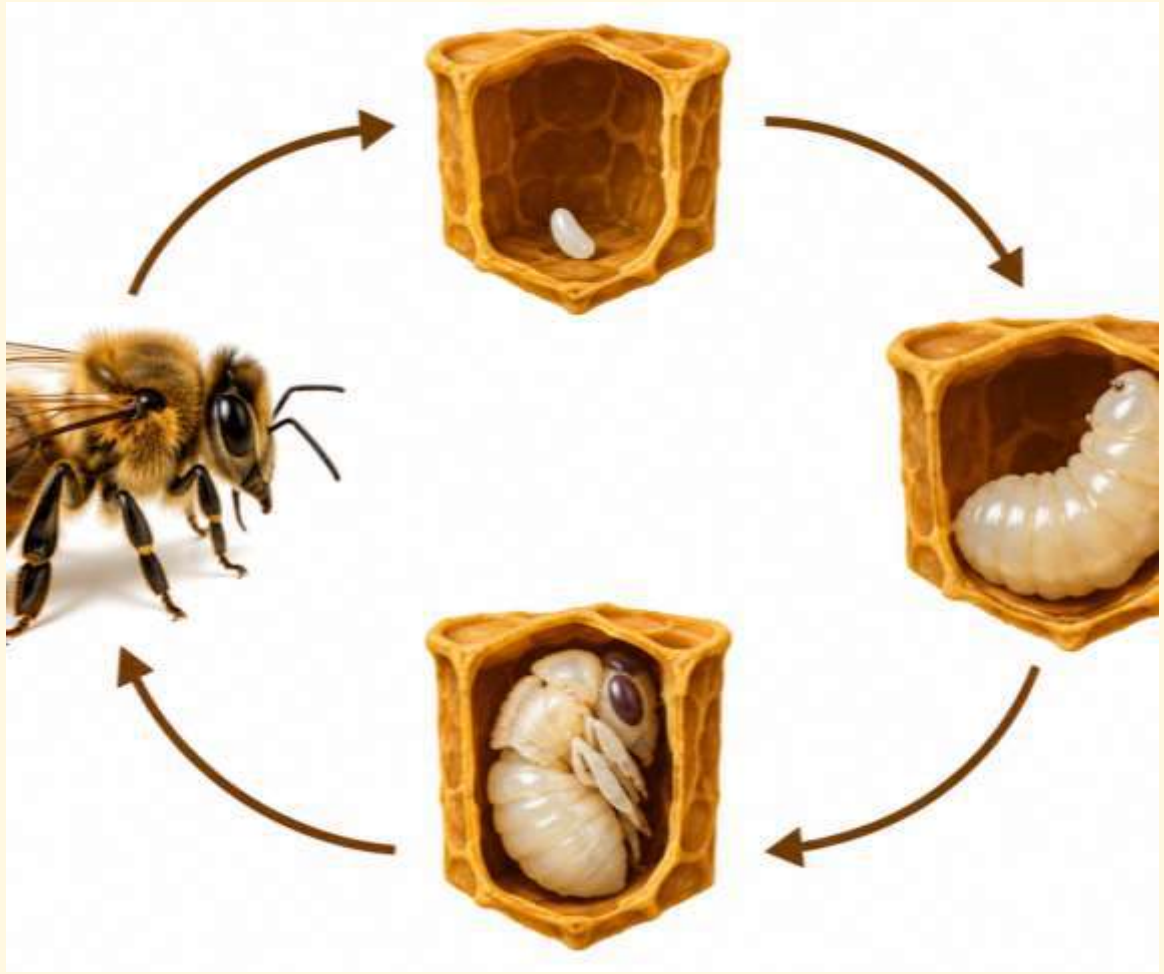
**Baiting:** Attracting a swarm to settle in a selected hive/location.
**Stocking:** Placing bees into a new hive.
**Colonization:** Bees settling in and beginning work in the hive.
**Swarming:** A large group of bees leaving with queen to form a new colony.
**Bee comb:** Hexagonal wax structure for honey, pollen and brood.
**Foraging:** Worker bees collecting nectar, pollen, water and propolis.

# 1.4 Life Cycle of Honey Bee: Overview

Honey bees have a fascinating life cycle.
The queen bee lays tiny eggs in the honeycomb.
Some eggs become worker bees, others become drones, and special eggs become future queens.
Eggs hatch into tiny, worm-like larvae, which are fed by worker bees.
Larvae spin cocoons around themselves and change into pupa.
In the pupa stage, bees grow wings, legs and other adult features.
The pupa emerges as an adult bee.
The life cycle completes in four stages: Egg, Larva, Pupa and Adult.

# Life cycle of honey bee

Honey bees pass through complete metamorphosis.

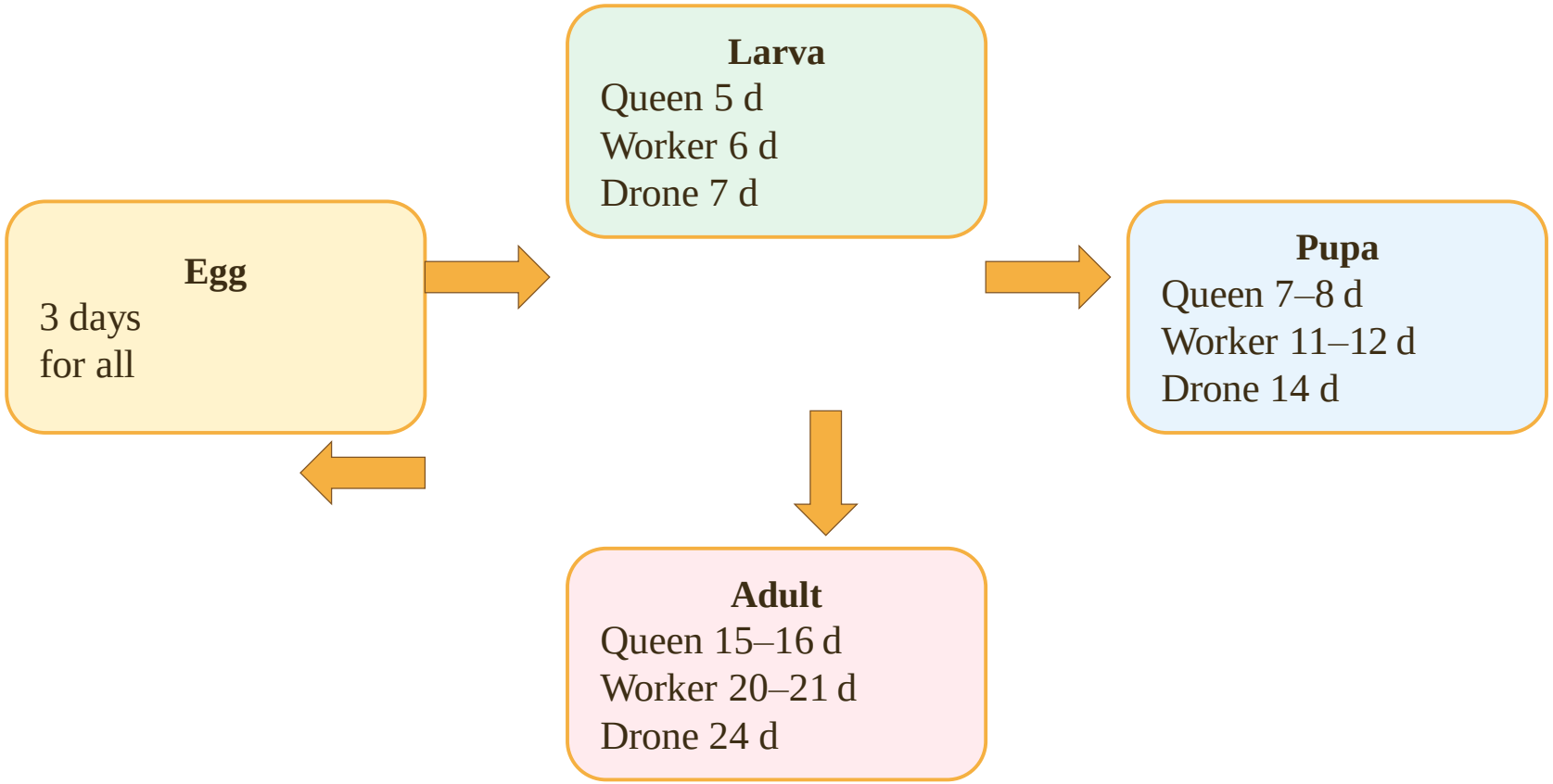


## 4 stages

Egg
Larva
Pupa
Adult

The queen lays eggs in honeycomb cells. Different eggs and foods lead to queen, worker, or drone bees.

# Figure: Four Stages of Honey Bee Life Cycle




**Classroom Use**

Ask students to draw this cycle in their copy and write duration for queen, worker and drone.

# Egg Stage (3 Days for All)

Egg stage is one of the crucial stages of honeybee life cycle.
The queen bee lays eggs that develop into queen, worker and drone bees.
She lays fertilized eggs in special, larger queen cells for future queen bees.
Fertilized eggs are laid in smaller, hexagonal cells, where larvae develop into worker bees.
The queen lays unfertilized eggs in slightly larger drone cells.
Unfertilized eggs hatch into drones, which are male bees.

# Larva Stage

During this stage bees are voracious and grow rapidly.
They completely depend on food provided by worker bees.
Different types of food decide what kind of bee they will become.
Queen larvae remain in larva stage for 5 days and are fed only royal jelly.
Royal jelly is a special, creamy, highly nutritious food made by young worker bees from special glands in their heads.
Continuous royal jelly diet helps larvae develop into fertile queen bees.
Worker bee larvae stay in larva stage for 6 days. They get royal jelly first, then honey and pollen.
Drone larvae stay in larva stage for 7 days and are fed honey and pollen from the beginning.
Duration and food type decide whether a bee becomes queen, worker or drone.

# Pupa Stage

After the larva stage, the bee enters the pupa stage.
The larva spins a cocoon around itself and starts changing into an adult bee.
This process is called metamorphosis.
Inside the cocoon, the bee slowly develops wings, legs, eyes and other adult body parts.
Queen bee stays in the pupa stage for about 7 to 8 days.
Worker bee takes around 11 to 12 days.
Drone bee needs about 14 days to complete transformation.
The bee does not eat or move during this time.
When transformation is complete, adult bee chews cell covering and joins life in the hive.

# Adult Stage

Adult stage is the fully grown stage of the bee.
Queen bee comes out of its cell after 15–16 days.
Queen is the only female in the hive that can lay eggs.
A healthy queen can live for 2 to 5 years.
Worker bee comes out after 20–21 days.
Worker bee is female and does almost everything in the hive.
Worker bee usually lives for about 6 weeks to 6 months.
Drone or male bee comes out after 24 days.
Drone's job is to mate with a queen.
Drone bee does not have a stinger and usually lives around 2 months.

# Roles of Adult Bees in the Hive

Worker bees do all the work in the hive.
Workers clean the hive, feed young bees, collect nectar and pollen, and guard the hive.
Drones have only one main job: to mate with the queen.
The queen bee is the most important bee in the hive.
The queen lays thousands of eggs to keep the colony growing.

# Development of Queen in Hive

Worker bees carefully select a specific larva to become the future queen.
They choose a healthy, well-developed larva.
They feed it exclusively with royal jelly.
This special diet triggers the larva to develop into a queen bee.
The old queen may leave the hive with some worker bees to start a new colony.
Or the old queen may be killed by the new queen.
The queen knows the cell size and decides where to lay eggs.
Fertilized eggs in smaller cells become worker bees.
Unfertilized eggs in larger cells become drones.
Fertilized eggs in special larger queen cells become future queens.

# Queen Bee: Spermatheca and Egg Decision

The queen bee has a special organ called spermatheca.
Spermatheca stores sperm from mating with drones.
When the queen lays an egg, she can choose to fertilize it or not.
If she fertilizes the egg, it becomes a female worker bee or a future queen.
If she does not fertilize the egg, it becomes a male drone.
Memory Key: Fertilized = Female; Unfertilized = Male Drone.

# Table: Life Cycle Stages and Life Span of Honeybee

| Types of honey bee | Egg stage (days) | Larval stage (days) | Pupa stage (days) | Adult (days) | Life span |
|---|---|---|---|---|---|
| Queen | 3 | 5 | 7–8 | 15–16 | 2–5 years |
| Worker | 3 | 6 | 11–12 | 20–21 | 6 weeks to 6 months |
| Drone | 3 | 7 | 14 | 24 | Around 2 months |

**Exam Tip**

Most asked: compare duration of queen, worker and drone life cycle.

# 1.5 Bee Colony and Management

A honeybee colony is a group of bees that work together to survive and grow successfully in a hive.
All bees in the colony work as a team.
Each bee contributes to the survival of hive and protects it from danger.
Beekeeping is the art and science of caring for honey bee colonies.
It involves providing bees with a suitable home.
It involves protecting bees from pests and diseases.
It involves ensuring bees have enough food.
Good management practices are necessary for better yield.

# Bee Colony Management: Main Practices

**1. Site Selection**
Better health, stronger colony and higher honey yield.

**2. Safety Precautions**
Better health, stronger colony and higher honey yield.

**3. Hive Inspection**
Better health, stronger colony and higher honey yield.

**4. Feeding**
Better health, stronger colony and higher honey yield.

**5. Disease & Pest Management**
Better health, stronger colony and higher honey yield.

**6. Swarm Prevention**
Better health, stronger colony and higher honey yield.

**7. Honey Harvesting**
Better health, stronger colony and higher honey yield.

# 1. Site Selection

Choosing the right location for beehives is crucial.
Proper site selection can lead to better yields.
Bees require a reliable nearby water source such as a pond, river or stream.
Ensure a diverse range of flowering plants within a reasonable distance to supply ample nectar and pollen.
Protect hives from strong winds and direct sunlight by choosing a shaded area or using windbreaks.
Place hives in quiet locations, away from noise and areas with high human activity.

# 2. Safety Precautions Before Approaching a Hive

Before working with bees, take the following precautions:
Always wear a beekeeping suit, including a bee veil, gloves and boots.
Smoke calms bees, making them less likely to sting.
Avoid sudden movements that may agitate the bees.
Choose a calm, windless day for inspections.

# 3. Hive Inspection: What to Observe

Queen Health: Make sure the queen bee is healthy and laying eggs, which keeps the colony strong.
Brood Pattern: Check how baby bees are developing to spot problems early.
Honey Stores: Check whether there is enough honey and pollen for bees to survive through winter.
Pests and Diseases: Observe the presence of pests like mites or signs of diseases that could harm bees.

# 4. Feeding of Honey Bees

Beekeepers need to feed their bees during periods of food scarcity.
Feeding in early spring stimulates growth and brood rearing.
Feeding in late autumn and winter provides energy for survival through cold months.
Feeding after harsh winters helps recovery and rebuilding.
Sugar syrup is a simple mixture of equal parts of sugar and water.
Sugar syrup is a common food source during nectar scarcity.
Beekeepers provide syrup using feeders attached to the hive.
Pollen is the protein source for bees.
Pollen substitute may be purchased or homemade.
Homemade patties can be made from soy flour, brewer’s yeast and water, then placed in feeders.

# Precautions During Feeding Honey Bees

Avoid Overfeeding: Excess food can attract pests and diseases.
Maintain Clean Feeders: Clean feeders prevent the spread of diseases.
Monitor Food Consumption: Regular monitoring ensures adequate food intake.
Consider Local Conditions: Adapt feeding strategies based on local climate and natural food sources.

# 5–7. Other Important Colony Management Practices

5. Diseases and Pests Management: Varroa mites, American foulbrood and small hive beetles are common threats.
Regular hive inspections, good hive hygiene and appropriate treatments help control pests and diseases.
Selecting genetically resistant bees and practicing integrated pest management improves colony health and productivity.
6. Swarm Prevention: Swarming is a natural process where a colony divides; it may weaken the original colony.
Swarming can be controlled by providing ample space, clipping queen's wings and artificial swarm control.
7. Honey Harvesting: Collect honey carefully without hurting bees.
Use smoke to calm bees; remove honeycombs gently; spin combs in honey extractor; filter and bottle honey.
This practice keeps both bees and honey safe and healthy.

# 1.6 Selection of Hive and Baiting

Choosing the right hive is crucial for successful beekeeping.
A well-designed hive provides a secure and comfortable home for honeybees.
Good hive design leads to better bee health and productivity.
Selection of hive is important for proper growth and development of honey bees.
Correct hive selection helps achieve high honey production.

# 1.6.1 Selection of Hive: Qualities of Good Hive

A good hive provides a safe, comfortable and efficient environment for bees to thrive.
It should be spacious enough to accommodate the colony.
Proper ventilation is necessary to maintain fresh airflow and prevent damp conditions.
The hive should be durable and made of strong materials.
It should protect bees from harsh weather and predators.
It should allow easy inspection.
Easy inspection helps beekeepers monitor colony health, manage pests and harvest honey without disturbing bees.

# 1.6.2 Baiting of Honeybees

Baiting of honeybees means attracting a swarm of bees to settle in a specific location or beehive.
It is usually done for beekeeping purposes.
Beekeepers use baiting techniques to catch wild swarms.
Baiting can also encourage bees to occupy an empty hive.
Purpose 1: To capture natural swarms.
Purpose 2: To increase the number of colonies under care.
Purpose 3: To capture wild swarms which may be healthier and less affected by diseases or pests.

# Methods of Baiting Honeybees

1. Using Bait Hives: Empty hives or boxes are placed in suitable locations, often near forage sources.
2. Adding Attractants: Different attractants can be used for baiting honeybees.

Pheromone-Based Lures: These contain synthetic versions of queen bee pheromones or other chemicals that attract worker bees.

Natural Attractants: Old honey comb carries scent of beeswax and honey, which is highly attractive to swarming bees.

The lure is kept inside a bait hive or applied near the entrance.

The hive is positioned in an ideal location such as a shaded spot near forage and water resource.

# 1.7 Colonization and Stocking

Bee Stocking is the act of placing bees into a new hive.
Colonization is the process of bees settling in and starting their work in that hive.
Stocking refers to introducing honeybees into a new hive, area or habitat to establish a productive colony.
Stocking is done after bees are baited or captured.
Baited bees are settled in a prepared hive or environment where they can live, grow and thrive productively.

# 1.7.1 Stocking of Bees: Steps

Clean and set up a natural or artificial hive with frames or combs for bees to use.
Gently place the captured or baited swarm into the hive.
If using a package of bees, carefully pour them into the hive along with the queen bee.
Introduce the queen in a protective cage so worker bees adjust to her presence.
After acceptance, release the queen into the hive to start laying eggs.
Seal the hive with enough ventilation to prevent bees from escaping initially.
Monitor the colony to ensure bees are settling in.
Provide sugar syrup as food until bees find flowers for nectar.

# 1.7.2 Colonization of Bees

Colonization is the process by which a group of honeybees settles into a new hive.
They establish their colony and begin building comb, storing food and reproducing under the queen’s leadership.
Once bees accept the hive, they start making wax combs inside it.
Combs are used for storing honey and pollen and raising bees.
The queen bee starts laying eggs in the new hive.
Worker bees feed the larvae and care for the hive.
Bees explore nearby areas to find flowers for nectar and pollen, which they bring back to the hive.

# 1.8 Swarming: Meaning

Swarming is a natural process in which a large group of bees with their queen leaves the hive to form a new colony.
It happens when the hive becomes overcrowded.
It also happens when the colony needs to reproduce and expand.
Before leaving, bees prepare by raising new queens, stockpiling food and scouting for a new home.
Swarming is essential for the survival and growth of bee populations.

# Causes of Bee Swarming

Population Growth: If the population becomes too large for the hive capacity, swarming may occur.
Reproductive Strategy: If the colony wants to reproduce on a larger scale, it may swarm by splitting into two groups.
Queen Pheromones: In a dense colony, queen pheromones may not reach all workers properly, triggering swarming behavior.
Swarming usually happens during spring or early summer when plenty of food is available.
The colony prepares to split into two groups: one stays in the old hive and another starts a new colony.

# Procedure of Swarming

### 1. New queens raised
Worker bees feed selected larvae with royal jelly and build queen cells.

### 2. Old queen prepares
After queen cells are capped (about 8 days), old queen prepares to leave with about half workers.

### 3. Swarm leaves
Old queen and workers leave 1–7 days before new queens emerge and gather nearby.

### 4. Scout bees search
Scout bees find safe hive locations and communicate using dance.

### 5. Swarm decides
Bees watch waggle dance, agree on best spot and move to build a new hive.

# Swarming Management

Swarming management is essential to prevent loss of colony and ensure hive stability.
Regular Hive Inspections: Monitor hives during spring and early summer; queen cells indicate swarming preparation.

Remove Queen Cells: Remove queen cells to prevent bees from making a new queen and swarming.

Split the Colony: If hive is crowded, divide colony into smaller parts to provide space.

Provide Adequate Space: Add extra frames to prevent overcrowding.

Increase Ventilation: Add ventilation holes or use entrance reducer to keep hive temperature comfortable.

Regular Requeening: Replace old or weak queen with younger and healthier queen.

Feed the Bees: Feed sugar syrup and pollen if necessary in dry periods.

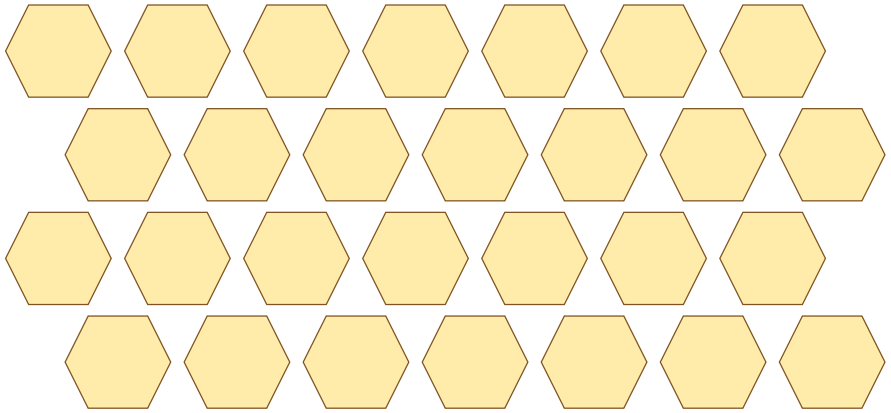
Use Swarm Traps: Place traps around hives to catch swarms before they leave.

Watch for Early Signs: Check queen cells or bees clustering outside hive and act quickly.

# 1.9 Combs and Their Management

A bee comb is a structure made of hexagonal cells built by bees using beeswax.
It stores honey and pollen.
It houses developing brood or baby bees.
Comb management involves inspecting combs.
Comb management involves replacing old combs.
Comb management ensures the hive has enough space for bees to grow and thrive.

# Figure: Bee Comb and Hexagonal Cells



**Bee Comb**

Made by honeybees from beeswax. It is used to store food (honey and pollen) and raise young bees (brood).

**Honey Cells**

Store nectar converted into honey; honey is food during winter; cells fill when nectar is surplus.

**Pollen Cells**

Store pollen collected from flowers; pollen is protein source and often stored near brood cells.

**Brood Cells**

Used to raise baby bees: worker brood cells, drone brood cells and queen brood cells.

# 1.9.1 Bee Comb: Parts

Honey Cells: Cells where bees store nectar that they convert into honey.

Honey is used as food for bees, especially during winter when flowers are not blooming.
Honey cells are usually filled when there is a surplus of nectar.

Pollen Cells: Cells used to store pollen collected from flowers.
Pollen is an important source of protein for bees.

Pollen is often stored near brood cells because it is used to feed developing larvae.

Brood Cells: Cells used to raise baby bees.

Worker Brood Cells: Smaller cells where female worker bees are raised.

Drone Brood Cells: Larger cells where male bees or drones are raised.

Queen Brood Cells: Larger, vertical cells used to raise new queens; larvae are fed royal jelly.

# Building Honeycomb and Feeding Royal Jelly

Building Honeycomb: Young worker bees have wax glands on their abdomens.
Wax glands secrete small waxy scales.

Bees chew and shape wax scales into hexagonal cells that form the honeycomb.

Feeding Royal Jelly: Young worker bees aged 6–12 days have hypopharyngeal glands in their heads.
These glands produce royal jelly, a thick, milky substance.

Royal jelly contains water, proteins, sugars, lipids, vitamins and minerals.

Worker bees feed royal jelly to larvae.

Worker and drone larvae receive royal jelly for a few days, then get honey and pollen.

Queen larvae are fed royal jelly throughout their lifespan.

# 1.9.2 Management of Comb

Beekeepers manage combs to ensure that colony stays healthy and productive.
1. Inspecting the Comb: Check combs to ensure they are in good condition and not infected with pests or diseases.

2. Replacing Old Combs: Old combs become dark and less effective; replace them to keep colony healthy.

3. Preventing Overcrowding: If hive becomes too crowded, bees may swarm; add extra space like frames and boxes.

4. Harvesting Honey: Extract honey from comb; this also helps bees continue building new comb for next season.

Use PPE such as bee suit, gloves and veil to protect from stings.
Use hive tool to open hive and lift/shift frames.
Use knife to scrape wax caps sealing honeycombs.
Put honey-filled frames in extractor to spin honey out, leaving comb intact.
Return empty frames with comb structure to the hive so bees can clean and refill cells.

# 1.10 Pests, Predators and Diseases

Honey bees are vital for pollination and honey production.
However, they face many threats including pests, predators and diseases.
Understanding these threats and using effective management strategies is crucial for maintaining healthy bee populations.
This topic helps identify and address common issues affecting honey bees in Nepal.
Pests of honeybee can harm the honey bee colony.
Predators of honeybee hive disturb or kill bees.
Diseases may affect brood stage or adult stage.

# Pest 1: Varroa Mite (Varroa destructor)

Description: Small reddish-brown mites attach to bees and suck their blood, weakening them and spreading diseases.
Symptoms: Deformed wings and bodies in adult bees.
Symptoms: Reduced bee population due to weakened immune systems.
Symptoms: Increased bee mortality rate.
Symptoms: Reddish-brown mites visible on bees.
Management: Dust bees with powdered sugar to encourage grooming.
Management: Regularly inspect hive and remove infested brood.
Management: Select or breed bees resistant to Varroa mites.
Management: Mix 35 g oxalic acid in 1 L sugar syrup (50% solution) and apply 5 mL solution per colony.

# Pest 2: Wax Moth

Scientific names: Galleria mellonella (Greater Wax Moth) and Achroia grisella (Lesser Wax Moth).
Description: Moths lay eggs in the hive and larvae eat beeswax, pollen and honey.
Symptoms: Larvae feeding on honey, wax and pollen.
Symptoms: Damaged and weakened combs due to moth larvae activity.
Symptoms: Presence of webbing and cocoons inside the hive.
Symptoms: Bees seem agitated and unable to keep hive clean.
Management: Keep hive strong and healthy to fend off moths.
Management: Store empty combs in cold or lighted areas to deter moths.
Management: Use traps and place 60 mL formic acid in sealed bag with 5 frames of combs; fumigate 24–48 hours.
Management: Regularly check and clean hive to remove moth larvae.

# Pest 3: Small Hive Beetle (Aethina tumida)

Description: Tiny, dark beetles that lay eggs in hives.
Their larvae eat honey, pollen and wax, making a mess of the hive.
Symptoms: Beetles present inside hive, especially on frames and combs.
Symptoms: Beetle larvae seen eating honey, pollen and wax.
Symptoms: Fermented honey producing foul odor.
Symptoms: Bees abandoning brood frames due to beetle infestation.
Management: Maintain strong and well-ventilated hives so bees can defend against beetles.
Management: Use beetle traps placed in hive.
Management: Remove and clean infected combs and frames.
Management: Place 60 mL formic acid in sealed bag with 5 frames of combs; fumigate 24–48 hours.

# Predator 1: Ants

Description: Ants raid hives to steal honey and disturb bees.
Symptoms: Ants observed raiding hive for honey and brood.
Symptoms: Bees become agitated or stressed by presence of ants.
Symptoms: Damaged honeycombs due to ant activity.
Symptoms: Ant trails near or inside hive.
Management: Use sticky barriers around base of hive to prevent ants.
Management: Clear vegetation and debris around hive to reduce ant pathways.
Management: Apply 10–15 drops peppermint oil or cinnamon powder in 500 mL water and spray around hive perimeter.
Management: Place hive stand legs in water-filled containers, ensuring 1–2 inches water depth.

# Predators 2–3: Lizards, Mice and Rats

Lizards - Symptoms: Seen near hive entrances, preying on foraging bees.
Lizards - Symptoms: Reduced bee activity around hive; dead bees outside hive; visible marks/tracks around hive.
Lizards - Management: Keep apiary clean and free of hiding spots like wood piles.
Lizards - Management: Use netting/fencing; place hives where lizards are less likely; monitor and remove lizards.
Mice and Rats: Rodents enter hives during colder months to feed on honey, wax and brood.
Mice/Rats - Symptoms: Rodents entering hives, especially in winter; chewed combs and honey stores; droppings/gnaw marks; reduced activity.
Mice/Rats - Management: Install mouse guards or mesh over entrances; keep apiary clean; inspect hives in cold months; set traps around apiary.

# Predator 4: Spiders

Description: Spiders create webs near hive entrances to catch foraging bees.
Symptoms: Webs found near hive entrances, trapping foraging bees.
Symptoms: Decreased bee traffic due to spider webs blocking entrance.
Symptoms: Presence of spider webs on honeycomb frames.
Symptoms: Bees struggling to navigate due to webs.
Management: Regularly remove webs from area around hives.
Management: Keep apiary area clean and well-organized.
Management: Use spider traps to capture spiders near hives.
Management: Inspect hive entrances regularly for webs and remove them.

# Diseases of Honeybee: Overview

Honeybee diseases may occur during brood stage or adult stage.
Brood diseases include American Foulbrood (AFB).
Brood diseases include European Foulbrood (EFB).
Brood diseases include Chalkbrood.
Brood diseases include Sacbrood Virus (SBV).
Adult bee diseases include Nosema disease.
Adult bee diseases include Deformed Wing Virus (DWV).

# Disease 1: American Foulbrood (AFB)

Causal organism: Paenibacillus larvae (Bacteria).
Symptoms: Larvae turn brown, sticky and emit bad odor.
Symptoms: Cell caps appear sunken or have holes.
Symptoms: Dead larvae stretch out in a 'rope test'.
Symptoms: Honey becomes foul-smelling and fermented.
Management: Burn infected combs and frames.
Management: Practice good hive hygiene and keep colonies strong.
Management: Regularly inspect brood for signs of disease.
Management: Feed antibiotics like oxytetracycline at 1 g per 1 L sugar syrup.

# Disease 2: European Foulbrood (EFB)

Causal organism: Melissococcus plutonius (Bacteria).
Symptoms: Larvae are yellow or brown and twisted.
Symptoms: Larvae die before being sealed in their cells.
Symptoms: Foul smell is noticeable, but less intense than AFB.
Symptoms: Dead larvae can be easily removed from cells.
Management: Remove infected brood and hive parts.
Management: Improve hive ventilation and reduce stress.
Management: Strengthen colony with proper nutrition.
Management: Feed oxytetracycline at 1 g per 1 L sugar syrup.

# Disease 3: Chalkbrood

Causal organism: Ascosphaera apis (Fungus).
Symptoms: Larvae turn white, become hard and look like chalk.
Symptoms: Dead larvae are often thrown out of the hive.
Symptoms: Disease is more common in damp, cold conditions.
Symptoms: Larvae may appear mummified.
Management: Improve ventilation in the hive.
Management: Remove infected combs and replace them.
Management: Maintain a dry and warm environment for the hive.
Management: Avoid overcrowding in the hive.

# Disease 4: Sacbrood Virus (SBV)

Causal organism: Sacbrood virus (Viral).
Symptoms: Larvae fail to pupate and die, forming a sac-like appearance filled with fluid.
Symptoms: Dead larvae may be stretched and look dry.
Symptoms: Adult bees are less active and productivity drops.
Symptoms: Larvae can be seen with shriveled appearance.
Management: Remove infected larvae from the hive.
Management: Provide adequate nutrition to strengthen colony.
Management: Avoid overcrowding to reduce stress.
Management: Maintain good hygiene and regular hive inspection.

# Disease 5: Nosema Disease

Causal organisms: Nosema apis and Nosema ceranae (Fungal disease).
Symptoms: Bees exhibit weak flight and poor coordination.
Symptoms: Abdomens of infected bees appear distended.
Symptoms: Dead bees found outside the hive.
Symptoms: Increased mortality rate of adult bees.
Management: Keep hives clean and free from contamination.
Management: Improve colony nutrition to boost immunity.
Management: Regularly inspect hives for early signs of infection.
Management: Feed Fumagillin at 1 g per 1 L sugar syrup for about 7–10 days.

# Disease 6: Deformed Wing Virus (DWV)

Cause: Virus transmitted by Varroa mites.
Symptoms: Bees have deformed wings and are unable to fly.
Symptoms: Infected bees have shriveled wings or abnormal body structures.
Symptoms: Reduced bee activity and weakened colony strength.
Symptoms: Larvae may die or show malformed features.
Management: Control Varroa mites, as they are vectors for the virus.
Management: Remove and destroy infected bees.
Management: Strengthen colonies by providing proper nutrition.
Management: Improve hive conditions to reduce stress.

# Quick Review Table: Pests, Predators and Diseases

| Group | Examples | Main Harm | Key Management |
|---|---|---|---|
| Pests | Varroa mite, Wax moth, Small hive beetle | Weaken bees, damage comb, spoil honey | Inspection, traps, hygiene, resistant bees, proper treatment |
| Predators | Ants, lizards, mice, rats, spiders | Steal honey, eat bees, disturb hive | Barriers, cleaning, guards, traps, netting |
| Brood diseases | AFB, EFB, Chalkbrood, SBV | Larvae die, brood pattern becomes poor | Hygiene, ventilation, remove infected combs/larvae, treatment |
| Adult diseases | Nosema, DWV | Weak adult bees, deformed wings, mortality | Nutrition, inspection, mite control, clean hive |

# 1.11 Hives, Their Types and Selection

Hives are the homes where honey bees live and work.
Different types of hives are used in beekeeping.
Choosing the right hive is important for bee health and honey production.
Common types include Langstroth hives, suitable for large-scale honey production.
Cerana Box hives are designed for native bees in Nepal.
When selecting a hive, consider size, material, cost and ease of management.
The right hive results in better growth and better yield of honey and other honeybee products.

# Types of Hives

**Traditional Log Hive**
Hollow logs of tree trunks; traditional rural method.

**Wall Hive**
Bee cavities built into house walls of mud or stone.

**Cerana Box Hive**
Modern smaller hive for native Apis cerana in Nepal.

**Modern Langstroth Hive**
Stacked wooden boxes with removable frames for commercial production.

# 1. Traditional Log Hives

Made from hollow logs of tree trunks.
Bees naturally build their comb inside.
One of the traditional methods of beekeeping in rural areas where local materials are available.
This method has been used for centuries.
Advantages: Made from locally available materials like tree trunks/logs; cost-effective to construct.
Advantages: Uses natural, biodegradable and sustainable materials.
Advantages: Easy to build without specialized tools or skills.
Disadvantages: Fixed comb makes inspection for diseases, pests or colony health difficult.
Disadvantages: Harvesting often damages or destroys parts of the comb.
Disadvantages: Lack of movable frames makes mites, wax moths or fungal diseases hard to spot effectively.

# 2. Wall Hives

Traditional method where bees are kept in cavities built into house walls, usually made of mud or stone.
Bees enter and exit through small holes.
Mostly used in temperate regions of Nepal.
Advantages: Uses locally available mud or stone, making it cost-effective.
Advantages: Saves space because hives are part of house walls.
Advantages: Thick walls protect from extreme weather, keeping bees warm in winter and cool in summer.
Advantages: Requires minimal management.
Disadvantages: Hard to monitor bee health or detect diseases/pests.
Disadvantages: Produces less honey compared to modern hives.
Disadvantages: Harvesting can damage hive; cannot be moved to better forage areas; predators can attack easily.

# 3. Cerana Box Hive

Modern beekeeping hive designed specifically for native Asian honey bee, Apis cerana.
Smaller in size compared to Langstroth Hive.
Ideal for smaller Apis cerana species commonly found in Nepal.
Lightweight, easy to manage and cost-effective; popular for small-scale beekeepers.
Allows inspection, pest management and honey harvesting without harming bees.
Helps preserve native bee populations while improving honey production in eco-friendly way.
Made from lightweight durable wood like pine or local hardwood.
Exterior often painted with non-toxic paint for weather resistance; interior left untreated.
Optional materials include metal sheets for top, wire for reinforcing frames and mesh at entrance.
Nails and screws assemble the hive, making it affordable and suitable for small-scale beekeeping in Nepal.

# Cerana Box Hive: Advantages and Disadvantages

Advantages: Designed for Apis cerana, the native Asian honey bee.
Advantages: Affordable and easier to manage for small-scale beekeepers.
Advantages: Lightweight and can be moved if needed.
Advantages: Helps preserve native bee species, which are more resilient to local pests and diseases.
Disadvantages: Produces less honey compared to Langstroth hives.
Disadvantages: May not be ideal for Apis mellifera, which are larger and produce more honey.

# 4. Modern Langstroth Hives

Modern Langstroth Hive is made of stacked wooden boxes with removable frames.
It was invented by Lorenzo Lorraine Langstroth in 1851 and changed beekeeping forever.
Langstroth introduced the idea of 'bee space', a gap of about 3/8 inch between hive parts.
Bee space lets bees move easily without filling space with comb or propolis.
Removable frames make checking hive, collecting honey and managing bees easier with less disturbance.
It is the most popular beehive in the world because it keeps bees healthy and helps produce more honey.

# Langstroth Hive: Advantages

Proper design helps maintain a healthy environment for bees in different weather conditions.
Compatible with modern tools and equipment, making beekeeping more efficient.
Made from sturdy materials; it can last for many years with proper care.
Removable frames make it simple and easy to inspect insects, pests and diseases.
Easy to collect honey without damaging hive or disturbing bees.
Designed to maximize honey yield, making it ideal for commercial beekeeping.
Additional boxes or supers can be added to accommodate growing colonies or increase honey storage.

# Langstroth Hive: Disadvantages and Selection Summary

Disadvantages: Initial cost for purchasing/building is higher than traditional hives.
Disadvantages: Requires technical knowledge and skills, especially for beginners.
Disadvantages: Bees may find it less natural than traditional hives, causing stress if not managed carefully.
Disadvantages: Requires dedicated setup area, which may not be feasible for everyone.
Overall: Langstroth hive is ideal for large-scale honey production.
It has removable frames where bees build combs, making inspection and honey extraction easy.
It prevents overcrowding and allows bees to focus on storing honey, leading to higher yields.
For small-scale beekeepers or Apis cerana, Cerana Box Hive is excellent, cost-effective and supports good honey production.

# Quick Comparison of Hive Types

| Hive Type | Main Feature | Best Use | Limitations |
|---|---|---|---|
| Log Hive | Hollow tree trunk; fixed comb | Rural/traditional beekeeping | Hard inspection; comb damage in harvesting |
| Wall Hive | Cavity in mud/stone wall | Temperate regions; low management | Low honey; immobile; difficult monitoring |
| Cerana Box | Small modern hive for Apis cerana | Native bee, small-scale Nepal | Less honey than Langstroth |
| Langstroth | Stacked boxes, removable frames | Large-scale/commercial honey | Costly, needs skill and space |

# 1.12 Foraging of Bees

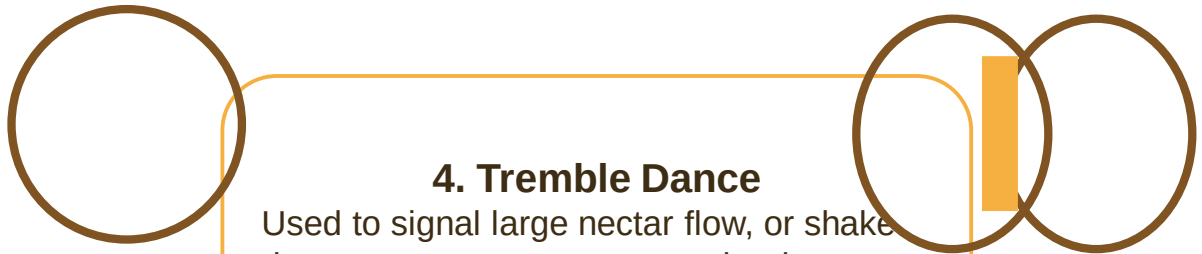
Bee foraging is the process where worker bees leave hive to collect nectar, pollen, water and propolis.
These resources are essential for survival and growth of the colony.
Nectar is a sweet liquid produced by flowers.
Bees use nectar as their main source of energy.
Pollen is a fine powder and male reproductive part of flower.
Pollen is collected to feed hive as a protein supplement.
Bees have amazing senses that help them find flowers.
They can see colors and smell scents from far away.
They use a special dance to tell other bees where to find good flowers.

# Bee Dance Language

### 1. Round Dance
Used for food source within short distance (about 10 m). Bee runs in small circles, alternating directions. It shows proximity, not direction.

### 2. Waggle Dance
Used for food source farther away (>100 m). Bee performs figure-eight pattern. Angle shows direction relative to sun; waggle duration shows distance.

### 3. Transitional Dance
Sickle dance between round and waggle dances; used for intermediate distances.



### 4. Tremble Dance
Used to signal large nectar flow, or shake dance to encourage more worker bees to leave the hive and forage.

# 1.12.1 Importance and 1.12.2 Managing Bee Forage

Importance: Bees help plants grow by spreading pollen.
Importance: Bees collect and make valuable products like honey, pollen and propolis from foraging.
Importance: Bees are vital parts of our ecosystem and keep plants healthy and productive.
Managing Bee Forage: Managing forage helps bees find enough food.
Plant a variety of flowers that bloom at different times of the year.
Avoid using harmful pesticides.
Provide water for bees to drink.
A shallow dish of water with stones or sticks for bees to land on can be very helpful.

# Lesson Summary: Memory Keys

Life Cycle: Egg → Larva → Pupa → Adult.
Queen develops from fertilized egg and continuous royal jelly feeding.
Good colony management includes site selection, safety, inspection, feeding, pest control, swarm prevention and harvesting.
Baiting attracts swarms; stocking places bees into hive; colonization means bees settle and start work.
Swarming is natural reproduction but must be managed to prevent colony loss.
Bee comb has honey cells, pollen cells and brood cells.
Major threats: Varroa mite, wax moth, small hive beetle, ants, lizards, mice/rats, spiders, AFB, EFB, chalkbrood, SBV, Nosema and DWV.
Hive selection depends on bee species, scale, cost and management skill.
Foraging provides nectar, pollen, water and propolis; dance language guides bees to food.

# Exercise: Choose the Correct Answer

1. What is the practice of keeping honeybees called? a) Apiculture b) Honey Production c) Pollination d) Foraging
2. Honeybees are classified as which type of insect? a) Solitary b) Social c) Both A and B d) None of these
3. Which is NOT obtained from a beehive? a) Honey b) Pollen c) Silk d) Royal Jelly
4. What is the primary reason honeybees swarm? a) Search food b) Escape predators c) Mating d) Reproduce and expand colony
5. Main material used to construct honeycomb? a) Wood b) Beeswax c) Mud d) Leaves

Answer Key: 1-a, 2-b, 3-c, 4-d, 5-b

# Exercise: Short Answer Questions

1. Briefly describe the difference between solitary bees and social bees.
2. List three reasons why beekeeping is considered an important activity.
3. What is the role of a queen bee in a honeybee colony?
4. Explain the process of beekeeping in a few sentences.
5. What are some of the challenges faced by honeybee colonies?

Teaching Tip: Ask students to write answers in 3–5 points for each question.

# Exercise: Long Answer Questions

1. Describe the life cycle of a worker honeybee, including the different stages and their durations.
2. Explain the different methods used for attracting a swarm of bees to a new hive (baiting).
3. List the various pests, predators and diseases of honeybee with disease symptoms. How can beekeepers manage them? Explain.

Exam Writing Tip: Use headings: Introduction, Main points, Table/diagram, Management, Conclusion.

# Project Work

1. Guide students to study and create a presentation on different species of honeybees found around your locality. Include characteristics, habitat and importance.
2. Ask students to design a bee-friendly garden plan, focusing on planting flowers that attract honeybees and other pollinators.
3. Assign students to write a creative story or poem about the life of a honeybee and present it in classroom.
Suggested Display: Put student posters on classroom wall or conduct gallery walk.

# Additional Practice: True/False

1. Queen bee lays eggs in honeycomb cells. (True)
2. Drone bees have stingers. (False)
3. Royal jelly helps selected larvae develop into queen bees. (True)
4. Swarming always strengthens the original colony. (False)
5. Honey cells are used to store pollen only. (False)
6. Varroa mites can transmit deformed wing virus. (True)
7. Langstroth hive has removable frames. (True)
8. Round dance tells direction of far-away food source. (False)

# Additional Practice: Fill in the Blanks

1. Honeybee life cycle has four stages: Egg, Larva, _____ and Adult. (Pupa)
2. The organ that stores sperm in queen bee is called _____. (Spermatheca)
3. The process of attracting swarms to a hive is called _____. (Baiting)
4. The process of placing bees into a new hive is called _____. (Stocking)
5. Bee comb is made from _____. (Beeswax)
6. A large group of bees leaving with queen to form a new colony is called _____. (Swarming)
7. A dance used for food source more than 100 m away is _____ dance. (Waggle)
8. Cerana Box Hive is designed for _____. (Apis cerana)

# Additional Practice: Matching

Match the following:

1. Varroa mite → Deformed wings, weak bees, mite visible on body
2. Wax moth → Webbing, cocoons and damaged combs
3. Small hive beetle → Fermented honey with foul odor
4. American foulbrood → Brown sticky larvae, rope test
5. Chalkbrood → Hard chalk-like larvae
6. Nosema → Weak flight and distended abdomen
7. Langstroth hive → Removable frames and supers
8. Waggle dance → Direction and distance of far food source

# Teaching-Learning Activities

Activity 1: Draw the honeybee life cycle and write stage duration for queen, worker and drone.
Activity 2: Group discussion on site selection for an apiary near the school.
Activity 3: Make a chart of pests, predators and diseases with symptoms and management.
Activity 4: Demonstrate bee dance language using round dance and waggle dance role play.
Activity 5: Compare traditional log hive, wall hive, Cerana box hive and Langstroth hive in a table.
Activity 6: Design a bee-friendly garden with flowering plants and safe water source.

# Thank You

**Revision Line**

Healthy bees need: good hive + good food + clean comb + disease control + proper forage.

**Class Discussion**

Why should schools and farmers protect honeybees?

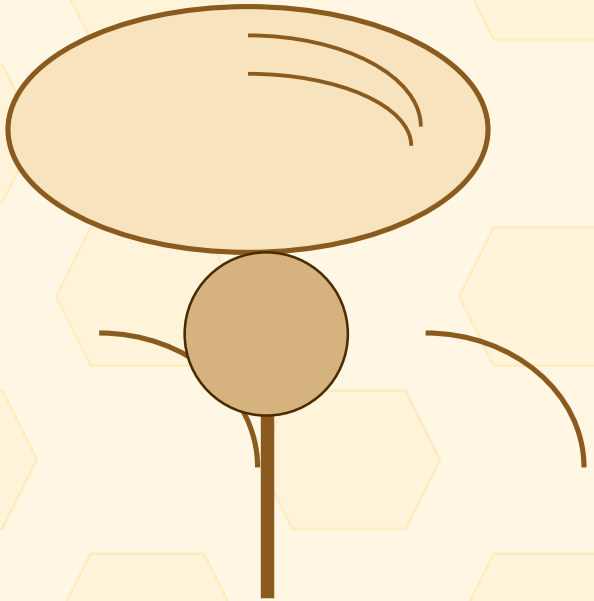
# SERICULTURE

## Silk Farming & Mulberry Cultivation

रेशम खेती • किम्बु खेती • रेशम किरा पालन

**Class focus**

Definition, importance, scope, history in Nepal, mulberry cultivation, propagation, transplanting and leaf harvesting



**Cocoon → Silk moth**

# Learning Objectives

By the end of this lesson, students should be able to:

Define sericulture and explain the origin of the word.
Describe the importance and scope of sericulture in Nepal.
Explain the main steps of silk production.
Identify suitable conditions and varieties for mulberry cultivation.
Compare mulberry propagation methods: seed, cutting, grafting and budding.
Describe transplanting, field care, pruning, harvesting and expected leaf yield.

## Key vocabulary

Sericulture – रेशम खेती
Silkworm – रेशम किरा
Mulberry – किम्बु
Cocoon – कोया
Moriculture – किम्बु खेती
Bombyx mori – घरेलु रेशम किरा

# 2.1 Introduction to Sericulture

Sericulture = cultivation of silkworms to produce silk

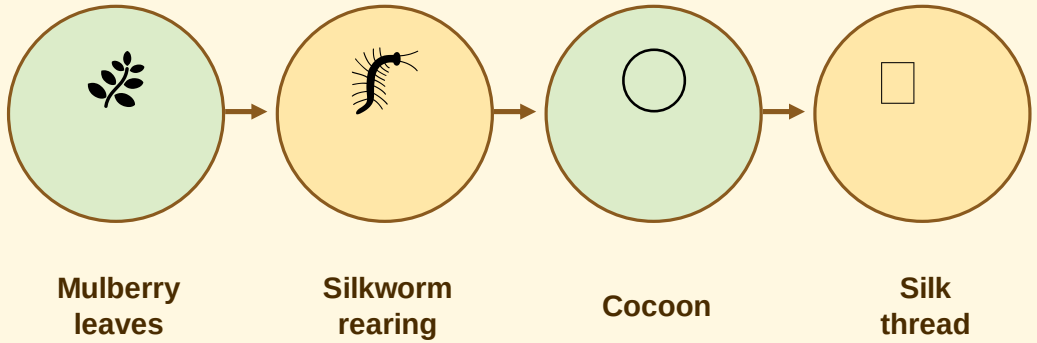
## Definition

Sericulture, also called silk farming, is the practice of raising silkworms for silk production.

## Word origin

Sericulture comes from Latin words:
- sericus = silk
- cultura = cultivation / culture

## Basic idea of sericulture

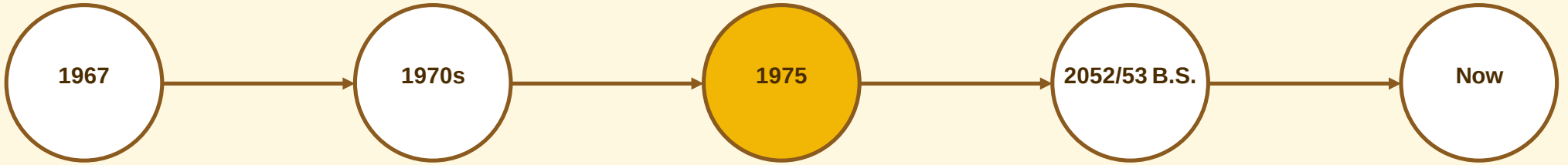



## Teaching note

Ask students: Why are fresh mulberry leaves necessary before silkworm rearing can start?

# History of Sericulture in Nepal

Important milestones from the provided unit




Department of Agriculture tested silk farming using mulberry leaves and silkworms from India.

10-Year Agriculture Plan promoted improved farming systems.

Khopasi Sericulture Center established in Kavrepalanchok.

Name changed to Sericulture Development Center.

Center supports farmers with eggs, training, mulberry plants and guidance.

## Class discussion

How can a government center help rural farmers to start and improve silk farming?

# Sericulture Support Network in Nepal

Centers and programs mentioned in the unit

## Main center

Sericulture Development Center
Khopasi, Kavrepalanchok

Main roles:
- Farmer training
- Healthy egg production
- Small silkworm distribution
- Technical guidance
- Market support for cocoons

## Other farms / centers

Syanja Silk Development Program
Bhandara Mulberry Nursery Management Center
Dhankuta Silk Development Program
Pokhara Silk Development Program
Bandipur Brood Cocoon Source Center
Itahari Silk Processing Center
Dhunibesi Brood Cocoon Source Center
Chitapol Commercial Grainage Center

# Importance of Sericulture in Nepal

Economic, social, environmental and cultural values

**SERICULTURE**
**रेशम खेती**

## Economic

Income and small-scale industry

## Employment

Jobs in farming, spinning, weaving and dyeing

## Environmental

Mulberry supports afforestation and reduces erosion

## Social

Supports rural livelihoods and reduces migration

## Cultural

Preserves traditional silk-making skills

# Scope of Sericulture in Nepal

Four opportunity areas

## Economic Growth

More jobs, higher household income and export potential for natural silk textiles.

## Poverty Reduction

Reliable income for smallholder farmers and rural women.

## Cultural Preservation

Keeps traditional skills of silk production alive.

## Environmental Sustainability

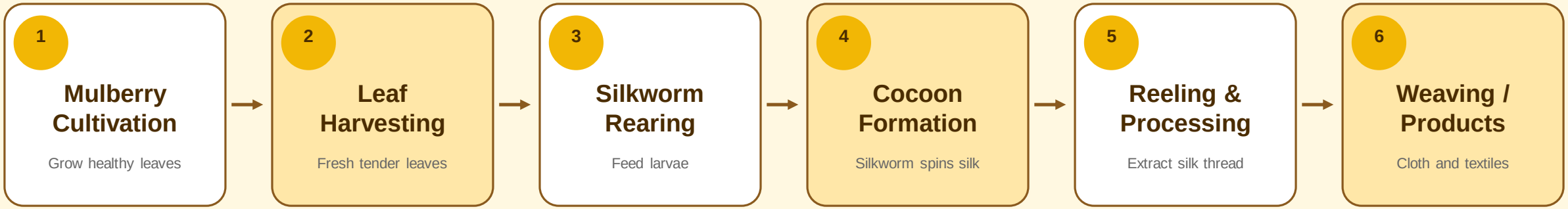
Mulberry cultivation and silk production can be more eco-friendly than synthetic textiles.

### Think–Pair–Share

Which scope is most useful for your local community: income, employment, culture, or environment? Why?

# Sericulture Production Chain

From mulberry garden to silk product




**Important point**

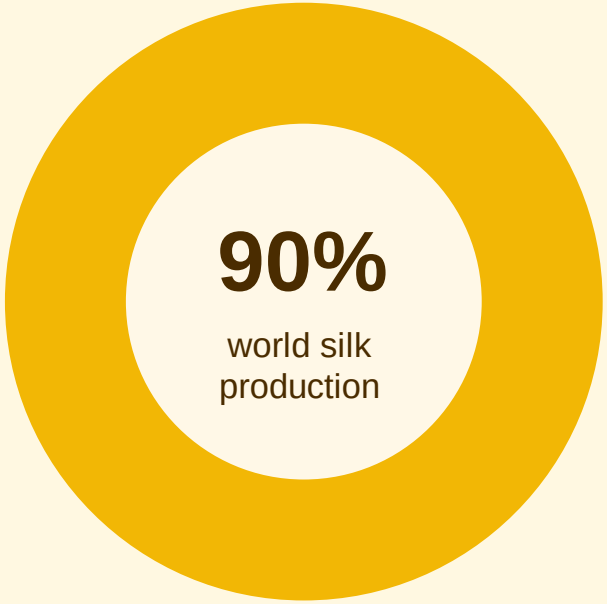
The quality of silk begins with the quality of mulberry leaves and the health of silkworm eggs.

# Mulberry Silk and Bombyx mori

Why mulberry cultivation is central to sericulture

## Mulberry silk

Mulberry silk is produced by the domesticated silkworm Bombyx mori. It is the most common silk globally and contributes about 90% of world silk production. In Nepal, it is cultivated for high-quality silk and use in traditional clothing and cultural textiles.




**Scientific name**

Bombyx mori – घरेलु रेशम किरा

# 2.3 Mulberry Cultivation / Moriculture

Growing quality leaves for silkworm feeding

## Site

Fertile soil, good drainage, water access, close to rearing unit.

## Climate

Warm, humid; ideal temperature 20–30°C.

## Soil

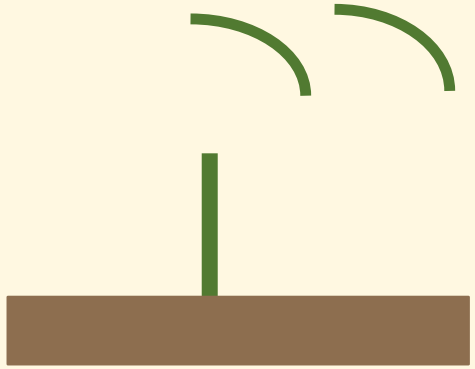
Well-drained fertile loam rich in organic matter.

## Elevation

Terai to mid-hills; about 58–300 m to 1500–1800 m.

## Varieties

Kanwa-2, Khopasi-1, Khopasi-3.



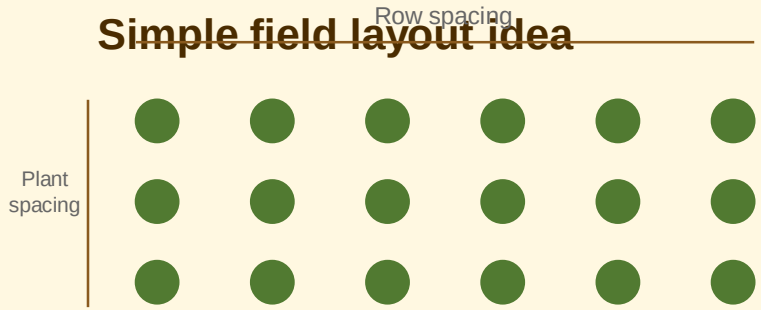
**Mulberry = food factory for silkworms**

# Spacing and Plant Population

Spacing depends on land type and pruning method

| Situation | Pruning system | Spacing | Plant population |
|---|---|---|---|
| Irrigated lowland | Short-height pruning: 20 cm | 1 m × 60 cm | ~800 plants/ropani |
| Non-irrigated slope / frost area | High-density pruning: 1.5 m | 1.5 m × 1 m | ~325 plants/ropani |
| High rainfall area | Medium-density pruning: 30 cm | 1.2 m × 75 cm | ~500 plants/ropani |

## Simple field layout idea




## Teaching point

Correct spacing improves air movement, leaf yield, fertilizer use, and ease of harvesting.

# Nursery Management and Propagation

Producing healthy mulberry saplings

## Nursery site

- Near mulberry farm
- Fertile, well-drained loamy soil
- Raised beds: 10–15 cm high, 1 m wide
- Add 10–15 kg well-decomposed manure per bed

## Propagation Methods

**Mulberry**

### Sexual propagation

Seeds are used. Seedlings may vary due to cross-pollination; often used as rootstocks.

### Asexual propagation

Cuttings, grafting and budding maintain desirable traits and uniform quality.

- Cutting
- Grafting
- Budding

# Cutting: Popular Mulberry Propagation Method in Nepal

Usually done from late October to December / 15 Kartik to 15 Poush

**1 Select stem**

Healthy, 6–8 months old stem with 3–5 active buds.

**2 Prepare cutting**

Cut into 15–20 cm pieces.

**3 Treat**

Use rooting hormones such as IBA or NAA to improve rooting.

**4 Plant**

Plant cuttings 10–15 cm apart in nursery.

**5 Transplant**

After about 8 months, move to the main field.

**Stem cutting with active buds**

### Why cutting is preferred

It is simple, economical and keeps the desirable characters of the parent plant.

# Grafting and Budding in Mulberry

Useful for improving yield and introducing better varieties

## Grafting

A scion from a desired variety is joined with a rootstock. It combines useful traits and can help propagate varieties that are difficult by other methods.

Success time: usually 3–4 weeks, depending on method and environment.

Scion + rootstock

## Budding

A single bud is removed from one plant and inserted into another plant. Methods include patch budding, T-budding and ring budding.

Success time: usually 2–3 weeks; later stock is cut back above the bud.

Inserted bud

# Transplanting and Field Care

Establishing healthy mulberry plants

## Best transplanting time

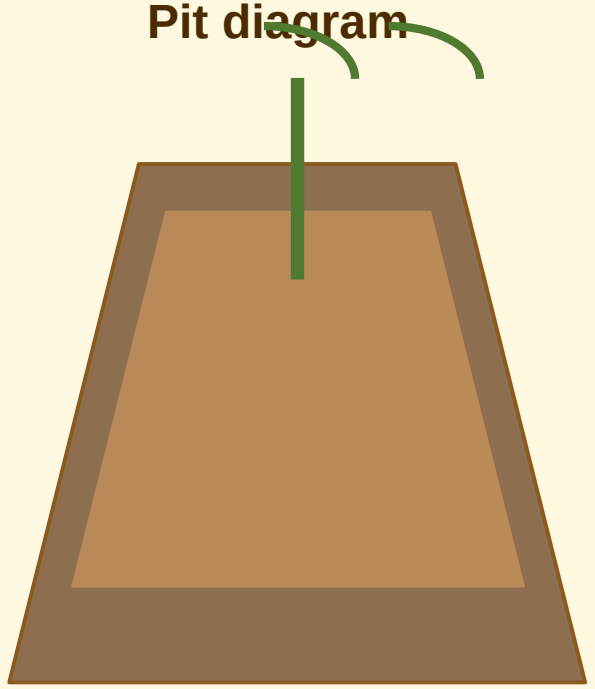
Irrigated areas:
Magh–Falgun / January–February

Non-irrigated areas:
Ashadh–Shrawan / June–July

## Pit preparation

- Pit: 30–40 cm wide and deep
- Prepare one month earlier
- Mix topsoil with 1 kg compost + 50 g wood ash or mustard cake + 10 g malathion dust
- Use contour planting on slopes

## Pit diagram



30–40 cm

## Field care

Mulching:
conserves moisture, suppresses weeds, improves soil health.

Fertilizer guideline:
15–20 t FYM/ha + 100 kg N + 40 kg P + 60 kg K/ha/year.

Irrigation:
water every 7–10 days during dry season; avoid overwatering.

# Training, Pruning, Harvesting and Yield

Managing mulberry for regular leaf supply

## Training & pruning

- Maintains healthy tree shape
- Improves leaf quality
- Winter is the main pruning season
- Terai: pruning twice a year
- Hills: winter pruning + light trimming after spring rearing
- Branch feeding can reduce labour

## Harvesting

- Begins 3–4 months after transplanting
- Matches silkworm rearing cycle
- Harvest fresh tender leaves
- Pluck leaves or cut branches
- Avoid excessive leaf removal

## Yield

Average leaf yield in Nepal:
15–30 tons/ha/year

Yield depends on:
- Variety
- Tree health
- Soil fertility
- Climate
- Management practices

# Lesson Summary

Main points to remember

Sericulture is the cultivation of silkworms for silk production.
Nepal’s major sericulture support began with government testing in 1967 and Khopasi center establishment in 1975.
Sericulture supports income, employment, culture, women’s participation and environmental sustainability.
Mulberry cultivation is essential because Bombyx mori feeds on mulberry leaves.
Healthy nursery management, correct spacing, field care and pruning improve leaf yield and silkworm performance.

## Key numbers

20–30°C
ideal temperature

15–20 t FYM/ha

100:40:60 kg/ha/year
N:P:K guideline

15–30 t/ha/year
average leaf yield

# Revision / Self-Assessment

Use these questions after teaching

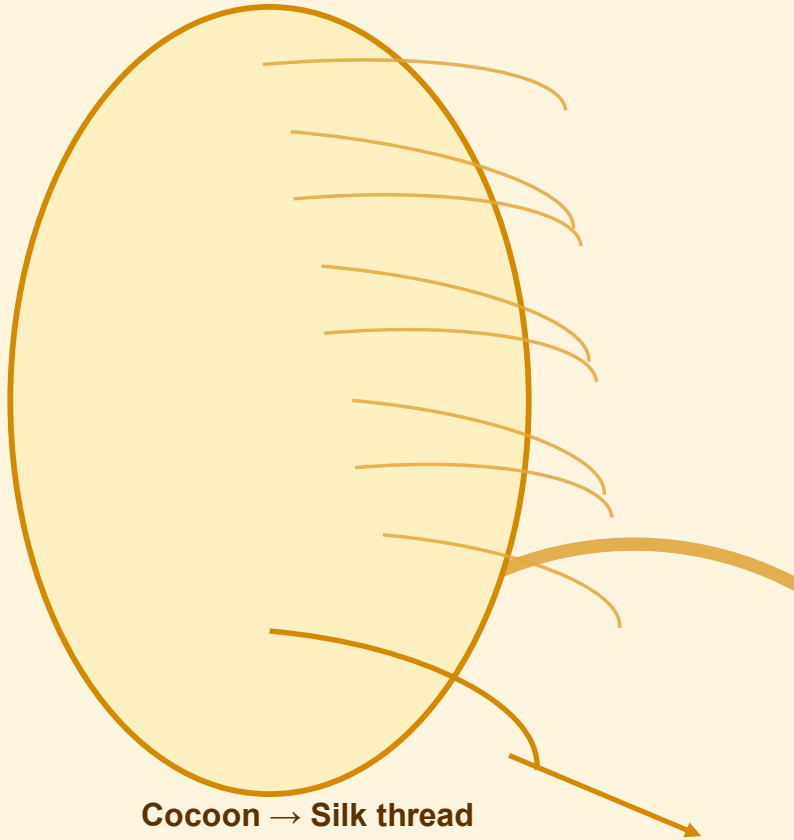
What is sericulture? Write the word origin.
Why is mulberry important in sericulture?
Mention any three importance of sericulture in Nepal.
List four scopes of sericulture in Nepal.
Which center is the major sericulture support center in Nepal?

Write the suitable climate and soil for mulberry cultivation.
Name three mulberry varieties cultivated in Nepal.
Compare sexual and asexual propagation of mulberry.
Describe the cutting method of mulberry propagation.
What are the major field care practices after transplanting?

# Silk Production

## Harvesting of Cocoon • Post-Harvest Activities • Silk Extraction

Teaching PowerPoint for Plant Science Students




**Unit 2.8 | Sericulture**

# Learning Objectives

By the end of this lesson, students will be able to:

1. **Explain cocoon harvesting**

   State correct harvest time and risks of early or late harvesting.

2. **Describe post-harvest activities**

   Disinfection, floss removal, sorting, grading, packing and storage.

3. **Compare extraction methods**

   Differentiate traditional and modern silk extraction processes.

4. **Recall key conditions**

   Remember softening temperature, degumming conditions and dried silk moisture.

# Silk Production: Complete Flow

From mature cocoon to finished silk fabric


**Core Idea**

Silk production is the process of converting good quality cocoons into continuous silk thread and then into fabric through reeling, cleaning, drying, coloring and weaving.

Teaching tip: Ask students to identify which stages are biological, post-harvest and industrial/processing stages.

# Harvesting of Cocoon

Correct timing is essential for silk quality and yield


## Normal harvesting

Usually 5–7 days after larvae complete cocoon spinning.

## Seed cocoon harvesting

For breeding purpose, harvest slightly later: about 8–9 days.

Do not harvest too early or too late; timing affects cocoon weight, shell quality and silk recovery.

# Why Harvest Timing Matters?

Common problems from wrong harvesting time

## Premature Harvesting

Cocoons may be underweight
Silk quality and yield decrease
Pupae may not be mature enough
Reeling becomes less efficient

## Delayed Harvesting

Moth may emerge and pierce cocoon
Pierced cocoons cannot give continuous filament
Pests such as uzi maggots may damage cocoon
Market value and quality decline

# Post-Harvest Activities

Activities after cocoon collection

1

## Disinfection of mountages

Removes disease organisms from cocoon-spinning structures.

2

## Floss removal

Removes loose outer silk for better handling and appearance.

3

## Sorting and grading

Classifies cocoons by size, color, shape and quality.

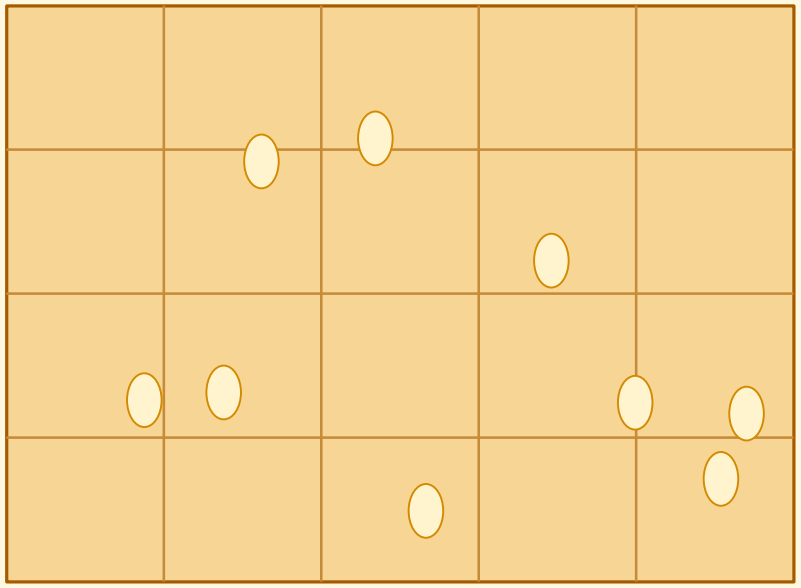
4

## Packing and storage

Keeps good cocoons in cool, dry and ventilated condition.

# Disinfection of Mountages

Mountages may carry diseases; disinfection protects pupae and cocoon quality



Mountage

## Common Methods

Spray slaked lime, formalin or bleaching powder solution
Use flame treatment for bamboo mountages
Submerge plastic mountages where suitable
Dry well before reuse

Main purpose: prevent pupal mortality and stop disease spread during cocoon storage/handling.

# Sorting, Grading, Packing and Storage

Maintaining cocoon quality before extraction

A

## Sorting

Separate cocoons according to size, color, shape and visible quality.

B

## Grading

Remove low-quality, pierced or diseased cocoons; dispose safely to prevent disease spread.

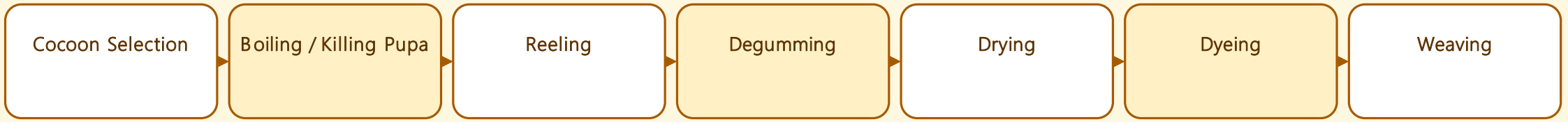
C

## Packing & Storage

Pack loosely in perforated bags; store in cool, dry and well-ventilated places. Transport in cooler parts of day.

# Traditional Silk Extraction Method

Slow, skill-based process that produces natural luster and softness




**Key Feature**

Traditional extraction depends heavily on manual selection, boiling, skilled reeling using brushes/charkha, and careful weaving by artisans.

Use this slide to help students memorize the full order of traditional silk processing.

# Traditional Extraction: Important Steps

What happens in each stage?

1 **Selection**

Choose uniform cocoons without holes, damage or defects.

2 **Boiling**

Cocoons are boiled for about 5–10 minutes to soften sericin and kill pupa.

3 **Reeling**

Silk filament is pulled gently and threads from several cocoons are joined.

4 **Degumming**

Sericin is removed using hot soap and soda solution.

5 **Drying & Dyeing**

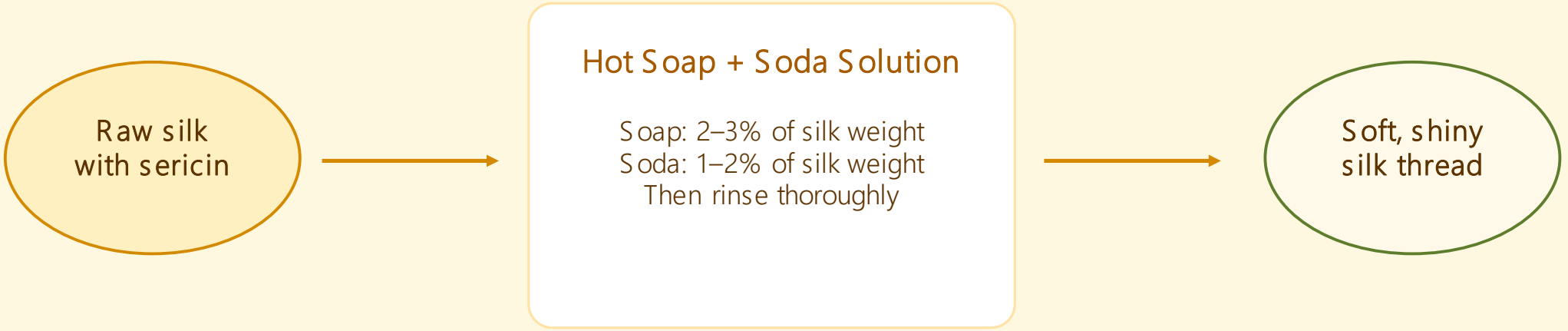
Threads are dried, then colored using natural or synthetic dyes.

6 **Weaving**

Threads are woven into fabric using handlooms or power looms.

# Degumming: Making Silk Soft and Shiny

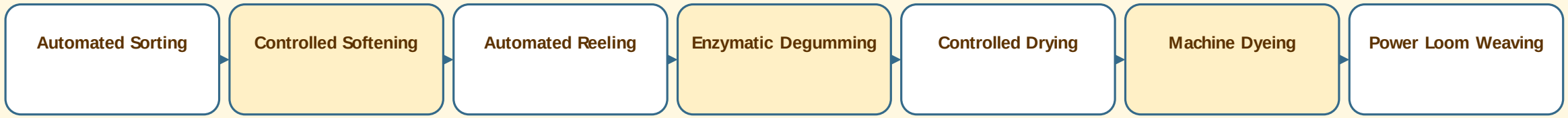
Removal of sericin from silk thread




Sericin acts like gum; degumming removes it and improves softness, luster and handle.

# Modern Silk Extraction Method

Uses machines for efficiency, uniformity and large-scale production




Automated systems reduce manual labor and improve consistency.
Temperature, moisture and thread quality are controlled by machines and sensors.
Best suited for industrial-scale production of high-volume silk fabric.

# Modern Extraction: Key Technical Conditions

Important figures students should remember

1

## Softening Temperature

Cocoons are softened in hot water at about 90–100°C.

2

## Enzymatic Degumming

Use about 0.5–1% proteolytic enzymes with detergent.

3

## Degumming Condition

Controlled temperature of about 40–60°C for 30–60 minutes.

4

## Dried Silk Moisture

Ideal dried silk moisture content: 8–11% to prevent mildew or brittleness.

# Traditional vs Modern Silk Extraction

Comparison for classroom discussion

| Basis | Traditional Method | Modern Method |
|---|---|---|
| Main labor | Skilled manual labor | Machine + trained operators |
| Sorting | Hand inspection | Automated sensors/cameras |
| Softening | Boiling in pots/vats | Controlled vats at 90–100°C |
| Reeling | Brushes, charkha, manual care | Automated reeling machines |
| Production scale | Small to medium scale | Industrial scale |
| Quality control | Depends on skill and experience | More uniform, sensor-controlled |

# Good Practices for Better Cocoon and Silk Quality

Important precautions in production

Harvest cocoons at correct maturity: usually 5–7 days after spinning.
Keep mountages clean and disinfected to reduce disease problems.
Avoid overheating and high moisture during packing, storage and transport.
Separate pierced, diseased or low-quality cocoons during grading.
Maintain correct temperature and moisture in modern processing.
Handle silk filaments gently during reeling to avoid breakage.

# Quick Revision: MCQs

Ask students to answer orally or in notebooks

1. Silk extraction by unwinding silk threads is called:

A. Spinning  B. Weaving  C. Dyeing  D. Reeling

2. Normal cocoon harvesting is generally done after:

A. 1–2 days  B. 5–7 days  C. 15 days  D. 30 days

3. Sericin is mainly removed during:

A. Degumming  B. Dyeing  C. Packing  D. Mounting

4. Ideal moisture content of dried silk is:

A. 1–2%  B. 4–5%  C. 8–11%  D. 20–25%

# Answers and Homework

Use this slide after student discussion

## MCQ Answers

1. D — Reeling
2. B — 5–7 days
3. A — Degumming
4. C — 8–11%

## Class Activity

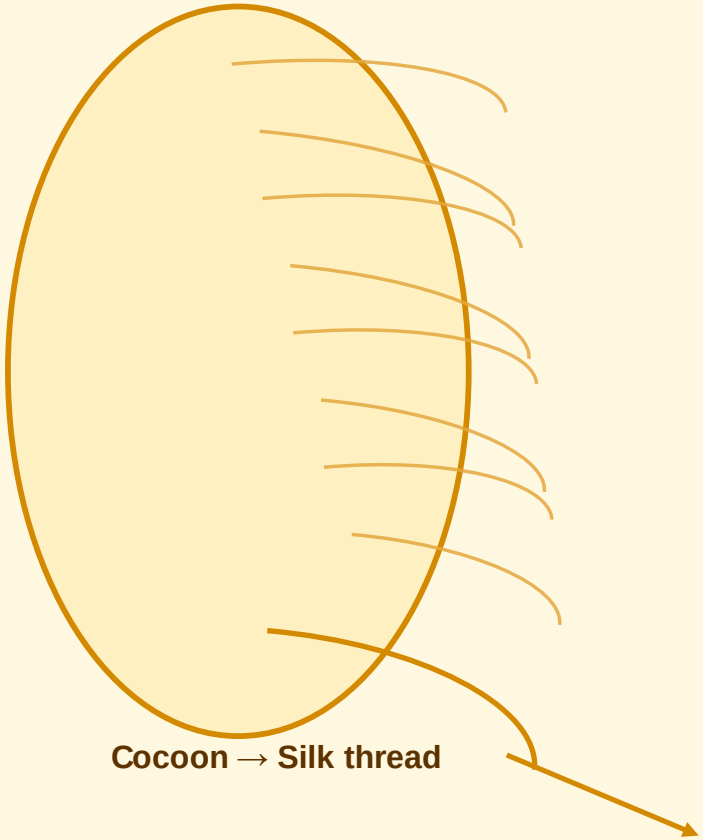
Make a group diagram showing: cocoon → thread → fabric.

## Homework / Project Work

Draw a flowchart of traditional silk extraction.
Write two differences between traditional and modern extraction.
Explain why late cocoon harvesting reduces silk quality.
Prepare a short note on packing and storage of cocoons.

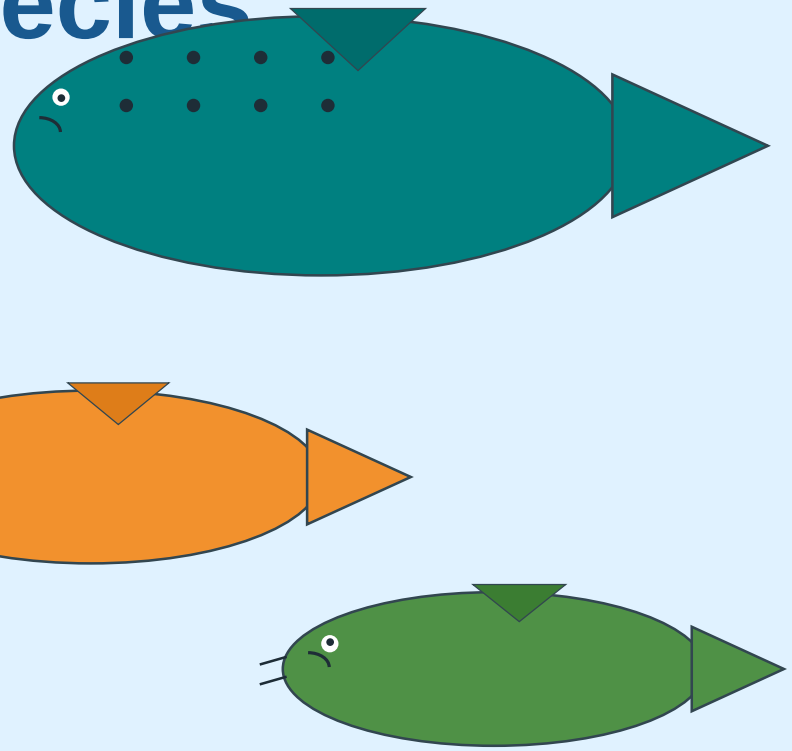
# Thank You

Silk Production | Sericulture




**Revision prompt: “Why is cocoon quality important in silk extraction?”**

# Indigenous and Exotic Fish Species



Identification, characteristics and feeding habits

Section B: Fish Culture • Unit 3

**Teaching focus: observe body shape, mouth position, barbels, scales, fins and feeding zone.**

# Learning Objectives



By the end of the lesson, students should be able to:

**1**

Differentiate indigenous and exotic fish species.

**2**

Identify major indigenous fish of Nepal: Rohu, Mrigal/Naini and Catla/Bhakur.

**3**

Identify major exotic fish used in aquaculture.

**4**

Compare fish by body shape, mouth position, barbels, scales, caudal fin and feeding habit.

**5**

Explain ecological risks of introducing exotic fish species.

# Indigenous vs Exotic Fish

Concept

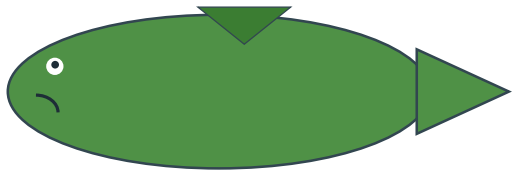
Basic concept before identification

## Indigenous fish

Naturally found in Nepal’s aquatic ecosystems.
Adapted to local rivers, lakes, streams and wetlands.
Important for ecology, culture and local economy.

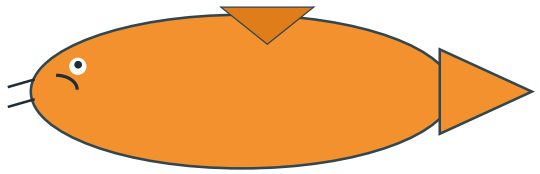
## Exotic fish

Introduced from other countries for farming, decoration or accidentally.
Useful for production and income when managed properly.
May compete with native species for food and habitat.



Native adapted

**Careful management needed**



Introduced

# Popular Indigenous Fish of Nepal

Indigenous

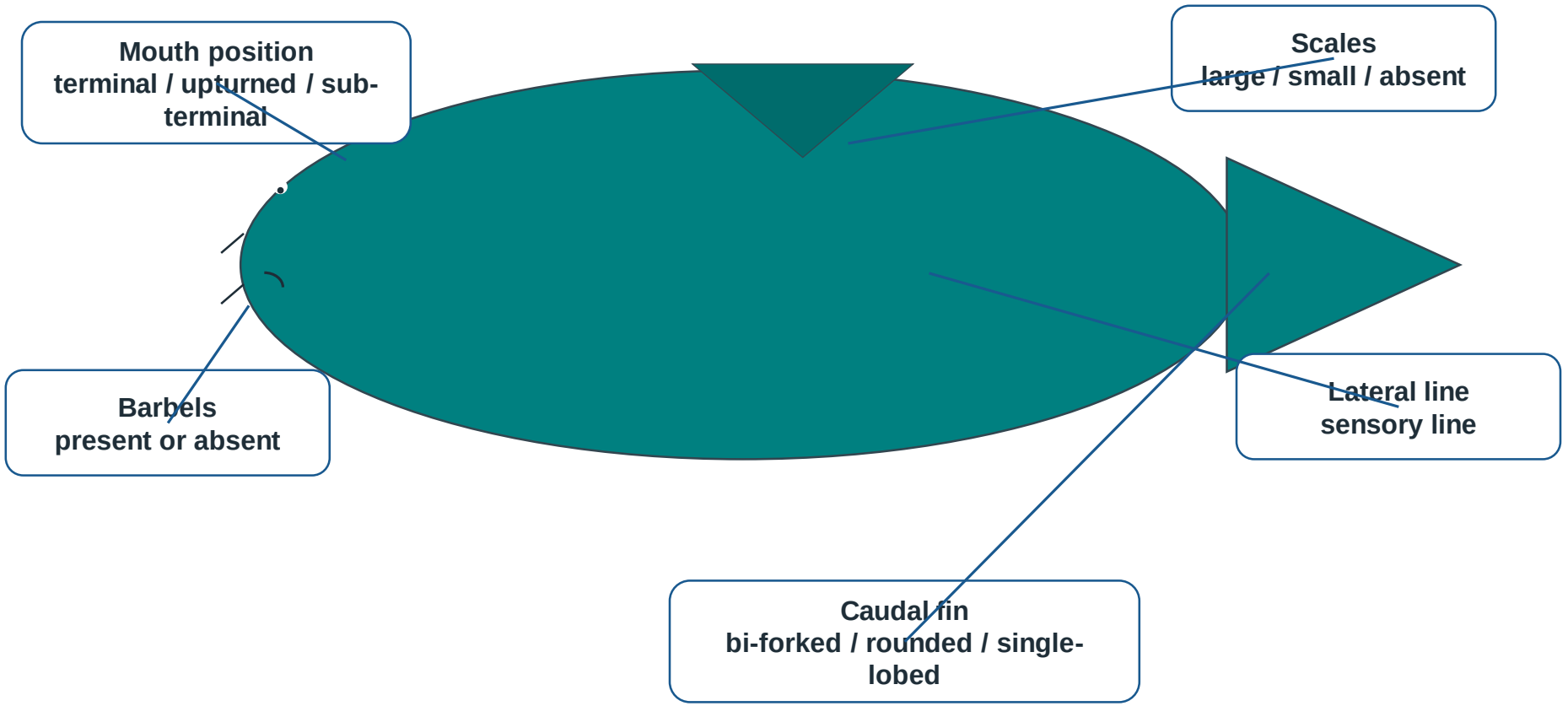
Examples found in rivers, streams, lakes and wetlands

| Fish | Scientific / group | Main note |
|---|---|---|
| **Mahseer / Sahar** | Tor spp.; Tor putitora | Prized game fish; golden hue; cultural/religious value |
| **Katle / Chocolate Mahseer** | Neolissochilus hexagonolepis | Cultural significance; popular food fish |
| **Asla** | Schizothoraichthys spp. | Cold-water fish of mid-altitude streams and rivers |
| **Rita** | Rita rita | Freshwater catfish of warmer Terai rivers |
| **Buduna** | Labeo dero | Valued taste; common in traditional diets |
| **Gonius** | Labeo gonius | Plains, lowland rivers and oxbow lakes |
| **Chitala** | Chitala chitala | Clown knifefish; larger Terai rivers and wetlands |
| **Raj Bam** | Anguilla bengalensis | Eel; mid- and low-altitude regions |
| **Pothi** | Puntius spp. | Small cyprinid in rivers, streams and ponds |

# How to Identify Fish in the Field

Identification

Observe external characters carefully



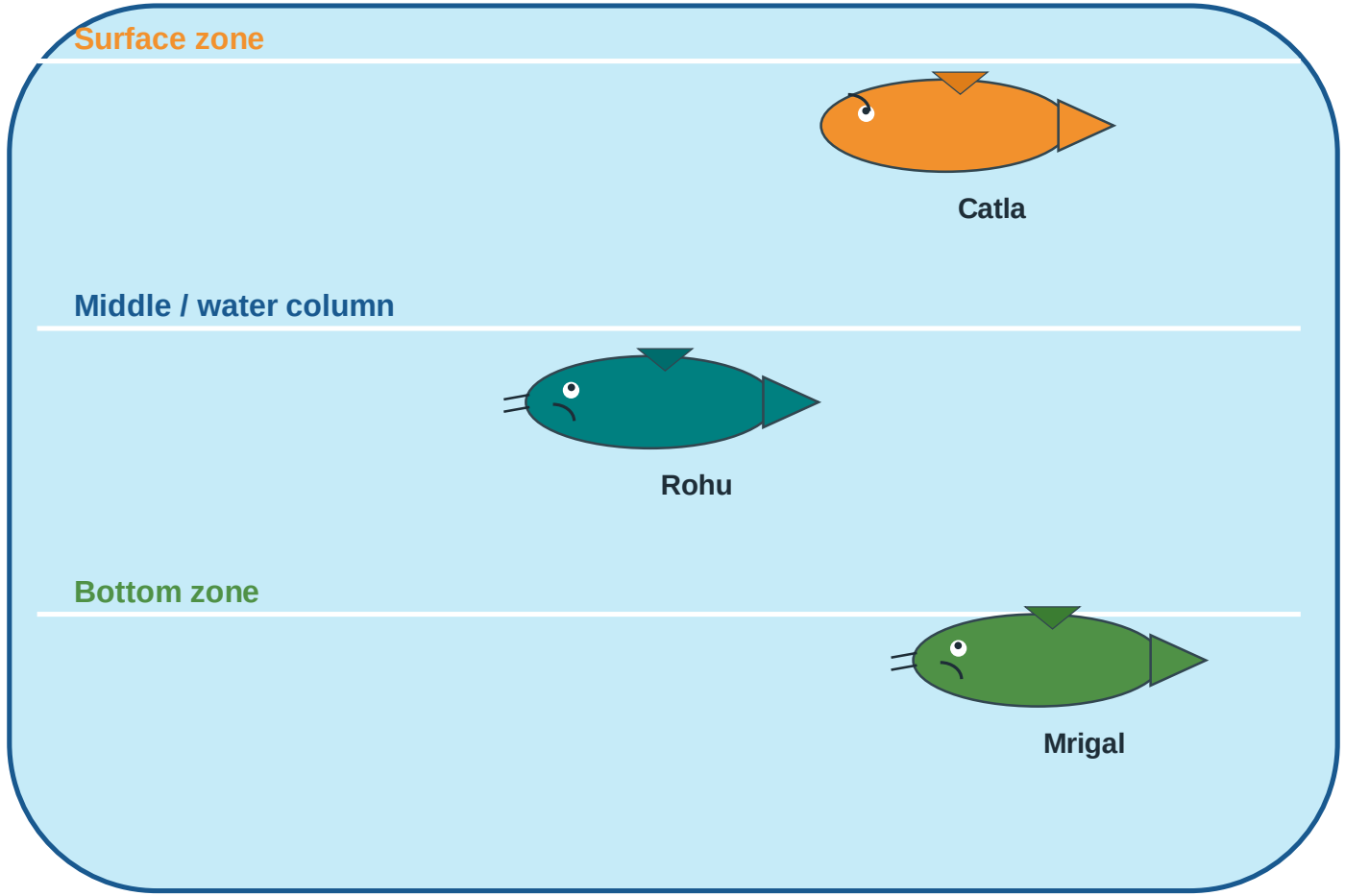

## Teaching tip

Ask students to identify mouth position first; it often indicates feeding habit and pond zone.

# Feeding Zone Concept in a Pond



Different fish use different water layers




## Surface feeders

Upturned mouth; feed near surface.
Example: Catla.

## Column / omnivores

Use plankton, plant matter and detritus.
Example: Rohu.

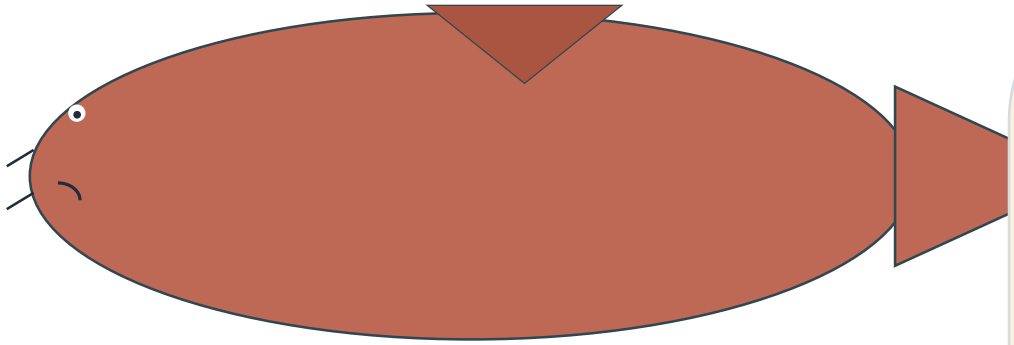
## Bottom feeders

Feed on detritus and organic matter.
Example: Mrigal/Naini.

# Rohu — Labeo rohita

Indigenous

Fast-growing indigenous carp of Nepal



**Identification clue**
**Sub-terminal mouth + 1 pair maxillary barbels + reddish sides**

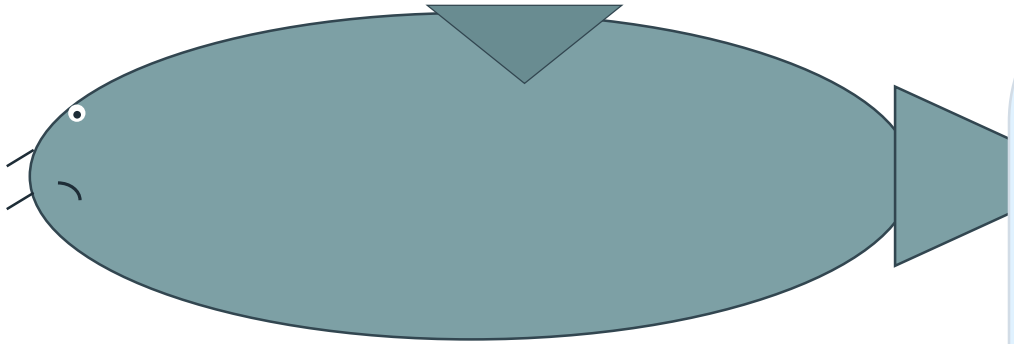
## Key characteristics

Elongated, cylindrical body with large silvery scales and reddish tinge.
Small pointed head; smooth, scaleless sub-terminal mouth.
Single pair of maxillary barbels; thick, fringed lips.
Dull reddish sides and whitish belly; clear lateral line.
Bi-forked caudal fin supports agile swimming.
Omnivorous: plankton, plant matter and detritus.
Rapid growth in warm waters; highly suitable for aquaculture.

# Mrigal / Naini — Cirrhinus mrigala

Indigenous

Important indigenous bottom-feeding carp



**Identification clue**
**Bottom feeder + rostral barbels + thin non-fringed lips**

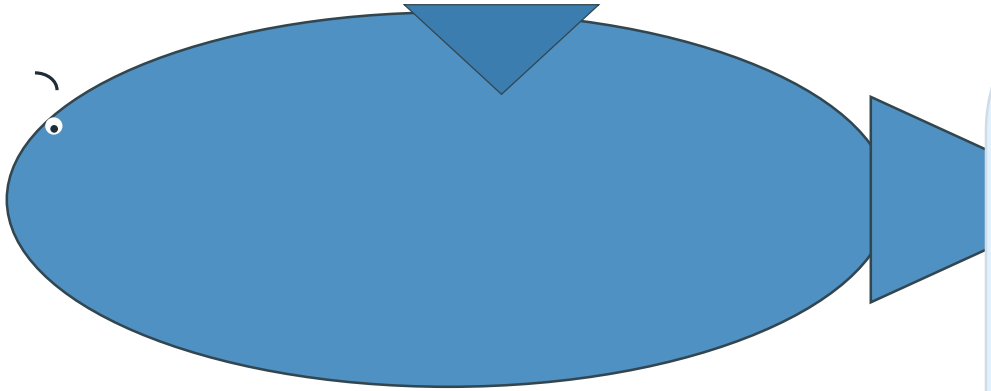
## Key characteristics

Elongated, cylindrical body with prominent silvery scales.
Small head; sub-terminal mouth without scales.
Thin, non-fringed lips; one pair of small rostral barbels.
Upper jaw slightly longer than lower jaw.
Grayish dorsal side and whitish belly; visible lateral line.
Bi-forked caudal fin; smooth swimming.
Bottom feeder: detritus and organic matter.
Moderate growth; useful for maintaining pond ecosystem.

# Catla / Bhakur — Catla catla

Indigenous

Fast-growing indigenous surface-feeding carp



**Identification clue**
**Deep body + large head + upturned mouth + no barbels**

## Key characteristics

Laterally compressed and deep body with large scales.
Large head; upturned scaleless mouth.
Barbels absent; smooth, non-fringed lips.
Grayish to silvery upper sides and whitish belly.
Visible lateral line; bi-forked caudal fin.
Surface feeder: mainly phytoplankton and zooplankton.
Rapid growth; may reach 20–30 kg under favorable conditions.
Highly valued in commercial aquaculture.

# Comparison Table: Major Indigenous Carps

Comparison

Carefully compare identifying features and feeding habits

| Feature | Rohu | Mrigal / Naini | Catla / Bhakur |
|---|---|---|---|
| **Scientific name** | Labeo rohita | Cirrhinus mrigala | Catla catla |
| **Body shape** | Elongated, cylindrical | Elongated, cylindrical | Deep, laterally compressed |
| **Mouth** | Sub-terminal | Sub-terminal | Upturned |
| **Barbels** | 1 pair maxillary | 1 pair small rostral | Absent |
| **Lips** | Thick, fringed | Thin, non-fringed | Smooth, non-fringed |
| **Feeding habit** | Omnivorous | Bottom feeder | Surface feeder |
| **Main food** | Plankton, plant matter, detritus | Detritus, organic matter | Phyto- and zooplankton |
| **Aquaculture value** | Fast growth; warm water | Pond bottom cleaning role | Rapid growth; large size |

# Exotic Fish Species in Nepal

Exotic

Introduced species: useful but need careful management

## Why introduced?

To increase aquaculture production.
To diversify fish farming systems.
For weed control, ornamental value and income generation.

## Possible ecological risks

Competition with native species for food and habitat.
Reduction of native fish population if unmanaged.
Disruption of natural balance in rivers and lakes.

**1956/1960**
**Common carp**
**India/Israel**

**1967/1968**
**Grass & Silver carp**
**India/Japan**

**1969/1972**
**Bighead carp**
**America/Hungary**

**1985**
**Nile tilapia**
**Thailand**

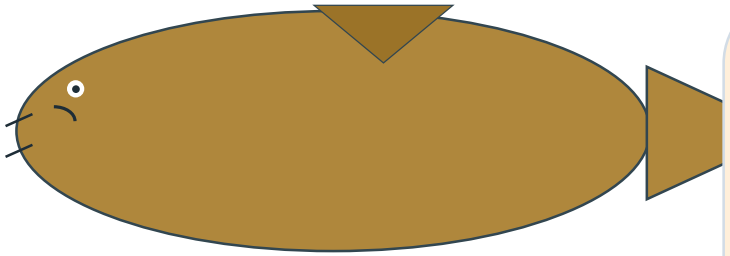
**1988**
**Rainbow trout**
**Japan**

**1990s**
**African catfish**
**India**

# Common Carp and Grass Carp

Exotic

Two important exotic carps with different feeding roles



Common carp

## Common carp

Cyprinus carpio

Deep, robust body.

Protractile mouth.

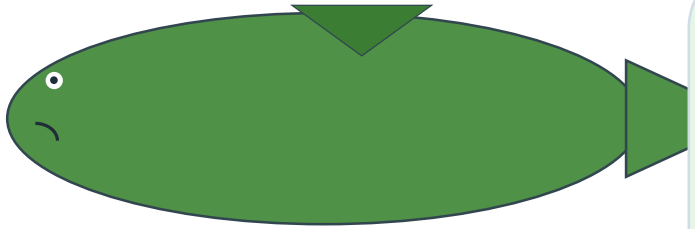
Two pairs maxillary barbels.

Large yellowish scales.

Long dorsal fin with sharp spine.

Omnivorous.

Thrives in ponds, lakes and rice fields.



Grass carp

## Grass carp

Ctenopharyngodon idella

Elongated cylindrical body.

Large greenish scales.

Broad scaleless head.

No barbels.

Sub-terminal mouth.

Herbivorous: aquatic plants.

Useful for weed control.

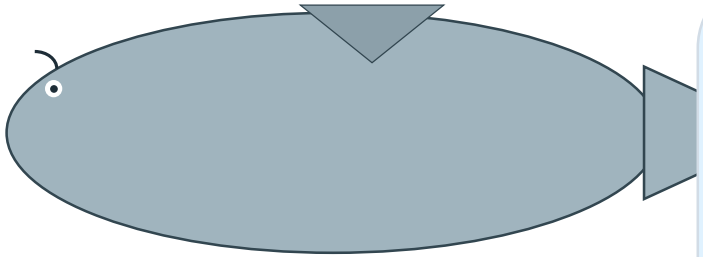
## Key comparison

Common carp = omnivorous and barbels present; Grass carp = herbivorous and barbels absent.

# Silver Carp and Bighead Carp

Exotic

Filter-feeding exotic carps



Silver carp

## Silver carp

Hypophthalmichthys molitrix

Flat, laterally compressed body.

Small shiny silvery scales.

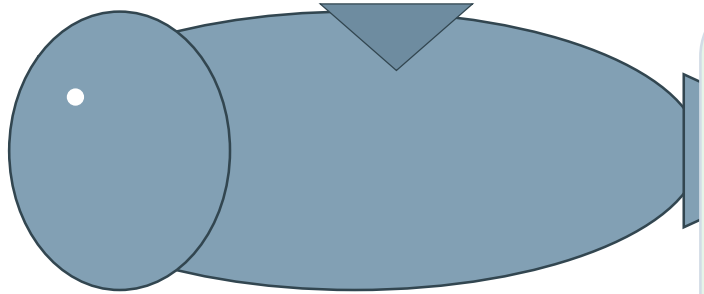
Small head; no barbels.

Upturned mouth; lower jaw longer.

Complete abdominal keel.

Pectoral fin does not pass pelvic base.

Filter feeder: plankton + organic matter.



Bighead carp

## Bighead carp

Hypophthalmichthys nobilis

Massive scaleless head.

Small silvery scales; brownish upper side.

Large upturned mouth.

Incomplete abdominal keel.

Pectoral fin extends beyond pelvic base.

No barbels.

Filter feeder: phyto- and zooplankton.

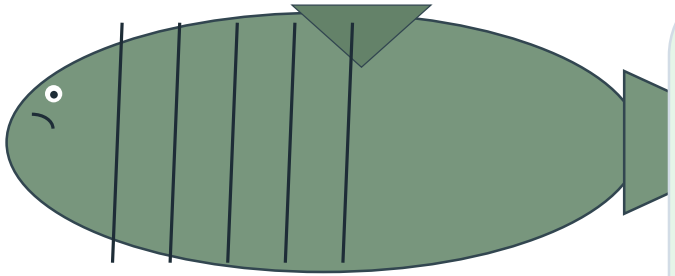
## Key comparison

Silver carp: complete abdominal keel; Bighead carp: massive head and incomplete abdominal keel.

# Nile Tilapia and Pangas/Baikhi

Exotic

Fast-growing exotic species used in aquaculture



**Nile tilapia**

## Nile tilapia

Oreochromis niloticus

Introduced from Thailand in 1985.

Laterally compressed body; large scales.

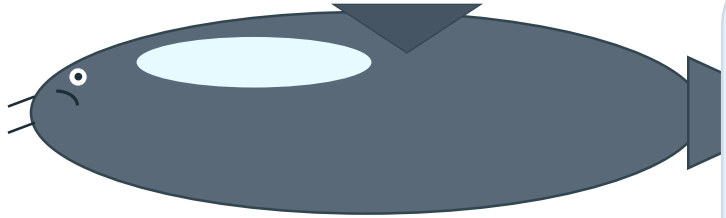
Scaled head with large eyes.

Terminal mouth with folded thick upper lip.

Long spiny dorsal; pelvic and anal fins spiny.

Interrupted lateral line; black body/tail stripes.

Omnivorous: plankton, aquatic vegetation, detritus.



**Pangas / Baikhi**

## Pangas

Pangasiodon hypophthalmus

Long, laterally flattened body; scaleless.

Flat bony head; large eyes.

Broad terminal mouth with small sharp teeth.

Two pairs of small barbels.

Dark grey/black fins.

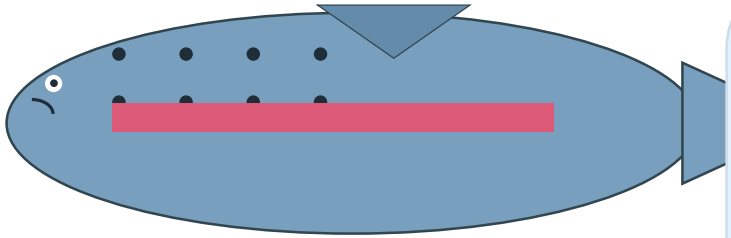
Bi-forked caudal fin.

Omnivorous; rapid growth and resilient.

# Rainbow Trout and African Catfish

Exotic

Contrasting cold-water and hardy catfish species



**Rainbow trout**

## Rainbow trout

Oncorhynchus mykiss

Introduced from Japan in 1988.

Cold running water; high-altitude regions.

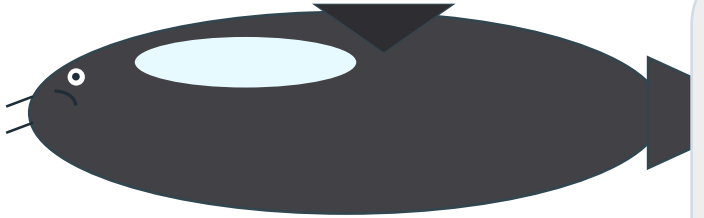
Elongated, laterally compressed body.

Silvery sides with pink/bluish/red band.

Many small black spots; spotted dorsal and caudal fins.

Caudal fin not distinctly bi-forked.

Carnivorous: smaller fish, insects, aquatic invertebrates.



**African catfish / Mangur**

## African catfish

Clarias gariepinus

Introduced from India in mid-1990s.

Long cylindrical body; scaleless smooth skin.

Flat bony head; broad terminal mouth.

Four pairs of barbels.

Long dorsal and anal fins without spines.

Pectoral fins have spines; rounded caudal fin.

Omnivorous; hardy, fast-growing, high reproduction.

# Comparison Table: Major Exotic Fish

Comparison

Origin/status, feeding habit and identification features

| Fish | Origin / introduction | Feeding habit | Main ID characters | Aquaculture value / caution |
|---|---|---|---|---|
| **Common carp** | India 1956; Israel 1960 | Omnivorous | Deep robust body; 2 pairs barbels; protractile mouth; large yellow scales | Adaptable; ponds, lakes, rice fields |
| **Grass carp** | India 1967; Japan 1968 | Herbivorous | Elongated body; greenish scales; no barbels; sub-terminal mouth | Weed control; rapid growth |
| **Silver carp** | India/Japan 1967–68 | Filter feeder | Upturned mouth; complete abdominal keel; no barbels | Plankton feeder; fast growth |
| **Bighead carp** | America 1969; Hungary 1972 | Filter feeder | Massive head; large upturned mouth; incomplete abdominal keel | High productivity; fast growth |
| **Nile tilapia** | Thailand 1985 | Omnivorous | Black stripes; interrupted lateral line; spiny fins; single-lobed caudal | Fast growth; high reproduction |
| **Pangas** | From India | Omnivorous | Scaleless; flat bony head; 2 pairs barbels; bi-forked caudal | Rapid growth; resilient |
| **Rainbow trout** | Japan 1988 | Carnivorous | Pink/red lateral band; black spots; not distinctly bi-forked caudal | Cold-water high-altitude farming |
| **African catfish** | India, mid-1990s | Omnivorous | Scaleless; 4 pairs barbels; long dorsal/anal fins; rounded caudal | Hardy and fast-growing; manage carefully |

# Comparison Table: Feeding Habit and Pond Role

Comparison

Use this table for polyculture planning and species identification

| Feeding group | Fish examples | Preferred food | Pond/water zone | Useful teaching point |
|---|---|---|---|---|
| **Surface feeder** | Catla/Bhakur | Phytoplankton and zooplankton | Surface layer | Upturned mouth helps surface feeding |
| **Bottom feeder** | Mrigal/Naini | Detritus and organic matter | Bottom zone | Uses wastes and organic material at pond bottom |
| **Omnivore** | Rohu, Common carp, Tilapia, Pangas, African catfish | Plant matter, animal matter, plankton, detritus | Multiple zones | Adaptable feeding; good for culture systems |
| **Herbivore** | Grass carp | Aquatic plants | Vegetation zone | Useful for aquatic weed control |
| **Filter feeder** | Silver carp, Bighead carp | Plankton and suspended organic matter | Open water column | Filters food particles from water |
| **Carnivore** | Rainbow trout | Small fish, insects, aquatic invertebrates | Cold running water | Requires protein-rich feed and cool water |

# Quick Identification Key

Identification

Simple field guide for students

1

## Scales absent?

Check skin: smooth/scaleless fish may be Pangas or African catfish.

2

## Barbels present?

Barbels are useful to identify catfish and some carps.

3

## Mouth position?

Upturned = surface/filter feeder; sub-terminal = bottom/column feeder.

4

## Body shape?

Deep body = Catla/Common carp; elongated = Rohu/Mrigal/Grass carp/

5

## Special marks?

Tilapia stripes; Trout pink band and black spots; Silver carp keel.

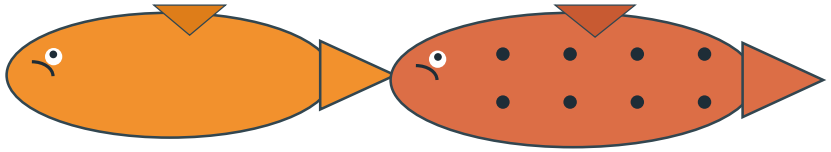
# Aquarium Fish

Aquarium

Ornamental fish for controlled aquarium environments

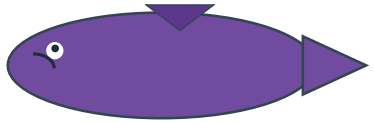
## Meaning

Fish bred or adapted to live in aquariums.
Selected for beauty, ease of care and interesting behavior.
Useful for education, relaxation and understanding aquatic biology.



Goldfish

Koi carp



Guppy

| Aquarium fish | Scientific / note | Main use |
|---|---|---|
| **Goldfish** | Carassius auratus | Ornamental |
| **Koi carp** | Decorative variety of Cyprinus carpio | Aesthetic pond/aquarium fish |
| **Guppy** | Poecilia reticulata | Aquarium and mosquito control |

# Classroom Activity: Identify the Fish

Activity

Use drawings/photos/specimens if available

## Group task

Divide class into 4–5 groups.
Give each group one fish drawing/photo.
Observe body shape, mouth, barbels, scales and fins.
Decide: indigenous or exotic?
Present feeding habit and pond zone.

| Observation | Write here |
|---|---|
| Fish/local name | |
| Scientific name | |
| Indigenous or exotic | |
| Body shape | |
| Mouth position | |
| Barbels | |
| Feeding habit | |
| Aquaculture importance | |

# Revision Questions

Assessment

Use for oral questioning, quiz or homework

## Short-answer questions

Define indigenous fish and exotic fish with one example each.
List two identifying features of Rohu.
How is Catla different from Mrigal in feeding habit?
Why can exotic fish cause ecological problems?
Name two scaleless exotic fish species from this lesson.
Which fish is useful for aquatic weed control and why?

## MCQ practice

Which fish has an upturned mouth and is a surface feeder? a) Mrigal b) Catla c) Rohu d) Pangas
Which exotic fish is herbivorous? a) Grass carp b) Trout c) Pangas d) African catfish
Which fish has four pairs of barbels? a) Silver carp b) Catla c) African catfish d) Rohu
Which fish has a pink/red lateral band? a) Rainbow trout b) Tilapia c) Common carp d) Gonius

# Lesson Summary

Summary

Key points to remember

## 1. Indigenous fish

Naturally occur in Nepal and are adapted to local water bodies.

## 2. Exotic fish

Introduced species can increase production but may affect native biodiversity if unmanaged.

## 3. Identification characters

Body shape, mouth position, barbels, scales, lateral line, caudal fin and body marks are important.

## 4. Feeding habit

Surface, bottom, omnivore, herbivore, filter feeder and carnivore groups help in pond management.

**Remember: Accurate species identification is the first step toward scientific fish farming.**

# Fish Pond Construction & Management

Section B: Fish Culture | Unit 4 | Grade 10 Plant Science

## Teaching PowerPoint

Construction steps • Pond management • Aquatic weeds • Fish predators and control

**Learning Focus**

Students learn how to design a practical fish pond and manage key pond problems safely.

# Learning Objectives

1. Define fish pond and explain why pond construction is important for fish farming.
2. List and describe step-by-step fish pond construction practices.
3. Explain pond management practices: water quality, feeding, stocking, waste control, and harvesting.
4. Identify major aquatic weeds and select suitable control methods.
5. Recognize common fish predators and recommend practical control measures.

# What is a Fish Pond?

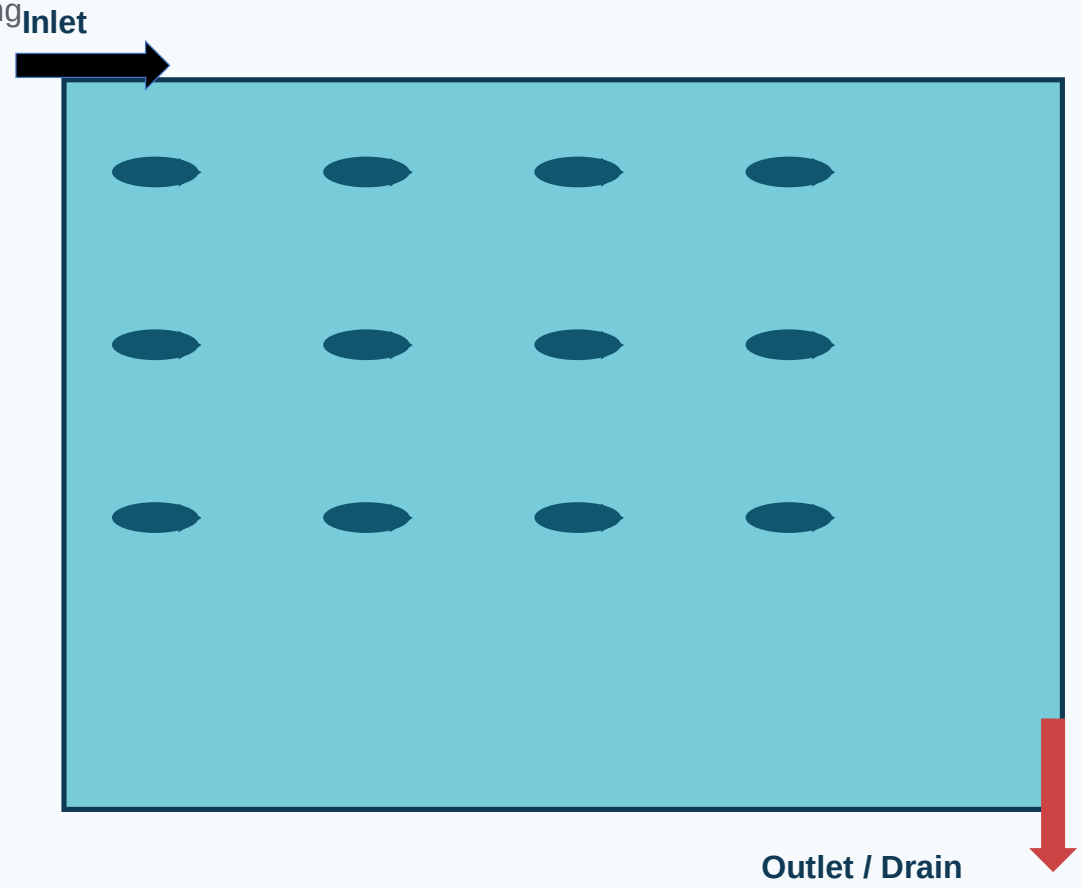
A controlled water body designed for fish growth, feeding, protection, and harvesting

## Core idea

A fish pond provides a managed environment where water, food, stocking density, health, and harvesting can be controlled.

## Why it matters

Good pond planning improves fish survival, growth rate, production, and profit while reducing disease and water problems.




Fish pond top-view diagram

# Step-by-Step Fish Pond Construction


**Teaching tip**

Ask students: Which construction step will create the biggest problem if done carelessly? Discuss seepage, oxygen, drainage, and predator entry.

# 1) Site Selection: Choose the Right Place

### Reliable water source
River, stream, spring, groundwater or canal nearby.

### Clayey soil
Clay soil holds water; sandy soil causes seepage.

### Sunlight 6–8 hours/day
Promotes plankton growth as natural food for carp.

### Accessibility
Easy for feed transport, maintenance, harvesting, and market access.

### Near market
Reduces transport cost and fish spoilage risk.

### Avoid
Sandy soil, polluted water, flood-prone area, and sites far from water or market.

# 2) Pond Design: Shape, Size and Depth

## Recommended shape

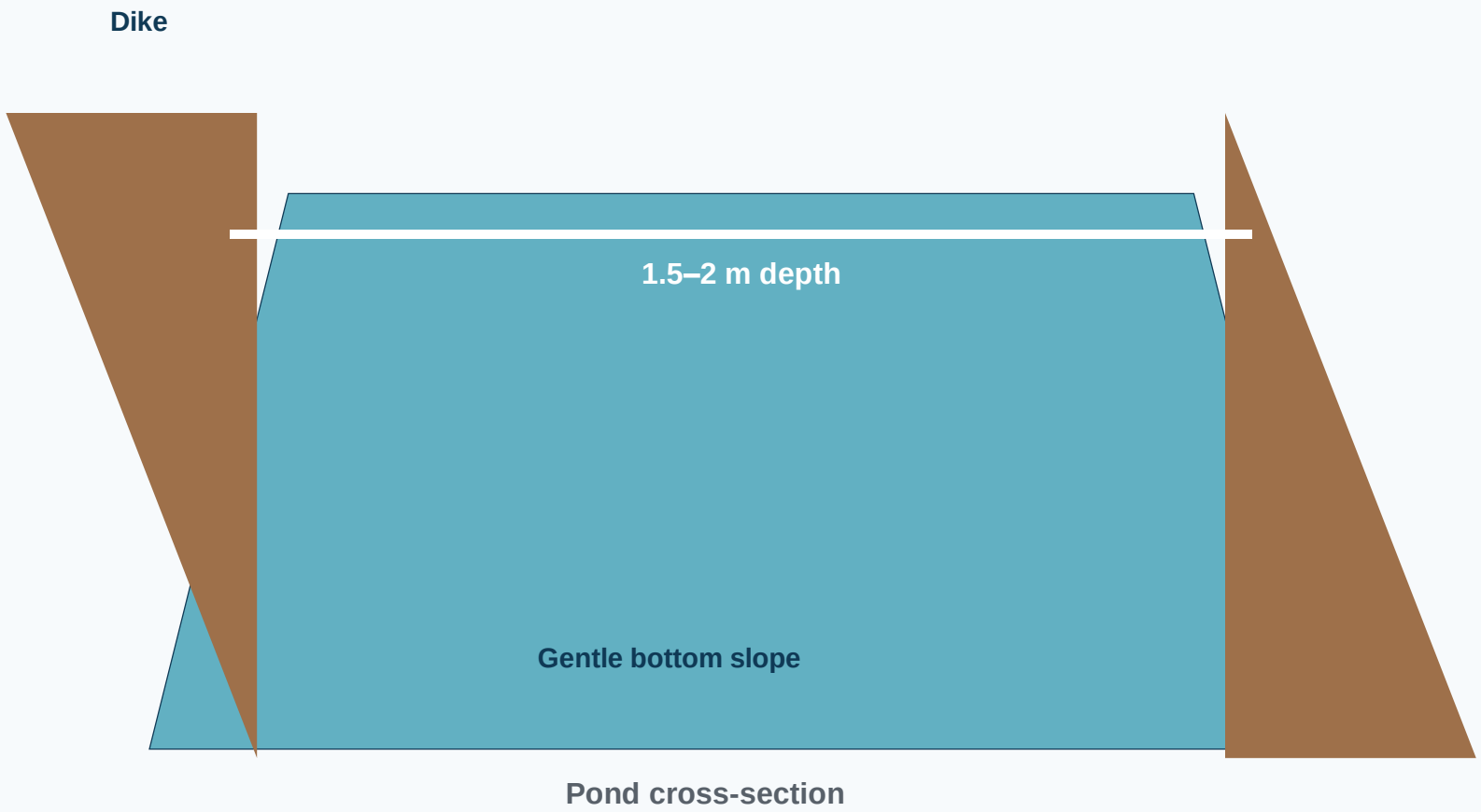
Rectangular or square ponds are easier to manage, feed, net, and harvest.

## Typical size

1000–2000 m² (0.1–0.2 ha) is suitable for small-scale carp farming.

## Ideal depth

1.5–2.0 m provides enough swimming space and stable water temperature.



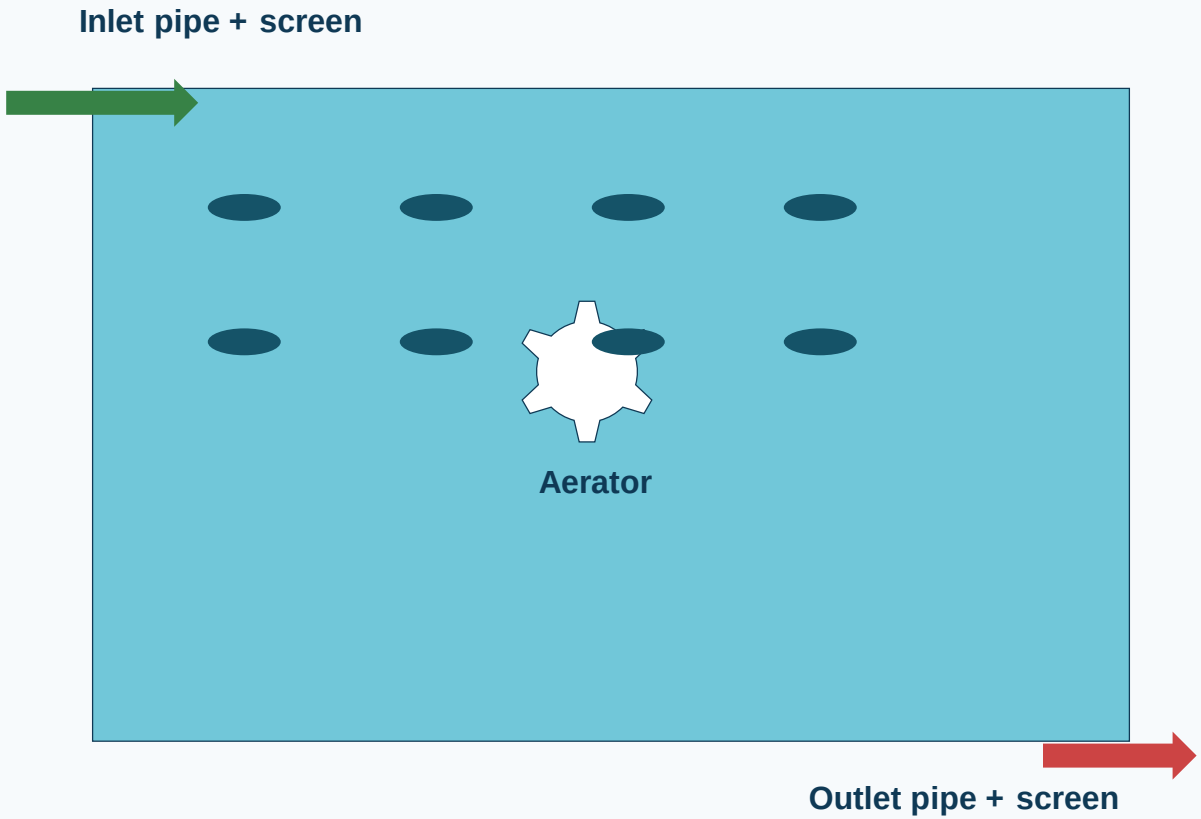

Pond cross-section

# 3–6) Land Preparation to Dike Construction

| Step | Main action | Why important |
|---|---|---|
| Land preparation | Clear vegetation, roots, rocks, and waste; level the ground. | Prevents uneven water distribution and future management problems. |
| Slope creation | Make a slight 1–2% slope toward centre/outlet. | Supports drainage and waste management. |
| Excavation | Dig to recommended depth and remove sharp objects. | Protects fish and prevents lining damage. |
| Pond lining | Use clay, plastic sheet, or pond liner where soil leaks. | Prevents seepage and maintains stable water level. |
| Dike building | Top width ~1 m; base width 2–3 m; plant grass. | Holds water safely and reduces erosion. |

**Remember**
Weak dikes and poor lining are major causes of water loss in fish ponds.

# 7–10) Water Control, Aeration, Filling and Stocking




## Inlet and outlet

Regulate fresh water entry, drainage, and water level. Screens prevent fish escape and unwanted species entry.

## Aeration

Paddle wheels or air pumps maintain dissolved oxygen, especially in heavily stocked ponds.

## Pond filling

Fill gradually, check leakage, and allow water to settle for a few days before stocking.

## Stocking

Use healthy disease-free fingerlings. For 1000 m² pond: about 2000–3000 fingerlings.

# Fish Pond Management: Main Practices

### Water quality
pH 6.5–8, clean water, enough oxygen

### Feed
balanced diet, regular small feeding

### Stocking density
avoid overcrowding and stress

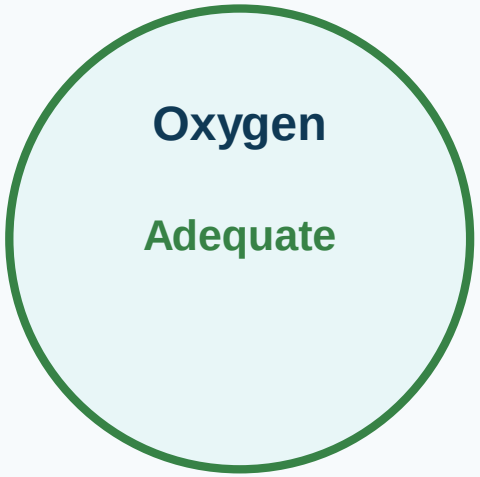
### Waste & weeds
remove weeds, algae, debris

### Predator & disease
protect fingerlings and monitor health

### Harvest & restock
harvest at proper size, clean pond, restock

**Goal**
Maintain a balanced pond environment for healthy fish growth and sustainable production.

# Water Quality and Feed Management



## Water quality checklist

- Keep water free from harmful chemicals.
- Use aeration in heavily stocked ponds.
- Check fish behavior: gasping indicates low oxygen.

## Feed management checklist

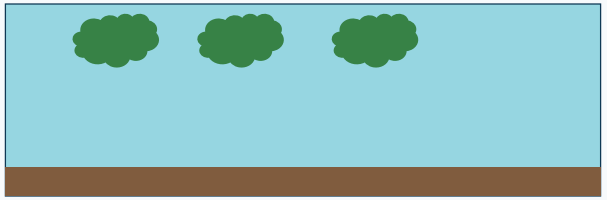
- Use plankton plus supplementary feed.
- Rice bran, oil cakes or commercial feed can be used.
- Avoid excess feeding because it pollutes water.

# Stocking Density, Waste Control and Harvesting

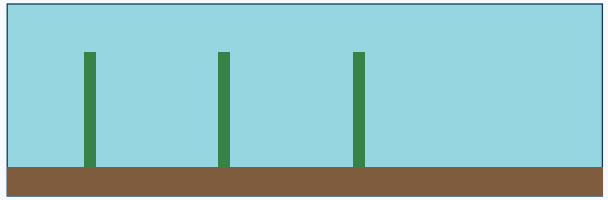
| Practice | Recommended action | Main benefit |
|---|---|---|
| Stocking density | 1000 m² pond: 2000–3000 healthy fingerlings. | Reduces stress, disease, and slow growth. |
| Waste control | Remove excess weeds, algae, debris and uneaten feed. | Improves water circulation and reduces pollution. |
| Predator/disease monitoring | Observe swimming behavior and appetite regularly. | Allows quick action before heavy mortality. |
| Harvesting | Harvest when fish reach desired market size with minimum stress. | Maintains quality and production cycle. |
| Restocking | Clean the pond and introduce new healthy fingerlings. | Continues sustainable production. |

# Aquatic Weeds: Types and Identification

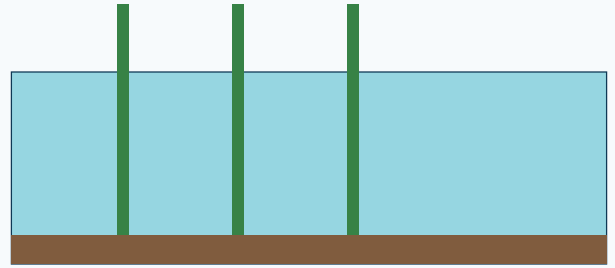
| Weed type | Where it grows | Examples | Major problem |
|---|---|---|---|
| Free-floating | Float freely on surface; roots not anchored | Water hyacinth, water lettuce, duckweed | Dense mat blocks sunlight and oxygen exchange |
| Submerged | Grow underwater; rooted or floating | Hydrilla, watermilfoil, elodea | Blocks fish movement and reduces clarity |
| Emergent | Rooted below; leaves/stems above water | Cattails, reeds, water lilies | Forms dense shoreline stands and reduces depth |



Free-floating



Submerged



Emergent

# Aquatic Weed Control Methods

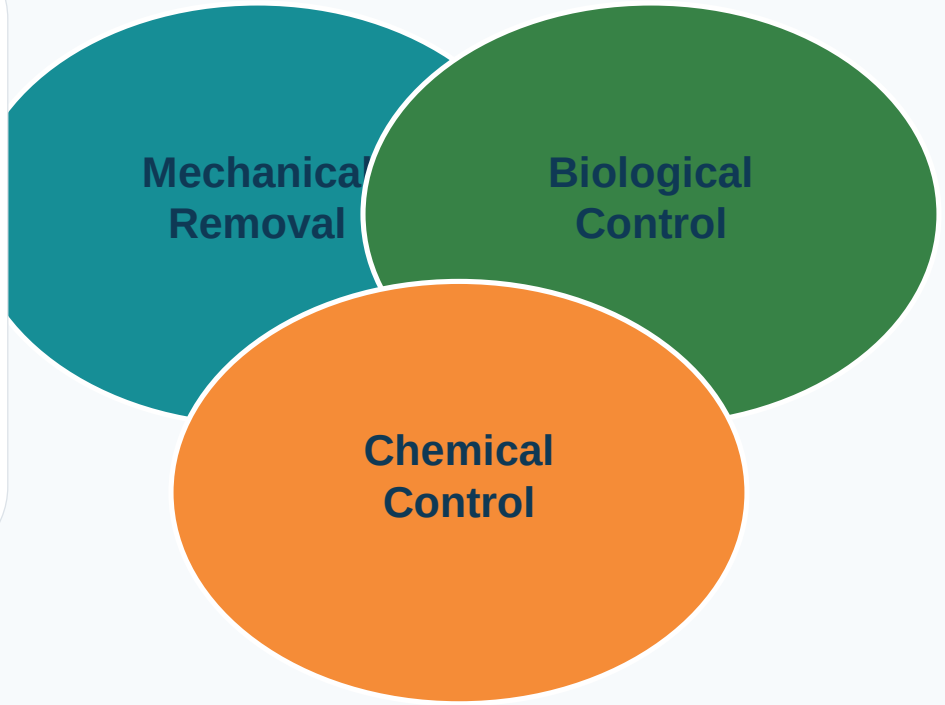
| Method | How it works | Suitable examples | Caution / note |
|---|---|---|---|
| Mechanical | Manual removal, rakes, nets, weed cutters or harvesters | Small free-floating infestations; submerged weeds | Labor intensive; remove weeds from pond bank |
| Biological | Use natural enemies such as grass carp, tilapia, or specific insects | Selected aquatic plants; water hyacinth weevil | Check ecological compatibility before introducing species |
| Chemical | Use aquatic herbicides such as fluridone, endothall or diquat | Submerged and free-floating weeds | Use only aquatic-approved herbicides; follow label strictly |
| IWM | Combine mechanical + biological + chemical methods | Most sustainable weed management approach | Choose method based on weed type and pond condition |

**Integrated Weed Management (IWM)**
No single method is best for all ponds. A combined, planned approach gives safer and more sustainable control.

# Integrated Weed Management: Concept Diagram

### IWM Decision Steps

1. Identify weed type
2. Estimate infestation level
3. Choose safe method combination
4. Monitor regrowth and water quality




### Final aim

Effective weed control with minimum environmental harm and healthy pond ecosystem.

# Fish Predators in Pond Aquaculture

### Birds
Kingfishers, herons, egrets, cormorants

### Mammals
Otters, raccoons, stray dogs

### Reptiles
Snakes, turtles, crocodiles

### Amphibians
Frogs and toads

### Fish
Large carnivorous fish such as Bhoti and Mungri

### Insects
Dragonfly larvae, diving beetles and aquatic pests

### Main impact
Predators consume fry and fingerlings, damage pond structures, compete for resources, and may introduce disease or parasites.

# Predators and Control Methods

| Predator group | Damage caused | Control methods |
|---|---|---|
| Birds | Attack fingerlings and small fish | Bird netting, scarecrows, reflective tapes, remove perching sites |
| Mammals | Eat fish and damage pond infrastructure | Sturdy fencing, humane trapping, remove hiding spots |
| Reptiles | Prey on small fish and eggs | Physical barriers, traps, remove hiding places |
| Amphibians | Eat fish fry and small fish | Periodic pond drying, habitat modification |
| Predatory fish | Eat cultured fish; compete for food and space | Selective fishing and removal before stocking |
| Insects | Attack fish fry and eggs | Reduce aquatic vegetation; introduce compatible predator-eating fish |

# Practical Checklist for Students

## Before stocking

- ☐ Clayey soil selected
- ☐ Reliable water source available
- ☐ 6–8 hours sunlight
- ☐ Rectangular/square design
- ☐ Depth 1.5–2 m
- ☐ Dikes strong and grass-covered
- ☐ Inlet/outlet with screens

## During management

- ☐ pH checked: 6.5–8
- ☐ Aeration available if needed
- ☐ Feed given in small doses
- ☐ Stocking density followed
- ☐ Weeds removed regularly
- ☐ Predators controlled
- ☐ Harvest and restock plan ready

# Revision Questions

1. Why is clayey soil better than sandy soil for fish pond construction?

2. What is the ideal depth of a carp pond?

3. Why are screens needed in inlet and outlet pipes?

4. List three types of aquatic weeds with one example each.

5. How can farmers reduce bird predation in fish ponds?

6. What is Integrated Weed Management?

7. Why is overstocking harmful in fish ponds?

# Project Work / Classroom Activity

### Project 1: Fish pond design

Design a small-scale fish pond for a school backyard or suitable local place. Include size, depth, water source, inlet, outlet, drainage and dike plan.

### Project 2: Aquatic weed survey

Observe common aquatic weeds in your local area. Collect photos or sketches, identify weed type, and present possible control methods.

| Assessment point | Marks idea |
|---|---|
| Correct pond layout and labels | 5 |
| Use of recommended size/depth/drainage concept | 5 |
| Weed/predator identification accuracy | 5 |
| Presentation with photos/drawings | 5 |

# Summary

### Construction

A good pond starts with site selection, design, preparation, excavation, lining, dikes, water control, filling and stocking.

### Management

Healthy production depends on water quality, feed, stocking density, waste control, disease monitoring and proper harvesting.

### Weeds & predators

Aquatic weeds and predators reduce productivity; use integrated, safe and practical control methods.

## Thank You

Unit 5

# Fish Culture System

Monoculture • Polyculture • Common Fish Diseases

Teaching PPT with diagrams and comparison tables

# Learning objectives

**By the end of the lesson, students can:**

- Define monoculture and polyculture
- Compare Tilapia, Pangasius, Common carp and Mangur
- Explain benefits and risks of each culture system
- Identify common signs of fish diseases
- Classify infectious and non-infectious diseases
- Suggest basic prevention and control practices

**Core idea: fish culture system choice affects growth, disease risk, feed cost and water quality.**

# Fish culture systems at a glance

Concept map

## Fish Culture System

### Monoculture

One fish species cultured in one pond, tank or cage.
Example: only tilapia / only pangasius.

### Main management focus

Species-specific feed, water quality and disease control.

### Polyculture

Two or more compatible fish species raised together.
Example: species with different feeding zones.

### Main management focus

Compatibility, balanced stocking, feeding zones and harvest schedule.

### Decision factors

Market demand • Water quality • Feed cost • Disease risk • Available skills

# Monoculture: meaning, advantages and risks

## Monoculture = cultivating only one fish species in a pond/cage/tank.

### Advantages

- Easy feeding, monitoring and harvesting
- Uniform fish size for market
- Species-specific management
- Disease can be limited to one species
- Farmer develops expertise in one fish

### Disadvantages

- Disease spreads fast at high density
- All fish have similar oxygen/water needs
- Risk from price and demand fluctuation
- May disturb pond ecology and reduce biodiversity
- Requires careful stocking and water monitoring

**Teaching point: monoculture is simple, but stocking density and water quality must be controlled carefully.**

# Monoculture species comparison



| Species | Scientific/common identity | Feeding habit | Key advantage | Main risk |
|---|---|---|---|---|
| Tilapia | Nile tilapia<br>Oreochromis niloticus | Omnivorous; uses plant and animal-based feeds | Fast growth; disease tolerance; adaptable diet | Pollution if waste is unmanaged; invasive risk if escaped |
| Pangasius | Striped catfish / Tra fish<br>Pangasius hypophthalmus | Omnivorous; good feed conversion | Fast growth to 1–1.5 kg within a year; tolerates low oxygen | Disease and pollution risk in dense culture |
| Common carp | Cyprinus carpio; bottom-feeding cyprinid | Omnivorous bottom feeder; plants, invertebrates, detritus | Hardy; tolerates varied water conditions; fast growth | Stirs sediment, increases turbidity; ecological competition |
| Mangur | African catfish<br>Clarias gariepinus | Omnivorous; plant and animal feeds | Very hardy; low oxygen and high temperature tolerance | Cannibalism; invasive potential; off-flavour risk |

**Remember: feeding habit helps decide pond zone use, feed formulation and species compatibility.**

# Species notes: Tilapia and Pangasius



## Tilapia

- Second most widely farmed fish globally
- Nile tilapia is popular in aquaculture
- Quick growth and marketable size
- Omnivorous: plant + animal diets
- Nutrients: vitamin B12, selenium, phosphorus
- Watch: omega-6:omega-3 ratio, escapes, disease in dense culture

## Pangasius

- Freshwater fish group native to Southeast Asia
- Commonly farmed species: Pangasius hypophthalmus
- Known as striped catfish or tra fish
- Mild flavour, tender texture, white boneless fillets
- Good feed conversion and low investment
- Watch: effluent, disease in dense monoculture, lower omega-3 than some fish

**Both species can grow fast, but intensive systems need good water exchange, oxygen and feed control.**

# Species notes: Common carp and Mangur



## Common carp

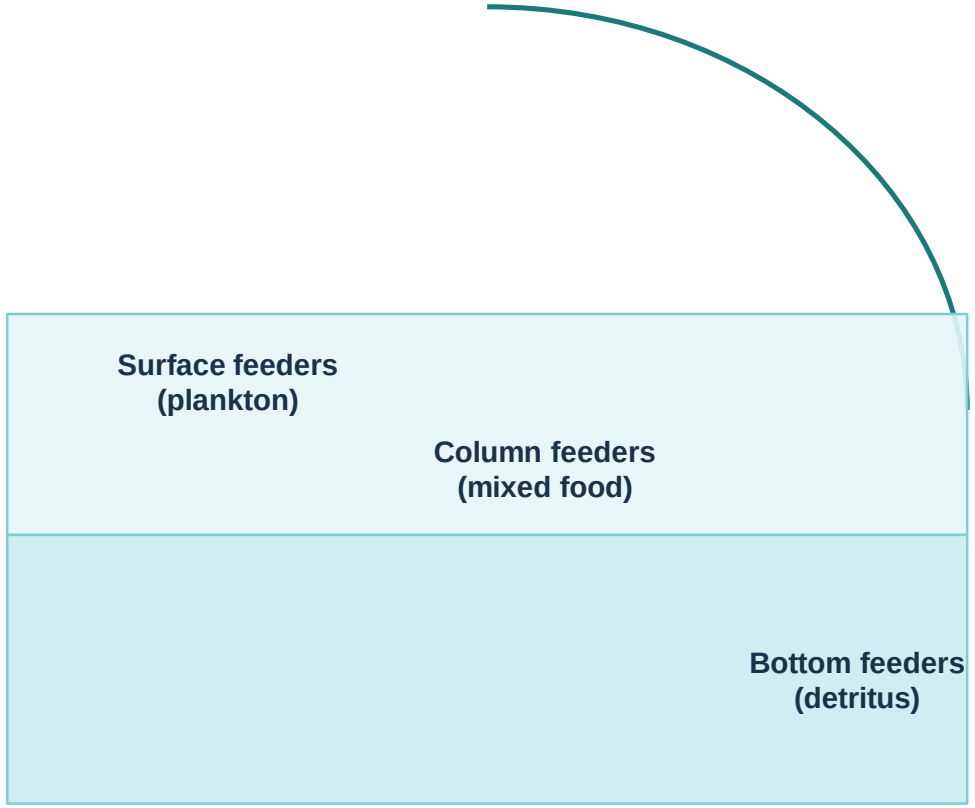
- Freshwater fish of family Cyprinidae
- Bottom-feeding fish with large scales
- Native to Europe and Asia; widely cultured globally
- Hardy, resilient and easy to handle
- Omnivorous: plants, invertebrates and detritus
- Watch: turbidity, overpopulation and competition with native fish

## Mangur / African catfish

- Scientific name: Clarias gariepinus
- Native to Africa
- Fast growth and high tolerance to water quality changes
- Can tolerate low oxygen and high temperature
- Omnivorous and efficient feed converter
- Watch: cannibalism, invasive risk, pollution and off-flavour

**Teaching clue: bottom-feeding common carp disturbs pond bottom; Mangur is hardy but must be managed securely.**

# Polyculture: concept and importance




## Why polyculture works

Different fish use different foods and pond zones. This reduces competition and improves resource use.

## Importance

- Better use of natural food
- Waste recycling improves water quality
- Higher total production
- Lower external input needs
- More balanced pond ecosystem

## Challenges

- Compatibility must be managed
- Disease diagnosis becomes complex
- Water quality needs more attention
- Different species grow at different rates
- Feeding and harvesting need planning

# Monoculture vs Polyculture

Comparison table

| Criteria | Monoculture | Polyculture |
|---|---|---|
| Species number | Single species | Two or more compatible species |
| Management | Simple and species-specific | More complex; needs compatibility knowledge |
| Resource use | Focused feed and water needs | Efficient use of pond zones and natural food |
| Disease risk | Fast spread within one species at high density | Diagnosis/control may be more complicated |
| Production | Uniform fish size and easier harvest | Higher combined yield possible |
| Market risk | High if demand/price of one species falls | Risk spread among several species |
| Ecology | May reduce pond biodiversity | Mimics natural ecosystem more closely |

**Best practice: choose system based on market, water availability, farmer skill, species behavior and disease risk.**

# Common signs of diseased fish

Observe early, act quickly

## Behaviour signs

- Restless or abnormal behavior
- Loss of balance
- Lying on side / floating
- Lethargy or reduced movement
- Rubbing or scratching on objects

## Body signs

- Discoloration
- Red or white spots
- Scale, fin, gill or skin erosion
- Mucus / slimy gray covering
- Swollen abdomen

## Feeding and breathing signs

- Reduced feeding or no feeding
- Pale/discolored gills
- Bloody, bulging or cloudy eyes
- Rapid/labored breathing
- Staying near water surface

# Fish disease classification

## Fish Diseases

### A. Infectious diseases

Caused by living organisms and can spread between fish.

Groups:
- Bacterial
- Protozoan
- Monogenean
- Digenean
- Cestode/helminth
- Crustacean parasitic
- Mycotic/fungal

### B. Non-infectious diseases

Not caused by germs and usually do not spread directly.

Main causes:
- Poor nutrition
- Protein/vitamin/mineral deficiency
- Bad water quality
- Low oxygen
- Gas supersaturation
- Sudden environmental change

# Important bacterial diseases



| Disease | Cause / common host | Key symptoms | Control focus |
|---|---|---|---|
| Columnaris (Saddle back) | Flavobacterium columnare; carps, pangasius | Gray-white saddle mark, torn fins, mouth rot, gill damage | Isolate fish; clean/aerate water; $KMnO_4$ 2 mg/L or $CuSO_4$ 0.5–1 mg/L for 1 hr |
| Aeromonas septicemia | Aeromonas hydrophila/sobria/veronii; many fish | Red sores, swollen belly, bulging eyes, weak swimming | Isolate; $KMnO_4$ 2–3 mg/L; $CuSO_4$; medicated feed oxytetracycline 50–75 mg/kg |
| Streptococcosis | Streptococcus iniae; fry/fingerlings | Pop-eye, dark body, circular/upside-down swimming, poor appetite | $KMnO_4$ 2 mg/L; oxytetracycline 75 mg/kg for 10 days; reduce stress |
| Cold water disease | Flavobacterium psychrophilum; young trout/salmon | Pale patches, frayed fins, weak swimming, weight loss | Clean water; $KMnO_4$ 2 mg/L; medicated feed; stable temperature |
| Pseudomonas infection | Pseudomonas anguilliseptica; adult trout | Red ulcers, swollen belly, frayed fins, bottom staying | Clean water; $KMnO_4$ 2–3 mg/L; oxytetracycline; avoid overcrowding |

**Treatment dose must be used carefully according to water condition and expert advice.**

# Protozoan and fluke diseases

Parasites on skin, gills and internal organs

| Disease group | Disease | Key signs | Control focus |
|---|---|---|---|
| Protozoan | White spot disease | White salt-like spots, scratching, clamped fins, breathing difficulty | Formalin 25 mg/L or malachite green 0.1 mg/L; repeat treatment |
| Protozoan | Trichodiniasis | Scratching, excess mucus, clamped fins, weak swimming | Formalin 25 mg/L or $KMnO_4$ 2 mg/L; repeat if needed |
| Protozoan | Whirling disease | Whirling swim, bent head/spine, dark tail, slow growth | Isolate; clean water; formalin or $KMnO_4$ as directed |
| Protozoan | Coccidiosis | Weakness, low feeding, swollen belly, diarrhea | Remove dead fish; clean/dry pond; formalin 25 mg/L for 30–60 min |
| Monogenean | Dactylogyrosis / gill flukes | Gasping, swollen gills, scratching, low appetite | Formalin 25 mg/L for 30–60 min; avoid overcrowding |
| Monogenean | Gyrodactylosis / body flukes | Skin irritation, excess mucus, weak swimming | Formalin 25 mg/L for 30–60 min; stress reduction |

# Worms, leeches and crustacean parasites

Visible parasites need quick action

| Disease | Causative agent | Key symptoms | Control measures |
|---|---|---|---|
| Metacercaria cysts | Diplostomum spp. | White cysts on skin/fins/gills; cloudy eyes; slow swimming | Remove infected fish; dry/clean pond; formalin 25 mg/L; prevent snails/wild fish |
| Asian tapeworm | Bothriocephalus acheilognathi | Thin body, swollen belly, weak swimming, slow growth | Praziquantel 2–10 mg/L in treatment tank; clean/dry pond |
| Piscicola infection | Fish leech<br>Piscicola geometra | Red/dark attachment spots, wounds, scratching, weakness | Remove leeches; 3% salt bath 5–10 min; $KMnO_4$ 2–3 mg/L |
| Argulosis | Fish lice<br>Argulus spp. | Scratching, red wounds, weak swimming, low appetite | Remove lice; 3% salt bath; $KMnO_4$ 2–3 mg/L |
| Lerniasis | Anchor worm<br>Lernaea cyprinacea | Worm-like parasite protruding; sores; scratching | Remove worms; $KMnO_4$ 2–3 mg/L; 2% salt bath 5–10 min if heavy |

# Fungal diseases



| Disease | Cause / season tendency | Key symptoms | Control focus |
|---|---|---|---|
| Saprolegniasis | Water molds; common in winter | White/gray cotton-like patches, damaged fins/skin, weak fish | 2–3% salt bath; malachite green 0.1–0.2 mg/L or $KMnO_4$ 2–3 mg/L |
| Branchiomycosis (Gill rot) | Branchiomyces spp.; late summer | Pale/brown rotten gills, gasping, sudden death | Clean water, strong aeration; $CuSO_4$ 0.5–1.0 mg/L or $KMnO_4$ 2–3 mg/L |
| Epizootic ulcerative syndrome (EUS / red spot) | Aphanomyces spp.; winter | Red patches, open ulcers, skin rotting, weak fish | Isolate; improve water; $KMnO_4$ 2–3 mg/L or malachite green 0.1–0.2 mg/L |
| Aspergillosis | Aspergillus spp.; Feb–Mar | Black/green/gray mold patches, breathing issue, weight loss | Clean water, aeration; malachite green or $KMnO_4$; avoid spoiled feed |

**General prevention: remove dead fish quickly, avoid overcrowding, clean pond bottom, and never use spoiled feed.**

# Non-infectious diseases

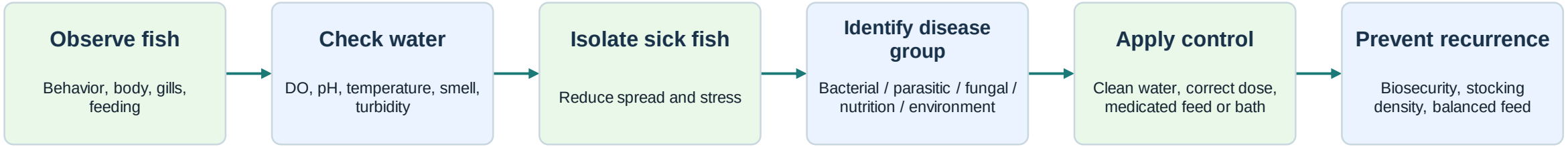


| Disease | Main cause | Symptoms | Control |
|---|---|---|---|
| Scoliosis and lordosis | Protein deficiency, especially in fry/fingerlings | Side bending or upward/downward spine curve; poor swimming; slow growth | Balanced protein-rich diet; 35–40% good quality protein; reduce stress |
| Malnutrition | Insufficient food or poor nutrient balance | Thin body, poor growth, dull color, frayed fins, low energy | Fresh balanced feed 2–3 times daily; vitamin-mineral premix 5–10 g/kg feed if needed |
| Gas bubble disease | Too many dissolved gases in water | Air bubbles under skin/fins/eyes; zigzag swimming; sudden death | Release extra gases; maintain DO 5–8 mg/L; partial water exchange; salt 2–3 g/L in emergency |
| Fish hypoxia | Low dissolved oxygen | Gasping at surface, weak swimming, poor appetite, early morning death | Aeration/splashing; DO above 5 mg/L; partial water exchange; avoid overfeeding |

**Non-infectious problems often indicate management failure: feed, oxygen, stocking density or water quality.**

# Disease prevention decision flow

Classroom diagram




## Biosecurity checklist

- Use healthy seed/fingerlings
- Quarantine new fish where possible
- Remove dead fish immediately
- Disinfect equipment and ponds/tanks
- Avoid overcrowding
- Feed fresh, balanced diet
- Maintain good water quality

## Treatment caution

- Use chemical doses accurately
- Consider water hardness for copper sulfate
- Treat in a separate tank when possible
- Do not mix chemicals without expert advice
- Observe fish during bath treatment
- Stop treatment if fish show severe stress

# Revision and class activity

## Quick MCQs

1. Culturing one fish species is called _____.
2. In polyculture, species should have different _____.
3. White cotton-like patches usually indicate _____ disease.
4. Fish gasping at surface often indicates low _____.
5. Common carp is mainly a _____ feeder.

## Short-answer practice

- Write two advantages and two disadvantages of monoculture.
- Compare feeding habits of Tilapia, Pangasius, Common carp and Mangur.
- List five common signs of diseased fish.
- Differentiate infectious and non-infectious diseases with examples.

## Project work

Survey a commercial or school fish farm. Record: species cultured together, reasons for species selection, feeding habit, stocking system, common disease signs, and preventive practices. Present with photos/drawings.

**Homework: prepare one comparison chart of monoculture vs polyculture with local examples.**

# Fish Preservation and Marketing

Harvesting • Icing • Packaging • Transportation • Live fish marketing

Grade 10 Plant Science | Industrial Entomology and Fish Culture

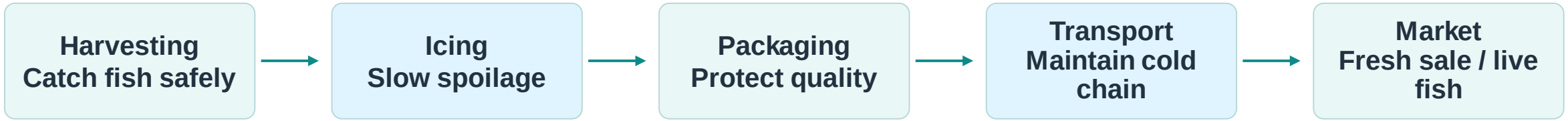
# Learning objectives

*After this lesson, students should be able to explain fish preservation and marketing steps.*

1. Differentiate active and passive fish harvesting methods.
2. Explain partial and complete harvesting in fish farms.
3. Describe the role of ice and hygiene during fish transport.
4. Compare traditional and modern fish packaging methods.
5. Identify traditional, modern, and live fish transportation systems.

# Fish preservation and marketing chain

*Quality must be protected from harvesting until the fish reaches the consumer.*




**Key idea: fish spoils quickly at room temperature. Rapid cooling, clean handling and proper packaging protect flavor, texture and safety.**

# Fish harvesting methods

*Wild-capture harvesting can be classified as passive or active.*


## Passive method

- Tools are placed in water and fish are trapped naturally
- Gillnets: fish trapped by gills
- Longlines: many baited hooks on one main line
- Traps and pots: fish enter but cannot escape

## Active method

- Fisher actively moves gear to catch fish
- Trawling: large net dragged through water
- Seining: large net encircles a school of fish
- Handlines/rods: targeted, one-by-one fishing

# Active vs passive harvesting: comparison

*Students should be able to identify the method from the gear used.*

| Aspect | Passive method | Active method |
|---|---|---|
| Main action | Wait for fish to enter gear | Move gear to capture fish |
| Common examples | Gillnets, longlines, traps, pots | Trawling, seining, handlines, rods |
| Effort | Lower active effort after placement | Higher labor/energy during catching |
| Best use | Stationary or deep-water catching | Targeting schools or selected fish areas |
| Classroom cue | “Set and wait” | “Move and catch” |

# Harvesting in fish farms

*Fish farms mainly use partial harvesting or complete harvesting.*

## Partial harvesting

- Only a portion of fish is removed
- Usually larger or mature fish are selected
- Smaller fish remain for further growth
- Useful to supply fresh fish regularly
- Tools: seine nets and cast nets

## Complete harvesting

- All fish are removed at the end of culture cycle
- Pond is drained to collect remaining fish
- Used when fish reach market size
- Commonly done using seine nets
- Pond can then be cleaned and prepared again

# Use of ice for fish transport

*Fish should be iced immediately after harvesting.*

**Recommended ratio**
**Fish : Ice = 1 : 1**

## Why icing is important

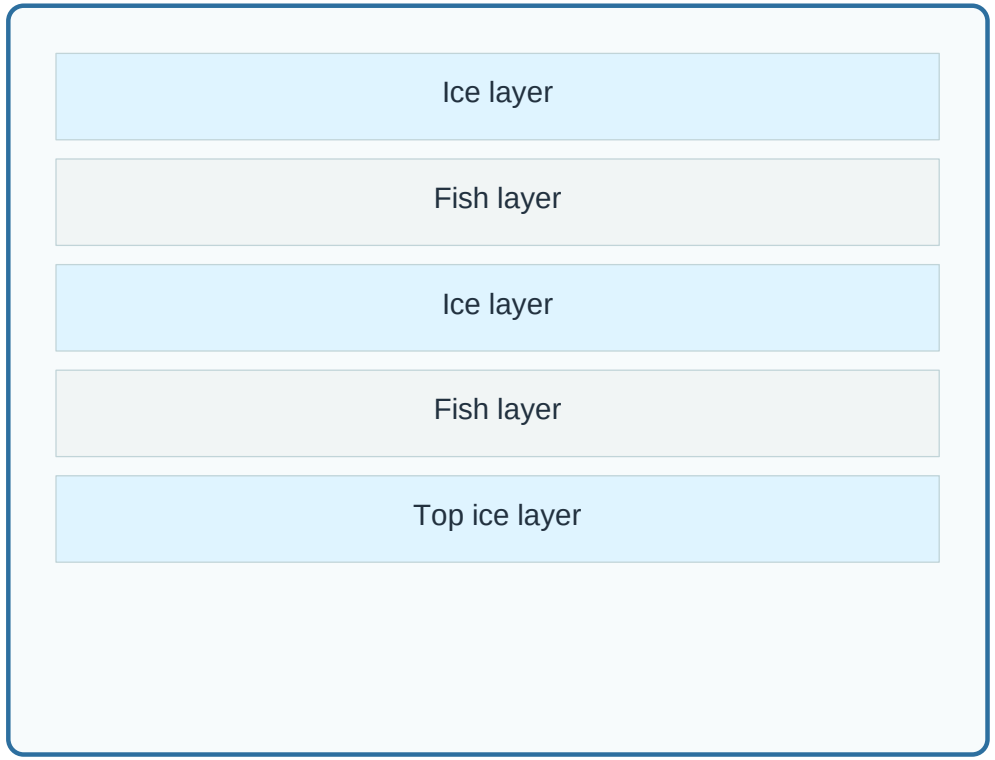
- Slows harmful microorganisms
- Maintains flavor, texture and safety
- Crushed ice gives better surface contact
- Block ice or gel packs last longer
- Insulated boxes reduce heat entry

## Freshness period

- Usually 1–2 days on ice under good conditions
- Depends on fish type, temperature and ice amount
- Fattier fish generally spoil faster
- Hygiene prevents cross-contamination

# Proper icing technique

*Layering fish with crushed ice keeps cooling uniform.*




## Handling checklist

- Use clean containers and clean utensils
- Keep fish completely surrounded by ice
- Use insulated containers such as Styrofoam or specialized plastic
- Keep meltwater drained if possible
- Transport during cooler part of the day

# Traditional fish packaging and preservation in Nepal

*Used where refrigeration is limited; simple, low-cost and locally suitable.*

## Smoking

- Moisture reduced to about 15–20%
- Paper bags, cloth bags or hanging display
- Smoke adds flavor and antimicrobial effect

## Sun-drying

- Moisture reduced to about 10–15%
- Cloth bags or woven bamboo baskets
- Requires good sunlight and air circulation

## Salt curing

- Salt about 20–30% of fish weight
- Bamboo baskets or earthenware pots
- Salt draws out moisture and inhibits bacteria

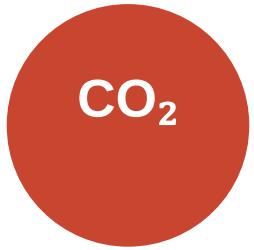
# Modern fish packaging methods

*Modern packaging extends shelf life and maintains quality during market distribution.*

| Method | Main principle | Typical shelf life / use | Important point |
|---|---|---|---|
| Ice packing | Fish packed with crushed/block ice in insulated boxes | 1–2 days near 0°C | Best for short-distance transport |
| Vacuum packaging | Air removed from durable plastic bag | 5–7 days at 0–4°C | Slows bacterial growth and prevents freezer burn |
| MAP | Air replaced by $CO_2$, $N_2$ and sometimes $O_2$ | 7–10 days at 0–4°C | Controls microbial activity and oxidation |
| Canning | Fish sealed in cans and heat sterilized | Months to years | Useful without refrigeration |

# Modified Atmosphere Packaging (MAP): gas roles

*MAP replaces normal air with selected gases to slow spoilage.*




**Inhibits growth of bacteria and molds**


**Filler gas; prevents package collapse**


**May maintain bright natural color in some products**

**Storage: refrigerated temperature 0–4°C; typical freshness 7–10 days**

# Fish transportation methods

*Nepal uses both traditional and modern approaches depending on distance, road access and market demand.*

## Traditional methods

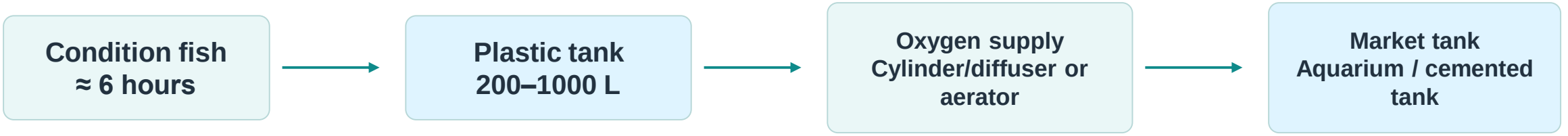
- Human porterage: baskets or bamboo containers on foot/bicycle
- Animal transport: donkeys, mules or yaks in rough terrain
- River transport: boats or rafts on rivers and streams

## Modern methods

- Refrigerated trucks for long road transport
- Ice packaging for short-distance transport
- Air transport for long distance or international delivery
- Refrigerated shipping containers for large global transport

# Live fish transportation in Nepal

*Live fish markets are growing in urban areas because consumers value freshness.*




## Capacity and care

- Vehicle tanks may hold up to about 75 kg fish
- Water circulation pumps and aeration devices support fish health
- Careful handling reduces stress and injury
- Best suited for urban markets where price is higher

# Live fish markets: challenges and opportunities

*This system can improve freshness but needs investment and good infrastructure.*

| Challenges | Opportunities |
| --- | --- |
| High cost of tanks, aerators and oxygen systems | Consumers can choose live fish and pay higher prices |
| Poor roads and unreliable transport increase stress | Better freshness and quality build consumer trust |
| Less feasible in rural markets unless volume is high | Supports farmers with improved market value |
| Requires careful conditioning and oxygen management | Contributes to food security and aquaculture growth |

# Quality and safety rules from harvest to market

*Preservation is not only cooling; hygiene and handling are equally important.*

| | |
|---|---|
| **Cool quickly** | Place fish on ice immediately after harvest |
| **Keep clean** | Use clean containers, utensils and hands |
| **Avoid damage** | Handle gently to maintain appearance and texture |
| **Prevent contamination** | Separate dirty water, waste and spoiled fish |
| **Maintain cold chain** | Use insulated containers or refrigerated vehicles |

# Lesson summary

*Use these points for quick board revision.*

## Key points

- Fish harvesting can be passive, active, partial or complete.
- Ice slows spoilage; the ideal fish:ice ratio is commonly 1:1.
- Traditional preservation includes smoking, sun-drying and salt curing.
- Modern packaging includes ice packing, vacuum packaging, MAP and canning.
- Live fish transport requires conditioning, oxygenation and clean tanks.

# Revision questions

*Use for oral practice or quick written test.*

1. What is the difference between active and passive fish harvesting?

2. Why should harvested fish be placed on ice immediately?

3. What is the difference between partial and complete harvesting?

4. Name two traditional and two modern fish packaging methods.

5. What equipment is needed for live fish transportation?

# Project work

*Students can connect classroom learning with local fish markets and ponds.*

## Project 1: Transport model

- Design a simple method to transport fish from a local pond to market
- Use household materials such as bucket, bottle, cardboard or foam box
- Label parts: fish container, ice layer, drainage, lid, carrying support

## Project 2: Community survey

- Ask fish sellers or farmers how they transport fish
- Record traditional and modern methods used in your area
- Present findings with pictures, drawings or a short report