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Ministry of Labor and Skills

Animal Health

Level-III

Based on March 2022, Version 4 Occupational standard



Module Title: - Identifying and Handling Pests, Predators and Diseases of Honey Bee Colony

LG Code: AGR ANH3 M07LO (1-3) LG (21-23)

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Introduction to the Module

This module specifies the knowledge to understand biology and behavior of honey bee, skills and attitude required to inspect a honey bee colony for indicators of disease or evidence of pests, and take appropriate follow-up action. It also comprises trainees' ability to prevent and control diseases and pests of honey bee colony.

LG #21	LO #1- Understand biology and behavior of honey bee

Instruction sheet 1

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Biology of honey bee
- Developmental stage and work duties in honey bee colony
- Caste system of honey bee colony
- Feeding and communication behavior in society of honey bee
- Characteristics of honey bee races in Ethiopia

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Describe basic information on biology of honey bee
- Mention developmental stage and work duties
- Discuss caste system (social status) in the honey bee colony
- Discuss feeding and communication behaviour in society of honey bee
- Describe characteristics of common Honey bee races in Ethiopia

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below and try to understand what are being discussed. Ask your teacher for assistance if you have hard time understanding them.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 1

Introduction

Honey bees are a fascinating model organism with a complex mating and inheritance system, highly evolved social behavior, dance communication language, and mutualistic interaction and evolution with flowering plants. Honey bees, along with wasps and ants, live in highly structured colonies where the inhabitants are, in the case of Honey Bees, all sisters and brothers, from a single queen bee. Within the colony, the inhabitants have changing roles throughout their lifetime and the generations usually overlap. This is known as eusocial behavior which enables the colony to survive and adapt as a complete functioning and highly complex unit or organism which is controlled by combinations of sound, vibrations, smells and touching.

Their natural nest is usually in a hollow such as a rotting tree or a house roof. Within it are combs hanging vertically made from thin wax secreted by the worker bees from glands between the abdominal sections. This is formed into hexagonal cells by the bees and is used to raise brood and store pollen and honey. The nest is lined and any cracks are sealed with a sticky substance called propolis made from tree resin, honey and bees wax. This not only seals the nest against rain and draughts but is anti fungal, anti bacterial and some types are antiviral, and is used to disinfect the nest cavity. One commonly known fact about bees is that they are one of the best pollinators of plants. This is done when they are bringing in the pollen for food.

1.1 Biology of honey bee

Honey bees undergo complete metamorphosis (holometabolism) and develop through four life stages, egg, larva, pupa, and adult. Several thousand worker bees cooperate in nest building, food collection, and brood rearing. Some of the major biological features that beekeepers need to understand are: basic bee nest ecology, the bee caste system, bee anatomy, the development of bee brood, worker bee sequence of duties, caste brood rearing/adult population seasonality, communication as a “key” to maintaining the social cohesion of the colony, queen and colony reproduction/replacement, and how to read/understand bee behavior.

1.2 Developmental stage and work duties in honey bee colony

1.2.1. Life cycle of honey bee

The life cycle of honeybees consists of four stages: eggs, larva, pupa and adult. This entire process varies lengthwise amongst the different honey bees. For all three forms of honeybees, eggs hatch in three days and then develop into larvae that are known as grubs. All grubs are fed royal jelly at first, but only the future queens are continued on the diet. When fully grown, the grubs transform into pupae. Queens emerge in 16 days, workers in about 21 days (on average), and drones in 24 days. After emerging, the queens fight among themselves until only one remains in the hive. The old queen and the majority of her workers typically have left the hive by the time the new queens emerge. The swarm, which typically reproduces during swarming, may form two or more new colonies at different nesting sites.

- **The phases of a bee's development**

Honey bees take different amounts of time to develop from an egg to adult bee, depending on their caste. The total development time is 16 days for queens, 21 days for worker bees, and 24 days for drones. The honey bee is a complex creature that develops from egg to fully-functioning adult within a few weeks. That's an impressive feat. The time it takes to develop, along with the bee's life expectancy, will depend on whether it's a drone, worker, or queen. Queens develop the quickest but can expect to live the longest so long as it performs for the hive.

- ✓ **Phase 1: Egg: -** A queen bee can lay up to 3,000 eggs in a single day. Most of those will be fertilized to produce a worker bee, while the unfertilized will result in a drone. To produce a queen bee, she lays an egg in a queen cell. A single egg that is the size of one grain of rice is laid in one of the hive's hexagonal beeswax egg cells. While the egg lies upright for the first couple of days, by the third day it will fall to its side. After three days, a honey bee egg will hatch to reveal a larva.



Figure 1.1:-Phase 1of bee development,

- ✓ **Phase 2: Larva: -** After three days of incubating, the egg hatches to reveal a larva. This small white grub has no sight or legs at this point. To sustain the larvae, young nurse bees feed them royal jelly for the first 3-4 days. After that, the feeding regime changes depending on their caste.
  - Queens are fed royal jelly which is what enables them to become a queen.
  - Female workers are fed worker jelly containing less protein.
  - Male drones are fed drone jelly containing less protein.

Bees spend different amounts of time in the larva phase depending on their caste. Queens spend the least amount of time as larva while drones take the longest to progress through this stage. A larva will shed its skin (molt) several times as it grows.



Figure 1.2:- Phase 2of bee development

- ✓ **Phase 3: Pupa: -** Throughout the pupa phase, the future bee is starting to take shape under the capping. It is still a tiny organism but is growing fast and developing wings, antennae, legs, and eyes. Tiny hairs will start to sprout up over its body. You can learn more about the parts of a bee here. The queen takes the least amount of time to develop through the pupa stage. Within 8 days she'll be ready to chew her way out of the queen cell and begin her life. Workers take 4 days longer to develop, while drones are the slowest to emerge, taking over 2 weeks.

Table 1.1 Duration of each cast of honeybee colony to be pupa

Bee Caste	Days spent as a pupa
Queen	8 days
Worker	12 days
Drone	14½ days



Figure 1.3:- Phase 3 of bee development

- ✓ **Phase 4: Adult: -** Now that the honey bee has reached adulthood, it will immediately go about its duties as part of the colony. Unlike humans, bees don't require nurturing in infancy. They are ready to go from the moment they leave the cell.

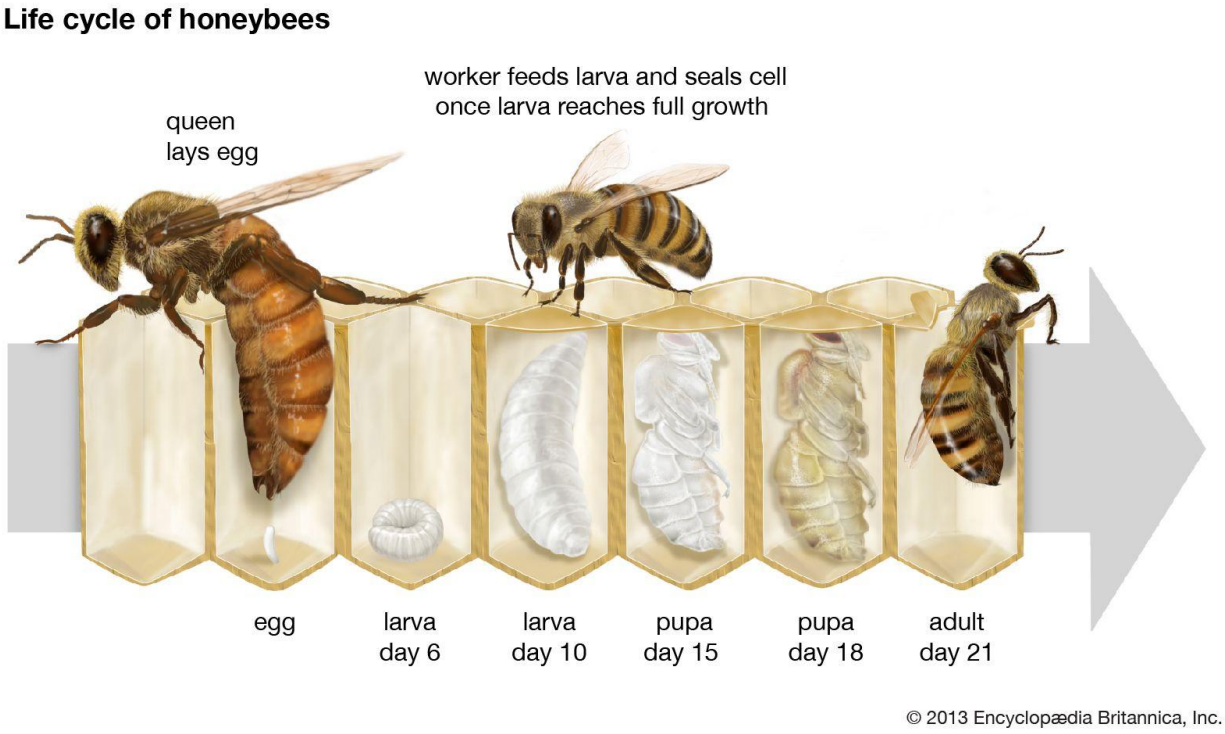


Figure 1.4:-complete lifecycle of honeybee.

1.2.2. Work duties of bee colony

- **Duties of the Queen bee**

Since the queen bee is the only female in the hive with fully developed ovaries, she plays two key roles within the hive: to lay eggs and to regulate the colony through the use of chemical scents, called pheromones. Throughout her life in the hive (which is 2-3 years, on average), the queen will give off this pheromone scent to the workers that signals the current health of the queen this scent helps the worker bees understand if the colony needs a new queen, or if duties can continue on as normal.

The queen is like the goddess: her life is committed to selfless service by being the reproductive center of the hive. She lays all the eggs (about 1,500 per day!) and only leaves the hive once in her life in order to mate. Becoming the queen bee is a matter of luck. Queens become queens only because as eggs they had the good fortune of being laid in cells specifically designated for raising queens. Then, they are fed more “royal jelly” (which contains more honey and pollen than the “larval jelly” that is eaten by workers and drones), allowing them to grow larger than

other female bees. Without a queen, life in the hive grows chaotic. The queen controls the population of the hive, laying fertilized female eggs or unfertilized male ones.

- **Duties of the drone bee**

Drones are male bees and their sole purpose is to mate with the queen: they don't work, don't make honey and can't sting. Since a queen only needs to mate once, most of the drones won't even get the chance to fulfill their role.

- **Duties of the worker bees**

The duties of the workers varies with their age and the requirements of the colony for, example, in the event of a sudden honey flow or increase of nectar production from the flowers, bees that are usually not considered old enough will be called upon to leave the colony to go out foraging. These duties are flexible and overlap so that one bee may do several jobs in the same period of its life. Likewise the bees that leave in a swarm are generally the older ones but can revert to wax production to establish a new colony which is usually a juvenile bee's work. This may also happen within the colony if there is a sudden requirement for new comb for storing honey in a honey flow.

The following are not exhaustive and is a generalization of the tasks undertaken by the worker bees over their lifetimes.

- ✓ **Housekeeping – Days 1-3:-** Cleaning out and polishing cells from which young bees have recently hatched ready for the queen to lay eggs in.
- ✓ **Undertakers – Days 3-16:-** During this time they remove dead bees and brood swiftly away from the colony to maintain hygiene standards and prevent the spread of disease.
- ✓ **Nursery bees – Days 4-12:-** Feeding the larvae with royal jelly.
- ✓ **Queen's attendants - Days 7-12:-** As the queen cannot feed herself properly the workers feed her royal jelly which also maintains her ability to continue laying eggs. At this time they also groom her which passes the queen's pheromone around the colony, which helps regulate the bee's behavior of the colony.
- ✓ **Storing Pollen and nectar -Days 12–18:-** During this period the workers collect nectar and honey from the foragers at the nest entrance area, which they place

into designated cells. The pollen is stored with nectar and ferments into bee bread by enzyme action from their saliva and is later made into royal jelly. The nectar is stored and fanned by the bees to evaporate the water from it and this accompanied by enzyme action produces honey. Both are the food for the colony.

- ✓ **Ventilating the nest Days -12–18:-** Bees use their wings to regulate the temperature and humidity of the colony. This is especially important in very hot and cooler weather. It is very important to keep the brood area temperature controlled to between 32oc and 35oc degrees at all times
- ✓ **Wax production – Days 12-35:-** After 12 days the wax glands which are between the abdominal plates on the underside of the bees become mature. This wax is then used to build comb and to cap the cells containing brood and honey.
- ✓ **Guard bees – Days 18-21:-** These bees remain at the entrance and check all of the returning bees for the familiar home scent. If they bees do not have this scent they are not allowed to pass.
- ✓ **Foraging – Days 22 till death: -** At his point the bees leave the nest. They will circle the nest to orient themselves until they are satisfied they will find their way back and then leave on their journeys. Over the next few weeks, until they work themselves to death, they will be out bringing home pollen, nectar, water and resin for propolis.
- ✓ **Scout bees – Days 22 till death: -** While the bees are foraging some will take on the role of scout bees. They will look for sources of food and propolis, and will return to the colony to communicate the location of these by performing the waggle dance. The other foragers will then follow the route given to the food source. Another job undertaken by scout bees is to notify of a new nest location when the bees swarm.

1.3 Caste system of honey bee colony

There are two honeybee sexes, male and female, and two female castes. The two female castes are known as workers, which are females that do not attain sexual maturity, and queens, females that are larger than the workers. The males, or drones, are larger than the workers and are present only in early summer. The workers and queens have stingers, whereas the drones are stingless.

Queen honeybees store sperm in a structure known as the sperm theca, which allows them to control the fertilization of their eggs. Thus queens can lay eggs that are either unfertilized or fertilized. Unfertilized eggs develop into drones, whereas fertilized eggs develop into females, which may be either workers or virgin queens. Eggs destined to become queens are deposited in queen cells, which are vertical cells in the honeycomb that are larger than normal. After hatching, the virgin queens are fed royal jelly, a substance produced by the salivary glands of the workers. When not fed a diet consisting solely of royal jelly, virgin queens will develop into workers. During the swarming season, in the presence of a weak queen or in the absence of a queen, workers may lay unfertilized eggs, which give rise to drones. **Available at: -** Beekeeping - Honey Bee Caste - YouTube Accessed on May 19/2023.

1.4 **Feeding and communication behaviour in society of honey bee**

1.4.1. Feeding behavior of honey bee colony

The needs of a colony vary throughout the year and depend on the local climate. In certain situations, bees may need food to help the colony survive. Honey bees naturally collect two main types of food: nectar and pollen. Both are produced by flowering plants, including trees.

a) Nectar is high in sugars and is the main source of carbohydrates for the colony. Honey bees require carbohydrates for energy for example, to power their flight muscles so they can fly.

b) Pollen is the primary protein source for the colony. Just like in humans, bees need protein to grow bodies. For honey bee colonies, that means brood production. A colony with insufficient pollen will fail to grow, but a colony with insufficient nectar will die. It is therefore especially important to understand how and when to supplement nectar. Honey bees store honey in the hive for food:

- during winter
- When nectar-secreting flowers are scarce.

When nectar is in short supply or unavailable, bees draw on the honey stores in their hive. You need to frequently monitor the amount of stored honey during these times because when it has all gone the colony will starve.

Starvation can be prevented by:

- ✓ moving bees to an area where plants are yielding nectar
- ✓ feeding them white table sugar
- ✓ Feeding them syrup made with white sugar.



Figure 1.5:- Honeybee on nectar

1.4.2. Communication behavior of honey bee colony

Honey bee foraging consists of several behavioral components that include search of food, identification and memorization of food source location, carrying and storing of food, and interaction and communication. Honey bees have two primary methods of talking to one another:

a. **Movement/dancing/:-** When a honey bee has a successful foraging trip, it will return to the hive with valuable information about food sources, a safe drinking hole, or other knowledge about the surrounding area. The worker bees dance to communicate this information. The most well-known waggle dance has to do with locating food sources. When a worker bee dances for its fellow workers, it uses certain movements and angles its body in a specific pattern to tell the others where it found nectar- and pollen-rich flowers. Bee communication in the hive is amazing, considering they mostly dance in the dark. These types of dances are:-

i. Round Dance

There are two main food dances. The first, called a "round" dance, concerns nearby food sources within about 50 meters of the hive. Dancing bees will move in a series of narrow circles to let the other workers know the direction of the food. Then it turns around and walks in the opposite direction in the same circle, repeating the movement many times. The honey bee can also include a little waggle when turning around, the duration of which determines the quality of the flower patch.

ii. Waggle Dance

Honey bees perform a waggle dance in a figure-eight pattern for a food source further away from the hive. In 1940, Karl von Frisch discovered and named this special bee movement, which helps honey bees communicate the location of food and nectar.

The waggle dance involves vibrating and buzzing with its wings. The intensity of the waggle, interpreted by the bee's abdomen, indicates just how far the food source is. The honey bee also angles its body in relation to the sun to point toward the food source. Since multiple bees arrive and relay their discoveries, the hive then "votes" on the most viable site through the most number of bees joining the waggle dance and how intense it gets. The hive will only select a new hive site when the bees create a unanimous decision.

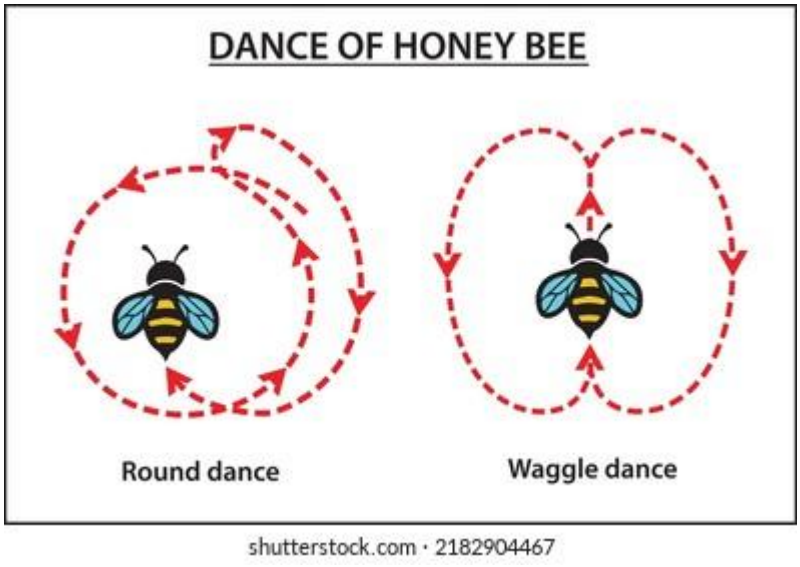


Figure 1.6 dancing type of honeybee

b. **Odor Cues (Pheromones):-** In honey bees, as in other animals, there are two types of pheromones: primer pheromones and releaser pheromones. Primer pheromones act at a

physiological level, triggering complex and long-term responses in the receiver and generating both developmental and behavioral changes. Releaser pheromones have a weaker effect, generating a simple and transitory response that influences the receiver only at the behavioral level.

1.5 Characteristics of honey bee races in Ethiopia

The honey bee Apis mellifera, a world-wide distributed species, is an insect with enormous environmental and socio-economic importance. Various hypotheses place the origin of this species is in Africa or the Middle with a subsequent diversification into lineages, subspecies, and ecotypes to cope with environmental challenges throughout most ecosystems of the world. Considering the distribution and classification of honey bee subspecies in Ethiopia, several reports exist that are partly inconsistent. There are five subspecies including A.m.scutellata, A.m.jementica, A.m.monticola, A.m.bandasii, and A.m.weyi-Gambella.

a) A.m.jementica**:-** *Apis mellifera jemenitica* is quite small and stocky of shape. The color of the abdomen of the workers shows one to three yellow rings, the yellow coloration is alternately extended. From the morphological data it partly resembles the eastern honey bee (Apis cerana). Apis mellifera jemenitica is autochthonous to a large area of the Arabian Peninsula (Saudi Arabia, Yemen and Oman) and it also occurs in vast areas of Africa in the Sahel climatic zone including Ethiopia. *A. mellifera jemenitica* is distributed in the northwest and eastern arid and semi-arid lowlands of Ethiopia.



Figure 1.7 Appearance of ***A.m.jementica***

b) *A. mellifera scutellata*: - It is the invasive "African honey bee" of the Americas and exhibits a number of traits that beekeepers consider undesirable. They swarm excessively, are prone to absconding (vacating the nest entirely), usurp other honey bee colonies, and exhibit heightened defensiveness. A. mellifera scutellata is native to eastern and southern Africa, from Ethiopia to South Africa. In Ethiopia, A. mellifera scutellata occupies the west, south and southwest humid midlands. Honey bees of Uganda represented an important biogeographical gap, defining the population structure of A. mellifera scutellata; however, morphometric analysis of worker honey bees has resolved this issue.

c) A.*m.weyi-Gambella:* - A.M.Weyi gambella races of honey bee associate in South Western part of Ethiopia. Those race have aggressive temperament that follow mean distance up to 115m away the nest and 80 stings counted on their behavior manipulators, this may due to the area is warm, humid and also reach in flora biodiversity and have highly hygienic above 90% pin-killed dead brood within 24 hours in most colonies. This make them to have resistance

to any unpleasant situation in their nest like pest's wax moth and bee beetle and parasitic Varro and have more swarming tendencies that constructs mean of four queen cell per year which allowed having population maximization.

d) *A.m.bandasii*:- *A. m. bandasii* is the most popular geographical race spread in the central highlands of the country, covering more than 90% of the highland areas. *A. m. bandasii* is a relatively fewer defensive subspecies, with less swarming and absconding tendencies. Nevertheless, a honeybee strain that performs well in one region may not perform well in another region with different conditions, as the survival and performance of honeybee colonies are strongly affected by environmental factors (apiary effects) and to a lesser degree by genotypes

a) **A.M.monticola:-** *Apis mellifera monticola* is known by the common name of the East African mountain honey bee. In 2017 its complete mitochondrial genome was sequenced, confirming that it belonged to the A Lineage of honey bees and concluding that "A phylogenetic tree showed that *A. m. monticola* clusters with other African subspecies". In 2017 DNA analysis identified differentiation between lowland (*A. mellifera scutellata*) and highland (*A. m. monticola*) honey bees, that is believed to give the *A. m. monticola* an advantage in the cooler and wetter environment of the highlands; some hybridization was observed in some hives but this appeared to be low. Their appearance is uniformly black in colour, with their wings having a darker tinge than other honey bees, with the Queens having somewhat longer legs.



Figure 1.8 A.M.monticola

Self-check 1	

Name_____ ID_____signature_____ date_____

Directions: Answer all the questions below accordingly.

Test I: write true for correct statement and false for incorrect one (1pt each)

1. _____The round dance indicates that the forager has located a profitable food source close to the hive and the round.

2. _____Understanding the biology and life cycle of a pest is the foundation for disrupting its reproduction and limiting the damage it can cause.

3. _____*Apis mellifera monticola* is known by the common name of the East African mountain honey bee.

Part II. Choose the best answers (1pt each)

1. Which one of the following dance type of honey bee is a figure-eight pattern for a food source further away from the hive?
   a) Round dance b) waggle dance c) pheromone d) none of the above
2. From the developmental stage of honeybee colony which one of the following is takes longer time to be adult?
   a) Worker bee b) drone c) queen bee d) all
3. What type of metamorphosis will carry out by honeybee?
   a) Complete metamorphosis b)

Test III: Short Answer Questions (2pts each)

1) Define the term pheromone?
2) What are the four phases of honey bee in their life cycle?
3) Write at list four type of PPE used only in honey bee keeping?
4) Enumerate five sub species of honey bee found in Ethiopia?
5) What is the importance of queen extractor?
6) Enumerate the task of worker honey bee?

Note: Satisfactory rating – 18 points **Unsatisfactory - below 18 points**

LG #22	LO #2- Asses health condition of honey bee colony

Instruction sheet 2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Selecting and checking PPE, tools and equipment to open a hive
- OHS hazards in opening hive
- Inspecting and notifying the signs of disease
- Examination and treatment pests and parasites of brood
- Signs and symptoms of disease and pests of adult honey bees
- Collecting and shipping samples of honey bee to laboratory

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select and check suitable PPE according to the organizational regulation.
- Select and check tools and equipment required to open a hive according to the organizational guideline.
- Identify OHS hazards associated with opening a hive and actions taken according to the organizational guideline.
- Inspect and notify disease signs in the brood, adults, poor or irregular flight patterns and dead or dying bees around hive entrance.
- Inspect brood for evidence of pests and parasites and, where found, appropriate action is taken and appropriate authorities are notified as required by legislation.
- Observe and inform adult bees and brood combs for signs of disease and, where notifiable disease is present, appropriate authorities as required by legislation and appropriate action is taken.
- Identify signs of disease or pest that adult bees face.
- Collect, pack and shipped appropriate samples for testing to the laboratory as per prevailing regulations and evidence is gathered to support a diagnosis according to relevant

standards and protocols. • Collect label, pack and shipped appropriate samples for testing to the laboratory according to the regional laboratory protocol; evidence is gathered to support a diagnosis according to relevant standards and protocols.
Learning Instructions:
1. Read the specific objectives of this Learning Guide. 2. Follow the instructions described below. 3. Read the information written in the information Sheets 4. Accomplish the Self-checks 5. Perform Operation Sheets 6. Do the “LAP test”

Information Sheet 2

Introduction

A healthy honey bee colony has below threshold levels of parasites, pathogens, and predators**;** no deficiency of, or out of balance, beneficial microbes; and strength and health is sustainable with a reasonable amount of management by the beekeeper to provide food, shelter, and safety as needed, as for any livestock operation. Hence, routine monitoring of colonies provides robust approaches to assess the health status of honey bees. By tracking specific colony parameters such as queen performance, colony dynamics, in hive products and the prevalence of pathogens, beekeepers can establish a health status of the colony. PPE, tools and equipments are very crucial to assess the health status of managed honeybee colonies.

2.1 Selecting and checking PPE, tools and equipment to open a hive

2.1.1 Selecting and checking Suitable PPE to open hive

Keeping the body from being stung by bees is one safe way of hive operation. Wearing comfortable protective clothing is imperative for the beekeeper. Better beekeeper offers a wide array of options in high-quality beekeeping jackets, suits, veils, helmets, gloves, and more. Before you choose, consider these five factors:

- **Past Experience:** Each hive has a unique personality some are more aggressive than others. Let the past behavior of the hive influence your choice of protective clothing.
- **Time of Year:** Bees typically display more aggression in the fall than in the spring. This is a result of heightened robbing behavior by predators, owing to the lack of forage, the aging of the bees, and the approaching winter.
- **Time of Day:** There are fewer bees in the hive at the hottest part of a sunny day. Fewer bees mean fewer opportunities for stinging.
- **Your Purpose:** Why are you going into the hive? If you're simply going in to top off feed, you may not need as much protective clothing as you would to perform a sugar roll varroa test.

- **Your Comfort Level:** Wear the protective beekeeping clothing and gear that makes you feel most comfortable.

Some people may be allergic to bee venom, some cannot tolerate the irritation of the bee venom and to this effect using protective tools would help to properly under take the hive operation or the business. Personal Protective Equipment include: Bee-proof overalls and gloves, Steel capped boots/shoes, a bee hat with broad brim, and Bee veils Sunscreen lotion. The bee veil is used to protect the neck and face parts. The veil fits over the hat and extends away from the skin of the face. This provides modest protection and air ventilation around the neck and head. Hand gloves are used to cover the active working parts of the arms and fingers, the overall (beekeeper suit) helps to protect the entire body part from shoulder to base foot, and the high laced steel capped boots prevent the bees from stinging our ankles (quite painful) and protect our feet from accidents.

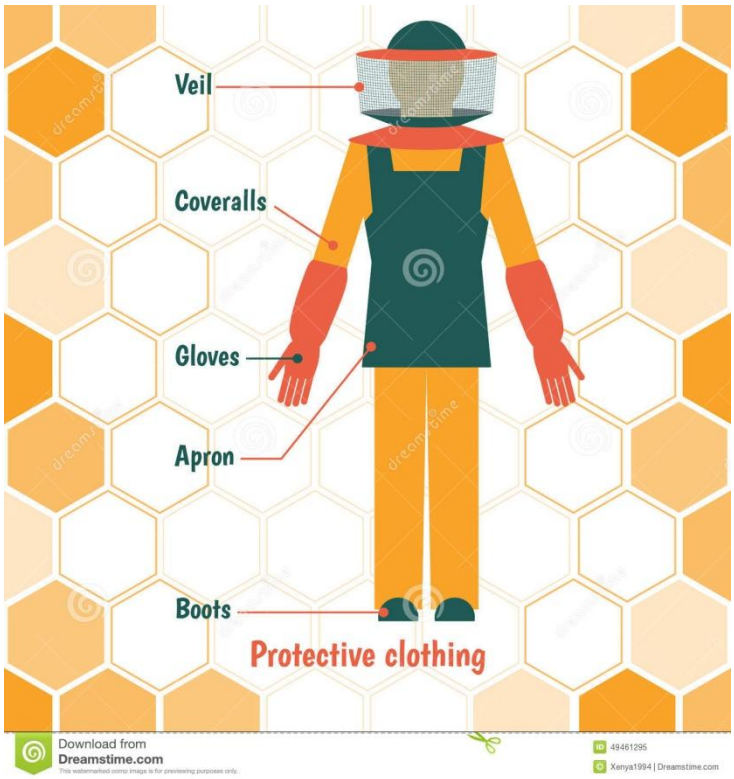


Figure 2.1:-Full PPE for beekeeper

Among those personal protective equipments few number of PPE used in beekeeping are described below.

Gloves

Your hands are the most exposed parts of your body. To keep them bite-free, a pair of gloves should be a beginner beekeeper's best friend. Any gloves would work as long as they reach the elbows. The sturdier the material, such as leather, is better. If you're using gloves shorter than the elbows, use duct tape to avoid bees flying inside.

Shoes

If you don't have a good pair of high boots at home, it might be time to invest in some. Bees are able to sting through thin fabric, so thick rubber boots are preferable.

Veil and Suit

Beekeeping safety involves avoiding stings. Getting stung on the face or scalp can be extremely painful. Like many insects, they also tend to love small cozy openings such as the nose and ears. Bees are able to sense carbon dioxide, which is emitted when we breathe. Originally used to protect themselves against bears, bees tend to become quite aggressive as they detect CO2 exhalations. When you're getting started, you'll likely be nervous. Bees can feel heavy breathing and you'll be more likely to be stung. This is the reason why you'll find experienced beekeepers handling their beehives without gloves and not getting stung.

2.1.2 Selecting and checking tools and equipment to open a hive

Hive tools are indispensable pieces of equipment that every beekeeper needs. Any physical item that is used to achieve a goal but is not consumed during the process can be defined as a tool. Beekeeping is an important part of the agricultural industry, and it's important to have the right kind of tools to make it successful. Whereas the idea of equipment represents all sorts of machinery, functional devices or accessories which serve an individual, household or a community purpose. Usually, a set of tools that are designated for a specific task is known as equipment. **Available at**:-Beekeeping Equipment's | Apiculture Tools | Beekeeping Tools and Equipment - YouTube accessed on: - May 19/2023

Here are tools and equipment used to beekeeping operation:

- Bee blower
- Bee smoker
- Brush
- Buckets and wheel barrow
- Detergent

- Glass slides, jars or cages for adult bee samples
- Geographic Positioning System (GPS)
- Compass and detailed locality maps
- Hive tool
- Hives
- Loading and unloading equipment
- Queen excluder
- Vehicle

- **Beehives: -** There are three types of bee hives namely traditional, transitional and frame hives.

Traditional beehive: - Traditional hives do not need special skills to build them, have low starting costs and are often made of simple, locally available materials. On the other hand, they have also disadvantages: the bee management is difficult (inspecting, harvesting, disease prophylaxis, adding supplementary food) and these hives are more susceptible against external environmental stress (climate conditions, pests and predators) and the yield of honey bee products is often lower compared to modern types and some hive types are even destructive to the surrounding forests (e.g. bark hives, log hives).

Modern bee hive: - Modern hives are the most common hives used by beekeepers today. They are also called Langstroth hives, named after the beekeeper who invented them in 1852. They consist of a series of stacked boxes, each with its own frames. The frames hold the beeswax comb, which the bees use to store honey and pollen. The modern hives have many advantages over traditional hives such as better ventilation and easier access to honey. Among modern bee hives types the most well know are:-

- ✓ Langstroth Hive
- ✓ Top Bar Hive
- ✓ Warré Hive

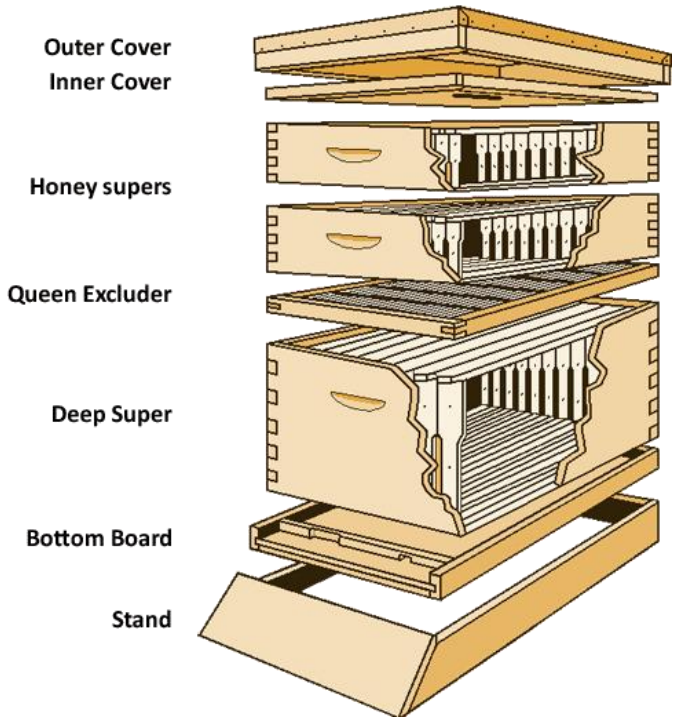


Figure 2.2:- 3D images of Langstroth Hive modern hive with its parts



Figure 2.3: Type of beehive

- **Queen excluder:** - A queen excluder is a barrier with holes made of metal or plastic that acts as a separator between the worker bees and the queen bee. This excluder prevents the queen bee from leaving the brood box while keeping the worker bees in the honey supers. This is done in order to prevent the queen bee from laying eggs in the honey super and to keep the honeycombs cleaner.



Figure 2.4 queen excluder

- **Bee Brush: -** It is made out of soft sisal thread so as to push away worker bees safely during hive operation. It is most useful to get away bees from the working areas of operation.



Figure 2.5 bee brush

- **Smoker: -** Smokers are used by most beekeepers to make bees more docile and calm. It is a device that produces smoke to be smoked on bees so that they should not attack beekeepers and others. Too much smoking during honey harvest is not recommended, because honey flavor and aroma would be spoiled.



Figure 2.6 Smoker

How to use smoker to open hive available at**: -** https://youtu.be/jyCpSO5lKpk?t=110 accessed on May19/2023

- **Queens' Cage: -** It is a useful tool to keep or confine the queen bee until the necessary task is to be accomplished especially during transferring, transporting and rearing of bee colonies.



Figure 2.7 queens cage

- **Bee blower**: - an engine with attached blower used to dislodge bees from combs in a honey super by creating a high-velocity, high-volume wind. Bee bread - a mixture of collected pollen and nectar or honey, deposited in the cells of a comb to be used as food by the bees. Bee brush - a brush or whisk broom used to remove bees from combs.



Figure 2.8 honey bee blower

- **Bee Hive Chisel**

It is used to open the hive, clean frames, pick frame, remove unnecessary things, prepare combs, and foundation sheets by cutting, collect propolis, etc.



Figure 2.9 hive chisel

2.2 **OHS hazards in opening hive**

Beekeeping is one of the high risk activities in agriculture. Beekeepers are exposed to physical difficulties such as environmental conditions, stress, bee venom and smoke. As a result of these factors fatigue, distractibility, psychological disorders, injuries and/or occupational accidents may occur.

There are three main risks specific to beekeeping:

a) Bee stings
b) Burns and fire hazards from the use of our smoker
c) Injuries from lifting and moving our hive

a) Bee sting

The worker sting is a highly modified for its defensive purpose. The sting is found in the sting chamber, invisible, last segment. The entire pack of the sting is divided into two regions. When people are stung by bees, the venom causes reddish body swell. After some hours the swelling subsides.

- **Factors affecting the sting of a worker honey bee**
  - ✓ **Genetic makeup**: - some are highly aggressive Eg. Tropical bees. Some bees are highly gentle/docile/. Eg. European bees
  - ✓ **Condition of time**: - When there is scarcity of forage or less nectar flow. During this time the bees use high venom.
  - ✓ **When the colony becomes queen less** during this time they get exited
  - ✓ **Insecticide poison**, mostly organophosphate
- **Reactions of stings**

In human reactions to stings take place on three levels: Localized reaction, Systematic reaction and Anaphylactic.

- ✓ **Localized reaction: -** In the first kind of reaction the initial localized swelling is followed by more extensive swelling a few hours later and the affected area may be red, itchy and tender for 23days.
- ✓ **Systematic reaction: -** A systematic reaction generally occurs within a few minutes of stinging and it may involve a whole body rash wheezing, nausea, vomiting, and abdominal pain and fainting.
- ✓ **Anaphylactic reaction :-** In this reaction symptoms can occur within a seconds, and they include difficulty in:
  - Breathing
  - confusion
  - vomition

- Falling blood pressure that can lead to loss of consciousness and death from circulatory and respiratory collapse.

Generally, one can develop some resistance to beestings the more one is stung although the reaction to stings can become shuddery acute for no apparent reason. Those who are extremely sensitive may die from a single sting.

- **First aid for sting (Caring for People Stung by Bees)**
  - ✓ The sting should be removed with a sharp needle or by scraping it away from the side with a knife or fingernail.
  - ✓ An ice -cold compress applied after sting has been removed will relieve the pain
  - ✓ ant-histamine; In the form of (1) Ointment (2) Injection
  - ✓ Adrenaline injection In addition to these;
  - ✓ Work with bees in the late or evening.
  - ✓ Avoid working bees in rainy, windy time
  - ✓ Smoke under the frame and wait two minutes before opening
  - ✓ While moving in apiary, move slowly and quietly
  - ✓ Avoid crashing
  - ✓ Wash your protective materials (glove, bee veil, etc) after three operation time.
  - ✓ When bee stings develop in to large swelling and rash, medical advice should be sought straight away
  - ✓ Anyone who is acutely allergic to bee sting and knows that unconsciousness may our a few minutes after a sting, must immediately inform someone, so that they may be transported as soon as possible to a doctor or a hospital for emergency injection treatment. Finally, any beekeeper suffering abnormal aping side effects from bee stings should give up keeping bees.

b) Burns and fire hazards from the use of smoker

In rural area when they collect honey they use fire and water. Because they don't has safety cloth. Their method is mostly depends on the traditional method. This traditional method has a side effect on themselves and also on the environments. For instance they use a fire to leave out the bees. But while they use those fire they could be burn the forest and the different things around them. It affects human health too; in case of carbon monoxide emission that could be harms our

eye, and even up to blindness was occurring. Other risks of using fire are that: the bee could be dead and when the bee leaves their hive they could sting the human body, animals and harm them. Additionally they use a rope to tie their safety cloth to their arm, in order to protect the bees' entry in their body, and the rope they use could be harm them and they could not move freely.In order to reduce or eliminate such difficulty wearing beekeeping safety cloth that is the easiest and comfortable for both the beekeeper and the environments is mandatory.

c) Injuries from lifting and moving our hive

This type of hazard is physical hazard. It occurs by lifting heavy hives, moving from place to place, climbing tree and falling of hive.

2.3 Inspecting and notifying the signs of disease

Correct and early identification of signs of pests and diseases in the colonies is essential for both preventive and remedial care. Honeybee colonies are susceptible to a variety of diseases and parasites. These agents have been particularly devastating for honey bee colonies.

- **Hive inspection for signs of disease**

Inspections of hive for any disease honeybee colony can be done by:-

I. General inspection of bee hive

Inspection for bee diseases is an important part of beekeeping. Apiary inspectors and beekeepers must be able to recognize bee diseases and parasites and to differentiate the serious diseases from the less important ones. Among methods of improved bee handling, follow up of external and internal conditions of colonies is a major and important activity. External inspection is follow up of the external conditions of a colony. Opening of a beehive to detect the internal conditions of a colony is internal inspection. So, colony inspection can be divided into two parts namely, external inspection and internal inspection.

II. External Bee Colony Inspection

External bee colony inspection is an observation of the condition of a colony from outside without opening the beehive. In external inspection, the strength or weakness of a bee colony can be determined by observing at the entrance of a beehive to find out the number of worker bees

that move in and out. During a flowering season, by looking at the worker bees that carry pollen grain balls by their legs into the beehive, it is possible to determine whether the colony has a queen bee and eggs. If workers do not carry pollen grains into the beehive, it can be an indication of the death of a queen, dearth period causing lack of forgeable food or due to unfavorable conditions they faced inside and outside the hive. If many bees cluster at hive entrance, this could be an indicative of one of the following: the internal temperature of the beehive is higher, or the beehive is congested and the bees need more space or it is a hint that it is time to harvest honey. Inspecting the surrounding where the beehives are placed helps to find out if there are ants and other predators. If so the necessary corrective measures should be taken. Therefore, inspecting the external conditions of each bee colony before doing any internal inspection assists to discover and gather information that is helpful to internal inspection.

III. Internal inspection

It is simply inspection with in hive environment. It includes hive, tools and equipment, combs, brood, wax, adult honey bees (drone, workers and queen) for absence and presence of sign of the disease. The purpose of this inspection is to distinguish healthy colony from diseased colony.

- **Pre Inspection Preparation and Care for hive inspection: -** Depending on the type, strength and season of the year, bees are aggressive. Necessary preparations should be made and care should be taken before opening a beehive.
- **Basic requirements in hive inspection for signs of disease**
  - ✓ **Determining Time and Weather Conditions of Inspection: -** It is necessary to choose a convenient weather condition to undertake inspection. Inspection should be done at night. Beehives should be opened when it is not windy, cold or rainy.
  - ✓ **Avoid using perfumes or other cosmetics: -** Sprayed clothes on inspection days are not advisable. Body and foot odor can also irritate bees and cleanliness is necessary.
  - ✓ **Avoiding Loud Voices, Disturbances and Fast Movements: -** When someone is around bee colonies and apiary, fast movements and loud voices should be avoided. During opening and closing of beehives, when adding or removing super and frames, the movements should be very gentle; bumps and noises should be avoided. This will not only calm the colony but also minimizes accidental death of the queen and the bees.

- ✓ **Avoiding the Exposure of larvae or brood from Draft and Sunlight: -** When doing internal inspection, the larvae or brood should not be exposed to draft and sunlight.
- ✓ **Using Standard Beehive Opening Procedures: -** To do any internal inspection, the top cover should be removed. The following steps should be followed to do this.
  - Stand on the side of the beehive and blow smoke into the beehive through the bee entrance. Wait for 2-3 minutes.
  - Stand on the side or behind the beehive and use a chisel or a knife to pull up the cover.
  - Lift the cover a little and blow smoke on the sides and into the beehive and wait for 2-3 minutes. One should always stand on the side or behind the entrance to do any inspection.
  - Working in front of the entrance blocks the in and out movement of the bees and forces them to change their flying direction. If they do, this disturbs the colony and makes them aggressive.
  - Remove the cover completely and blow smoke to move the bees to the base. Turn the beehive cover up-side-down and put it away. If the inspection is on the base of a beehive, the cover should not lean on the hive. Then proceed with the inspection.

The following are some of the major areas to be focused on during internal inspection.

- ✓ Observe if the beehive is too big or too small for the colony
- ✓ Make sure that there is enough feed
- ✓ Observe whether or not the colony is ready to swarm
- ✓ Check if the colony is attacked by disease, animals or pest
- ✓ Check if it is time to install queen excluders
- ✓ Check if honey is ripened enough to be harvested, if not, determine the time for harvest. **Available at**: - How to Inspect a Honey Bee Colony, Part 6: Collecting an Adult Bee Sample - YouTube Accessed on May 19/2023.

2.4 **Examination and treatment pests and parasites of brood**

2.4.1. Pests and parasite of brood

Like all other insects, honey bees are susceptible to pests and diseases, the majority of which are specific to honey bees. These disorders can impact the health of a honey bee colony with effects ranging from minor stress to the death of the colony. Some of these disorders are quite common while others are rarely encountered. It is important for beekeepers to be aware of these disorders, learn to identify them and effectively manage disorders to maintain healthy colonies.

The following are common parasites and pests of brood:

- Varroa mites
- Acarine
- Braulacoeca
- Tropilaelaps

- **Varroa mites**

The disease is caused by parasite called *varroajacpsonii* or by *varroa destructor* and it affects both adults and broods. It is dark brown and its size is 1-1.5 ml. It is hairy, eight legged and looks like ticks and it is big enough to be visible. Although varroa is classified as parasite, if there are many parasites in the colony it is considered as a disease. It reproduces in brood cells especially in drone brood cells. It feeds by sucking fluids, hymolymph from broods, harming the brood in the process. Sometimes the brood dies or is disabled. It is the female varroa that attacks both the larvae and adult honeybee. The parasite sometimes positions itself in between the thorax and abdomen and around the head and feeds on these soft parts of the bee. Young honey bees are the most affected. Varroa has the capacity to reproduce in a short time and can cover a colony without being detected. It has the capacity to spread to healthy colonies. It weakens and damages its hosts and is considered to be a severe disease. It attacks just when the larvae cells are about to cap. When the capping are opened and observed, there are dark brown spots on the external body of the young bee brood.



Figure 2.10 Varroa mites of brood

- **Acarine (tracheal mite)**

Cause: - The parasitic mite, *Acarapis woodi.* When assessing its effects on bees, the mite, *Acarapiswoodii*, has caused much controversy. This mite inhabits the prothoracic trachea of the honey-bee – the thoracic opening nearest to the bee's head on the thorax. These openings are really air inlets that allow air to enter the bee's blood stream. The mites enter this opening a few days after the bee emerges when the hairs surrounding the opening are still soft. Bees seem to vary in their susceptibility to this mite. There are no certain field methods for determining an infestation. Dissecting the bee and a microscopic examination of the trachea is the only way. There are no visible symptoms.

Symptoms

- ✓ There is no one tell-tale sign of this disease.
- ✓ Disjointed wings or 'K-wing,' distended abdomen.
- ✓ Bees often crawling on the bottom board appearing "morbid."

Means of prevention: - Resistant stock, such as Russian.

Methods of detection

- ✓ Positive identification of tracheal mites can only be made upon microscopic observation of trachea (the breathing tubes of adult bees).
- ✓ While once common and highly problematic, most honey bees have developed a natural resistance to them and are fairly rare.

Treatment recommendation

- ✓ Verify infestation level whenever tracheal mites are suspected.
- ✓ If the percentage of infested adult workers is 10% or greater, active control is warranted. Treat colonies in the late summer or autumn.

✓ Recommended treatments:

- **Mite-a-thol®** (menthol crystals)
- **Mite-Away II®** (formic acid pads)
- **Apilife VAR®** (thymol pads) or **Apigaurd®** (thymol gel)

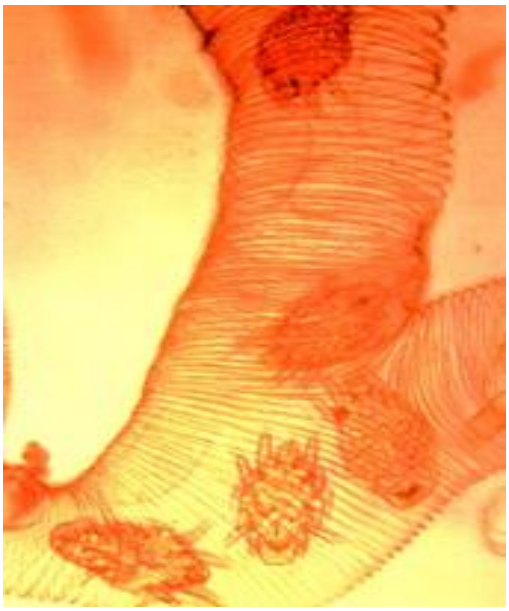


Figure 2.11 Tracheal mite

- **Tropilaelapsclarae**

This mite is similar to varroa in its effect on a colony, but it can be distinguished easily from varroa by its elongated shape, as opposed to the crab shape of varroa. *Tropilaelapsclarae* is not yet a pest in most countries outside its natural, far-eastern range but, like varroa it could spread, and beekeepers are asked to keep an eye out for this new danger. *Tropilaelapsclarae* is smaller than varroa, and it is elongated, not crab shaped. If the infestation is high, there will be an irregular, punctured brood pattern and malformed brood. The adult bees may have deformed. Similar diagnostic tests to varroa can be used to determine a *T. clarae* infestation, particularly an inspection of the capped brood.

- **Braulacoeca**

Braula fly (Braula coeca) is a small species of wingless fly that lives in honey bee colonies and looks similar to Varroa mite when viewed with the naked eye. Braula fly is not considered to be a serious threat to commercial beekeeping as it does not damage or parasitise any stage of the honey bee life cycle however it does impact on honeycomb quality and is a domestic trade pest.

Braula fly larvae damages the appearance of wax capping on honeycomb and adult Braula flies steal small amounts of food from adult honey bees.



Figure 2.12 Adult Braulacoeca

- **Parasitic mite syndrome (PMS)**

When varroa reaches high population levels in a colony the brood starts to show a range of disease symptoms known as parasitic mite syndrome (PMS). When the colony is near death most of the brood will exhibit these symptoms. Parasitic mite syndrome (PMS) is the name given to a range of abnormal brood symptoms associated with the presence of varroa in both brood and adult bees. The symptoms, which were first noticed by beekeepers and the US Department of Agriculture Bee Research Laboratory in the mid-1990s, were found in association with infections of both varroa and acarine (the tracheal mite).It is suggested that PMS could be caused by the varroa mite vectoring the acute bee paralysis virus (ABPV), and possibly other viruses, into the honey-bee larvae. PMS affects both brood and adult bees and is usually associated with colony collapse, especially in the autumn. The symptoms can appear at any time of the year, although they are more prevalent in mid-summer and autumn.



Figure 2.13:- PMS affected prepupa stretched out along the lower cell wall

- **Wax Moths**
  - ✓ **Cause: -** Larvae of the Galeria mellonella moth.
  - ✓ **Symptoms-** Large, 1.5 inch larvae tunneling through the wax combs of weak hives or stored bee equipment. Silk cocoons, typically found on the side bars or top bars of frames in infested hives or equipment.
  - ✓ **Means of prevention: -** Maintain strong colonies and inspect weak colonies often. Cycle combs through the freezer for 1-2 days before storing. Place **Paramoth® crystals** on stacks of stored combs according to the label.
  - ✓ **Methods of detection: -** Visual inspection.
  - ✓ **Treatment recommendations: -** Store unused combs with PDB crystals. **Never** place crystals on a living colony, as the fumes are highly toxic to adult bees and brood. If heavy infestations are found, freeze combs for 1-2 days before reusing.
- **Small Hive Beetle (SHB)**
  - ✓ **Cause: -** Larvae of the beetle Aethinda tumida.
  - ✓ **Symptoms**
    - Presence of adult beetles **and** eggs or larvae (presence of adults only does not necessarily indicate a problem).
    - Watery, fermenting comb with small white grubs eating the wax.

- Larvae crawling out of the front entrance of the hive and burrowing into the soil.

✓ **Means of prevention: -** There are no chemical products that deter SHB infestation. Researchers are currently working on a SHB lure, but the technology is not yet available for use by beekeepers. Beekeeping supply stores sell SHB traps that are inserted between the bottom board and brood chamber.

✓ **Methods of detection: -** Visual inspection and verification of SHB larvae. Young wax moth larvae can sometimes be mistaken for SHB larvae. The two can be distinguished since SHB larvae have dorsal spines, whereas wax moth larvae do not.

✓ **Control recommendations: -** If adults are present, tape ½ a str of **Checkmite+®** beneath a square of corrugated cardboard placed on the bottom board of the hive. The beetles often seek a refuge below the cardboard and come into contact with the pesticide. There are currently no in-hive chemical treatments for SHB larvae. In addition to the above brood diseases other brood diseases like Chilled brood and Bald brood can affect the brood of honeybee colony.

2.4.2. Bacterial viral and fungal disease of brood

- **American Foulbrood**

Cause

The spore-forming bacterium, Paenibacillus larvae.

Symptoms

✓ Brood is dull white, becoming light brown to almost black.

✓ Age of dead brood is usually older sealed larvae or young pupae.

✓ Sealed brood is discolored and sunken, often with punctured capping.

✓ Heavy infections have brittle, black scales that lie flat on the bottom of brood cells, formed from the dried remains of diseased brood. These scales contain billions of AFB spores and are highly contagious and persistent.

Means of prevention

✓ Hygienic stocks.

✓ Avoid robbing by keeping colonies strong.

✓ Minimize comb swapping between hives.

- ✓ Replace three combs in the brood chamber every year with foundation or drawn combs from honey supers.
- ✓ Disinfect bee hives or suspect frames and brood boxes at the NCDA&CS fumigation chamber using ethylene oxide.

It is not recommended to preventatively treat colonies with antibiotics, as it masks AFB symptoms (increasing the spread of the disease among hives) and resistant strains of AFB may develop.

Methods of detection

Ropy test:- Since larval remains of AFB-infected brood are elastic, a common field diagnostic is to pull the remains out of the cell with a toothpick or small twig. If the remains are elastic and "rope" out of the cell an inch or two, it is likely AFB rather than another brood disease.

Host milk test: - This is a simple procedure that can be accomplished in most beekeeping operations. Place a suspect scale or smear of a diseased larva in a glass vial containing 4 ml of 1% powdered skim milk. Place the tube in a warm place (preferably at 37 ºC). If AFB is present, the suspension should be clear in 10-20 minutes, since P. larvae spores produce proteolytic enzymes.

Other, more sophisticated tests can be performed in the laboratory.

Treatment recommendations

- ✓ Verify infestation and distinguish from other brood diseases
- ✓ Contact your regional Apiary inspector to inform them of an AFB outbreak.
- ✓ Burn all frames and euthanize bees.
- ✓ Scorch or fumigate empty brood boxes, bottom boards, inner covers, and lids.



Figure 2.14:- American Foulbrood disease

- **European Foulbrood**

Cause

- ✓ The bacterium *Melissococcus pluton* and associated flora.

Symptoms

- ✓ Brood is dull white, becoming light brown to almost black.
- ✓ Age of dead brood is usually younger, unsealed larvae.
- ✓ Consistency of remains is rubbery and granular, not elastic.

Means of prevention

EFB is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease.

Methods of detection

- ✓ Visual inspection.

Treatment recommendations

Verify infestation and distinguish from other brood diseases

For colonies with light infections, reduce the area of the brood nest, replace infected combs with foundation, and keep colony population strong. For colonies with heavy infections, use **Terramycin**® or other approved antibiotic according to the label. A veterinarian prescription is now required by the FDA in order to purchase and utilize antibiotics. Note that prophylactic use of any antibiotic is never recommended to avoid the evolution of resistance, and should only be applied as a last resort. For all cases, maintain a hive quarantine (i.e., do not exchange frames from or into the hive) and be vigilant for re-emergent signs of EFB.

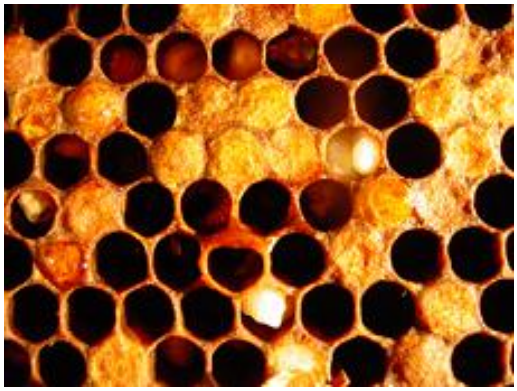


Figure 2.15: European Foulbrood

- **Chalk brood**
  - ✓ **Cause: -** The fungus, Ascophera apis.
  - ✓ **Symptoms: -** Hardened, white or black "mummies" that resemble the consistency of chalk. Mummies can be located in capped or uncapped brood cells, or they may litter the bottom board or on the ground directly outside the front entrance of a hive.
  - ✓ **Means of prevention: -** Chalk brood is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease. Chilling may also increase chalk brood, so ensure that there is an adequate adult population to keep the brood nest warm during cold weather.
  - ✓ **Methods of detection: -** Visual inspection is fairly obvious, thus the presence of mummies is usually sufficient to confirm infection.
  - ✓ **Treatment recommendations: -** There are no chemotherapies for chalk brood. Requeening may be beneficial.

- **Sac brood**
  - ✓ **Cause: -** A viral pathogen of bee larvae.
  - ✓ **Symptoms: -** Dead larvae appear watery and granular with a thick skin that forms a sac. The head of an infected larva is lifted toward the top of the cell, resembling the shape of a canoe.
  - ✓ **Means of prevention: -** Sac brood is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease.
  - ✓ **Methods of detection: -** Visual inspection.
  - ✓ **Treatment recommendations: -** There are no chemotherapies for sac brood. Requeening may be beneficial, and maintaining a strong colony often the best cure for the disease.

- **Chilled brood: -** Chilled brood is caused by chilling. Brood of all ages die because of a depletion in the number of bees looking after them. This could be caused by pesticide poisoning, insufficient bees in a hive that has been split after carrying out an artificial swarm or any other reason. Always be careful, therefore, when splitting hives or making up nucs that the brood have enough bees to look after them.

- **Bald brood: -** Bald Brood is so called because it occurs when the cell capping are removed while the larvae are still inside. This is not a disease but is the result of greater wax-moth larvae chewing through brood capping in a straight line. It is also the result of a genetic trait in some strains of bee, where small patches of brood are left uncapped. If the problem is due to wax moth, the bees remove the silk tunnels and leave the larvae bare – for some reason they fail to re-cap the cells. The capping are not always completely removed, and so there may be a slightly raised ridge at the edge. If the problem is due to the genetic trait, there are small patches of bald brood rather than straight lines

2.5 Signs and symptoms of disease and pests of adult honey bees

Honey bees often face viruses and other diseases that threaten their health and safety. Unfortunately, the close quarters and constant interaction of a honey bee hive means that diseases can spread quickly through the colony and cause serious damage. The trick to keeping your honey bees safe from such a fate knows the telltale signs and symptoms of these hazardous diseases.

- **Adult Honeybee Diseases**

a. Nosema

Cause

The protozoan, *Nosema apis* or *Nosema ceranae*. The latter has largely displaced the former over the last few decades so that *Nosema ceranae* is the most prevalent.

Symptoms

- ✓ There is no single symptom of the disease.
- ✓ Adults may have distended abdomens and defecate within the hive rather than take cleansing flights.

Means of prevention

- ✓ There is no exact means of prevention for nosema.
- ✓ Since the disease can be caused by stress, maintaining strong, healthy colonies is the best means of prevention.

b. Amoeba

Another protozoan adult honeybee disease is the amoeba. The amoeba that affects honeybee is called *Malighamoebamellificae* which forms resistant spores called cyst. A single bee can have a

half million cysts within three weeks of the initial infection. It can infect all adult honeybee casts. The bees ingest the cysts from contaminated food, water, fecal material or elsewhere in the hive. It is reproduced in the intestine. The infection cycle is similar to that of Nosema. Although there are particular symptoms of the disease, yellow dysentery, and crawling around hive entrance are the visible ones.

- ✓ **Effect on colony**: - Colony population dwindling as bees die away from the colony. The effect of heavy infestation results in reduced honey yield.
- ✓ **Symptoms**: - No good symptoms of infection, identification by analysis of bee abdomens. There is defecation in the hive, weak, crawling bees and retarded colony build up at the beginning of active season. Heavy infections may lead to dysentery.

- **Adult Honeybee Parasites**

a. Varroa Mites

Cause: - The parasitic mite, *Varroa destructor.*

Symptoms

- ✓ Presence of adult mites on adult bees, brood, or hive debris.
- ✓ Adults with shortened abdomens, misshapen wings, and deformed legs.
- ✓ Dramatic decline in adult population and brood area, with spotty brood pattern.

Means of prevention

- ✓ Mite-tolerant stocks, such as Russian, VSH, or Minnesota hygienic.
- ✓ Screened bottom boards.
- ✓ Drone-brood trapping.

Methods of detection

- ✓ Alcohol wash.
- ✓ Sugar shakes.
- ✓ Sticky board. (Qualitative only)
- ✓ Drone-brood inspection or visual inspection

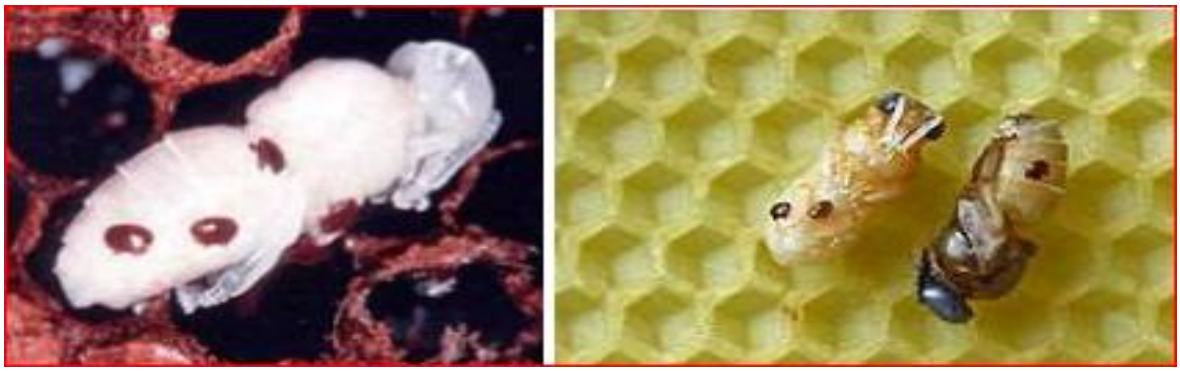


Figure 2.16:- Adult mites on pupa

b. Bee Louse

Braulacoeca, commonly known as the bee lice, is actually not a louse but a wingless fly that feeds on honey. The adults are small and reddish brown in colour. Its smaller size and reddish brown colour appearance resembles it with *Varroajacobsoni*. In general, bee louse are harmless, provided that there is only a minor infestation. However, they must be classified as pest insects because in case of sever infestation they can affect a colony.

Damages: - Under sever infestation, they reduce considerably the laying capacity of the queen and they disturb a colony.

- **Honey Bee Enemies (pests)**

The major honey bee enemies and predators of bee colonies may include certain wasps (yellow jackets), ants, wax moths, the black bear beetles, termites and birds. And last, but not least, man.

a. Ants and spider

Ants are the most prevalent enemy of honeybees in most beekeeping areas of the country, especially in moist or humid highland parts. Ants are not only the most prevalent pests but also share the greatest complaint in causing serious damages to honeybee colonies and their stores. Ants enter the hive and feed on honey, pollen and brood. Some of the ants feed on young bees. If there is a small he number of the invading ants, bees position them on the entrance of the hive facing outward, and flap their wings and drive the ants away. But the ants can outnumber and overrun the bees. This may result in colony death and those survived are induced to absconding.

However spiders are not typically considered pests of honeybees. In fact, they can even be beneficial by catching other insects that may harm the bees. However, if spider populations become too high, they could potentially create a nuisance or interfere with honeybee activity



Figure 2.17: Ants on adult honeybee

Damages they cause

Larger ants

- ✓ They kill bees
- ✓ Rob their combs contents, i.e., honey, brood and pollen which results in reduction of honey production
- ✓ Cause of aggressiveness and absconding of colonies

Small ants (kuchach)

In the areas where they are considered as a problem; they nibble and cause annoyance on the bees, and Sense of irritation on the beekeepers during hive inspections.

b. **Wax Moth:-**

The adult wax moths are grey-brown in colour. An adult wax moth resembles fire fly. There are two types of wax moth: Greater wax moth (Galleria melloella) and lesser wax moth (*Achoriagrisella*). Greater wax moth is 32 m.m. long; whereas the length of the lesser wax moth ranges from 16-20 m.m. Wax moth can reproduce only when a colony is weak. If a colony is weak, adult moth enters either through the entrance or looks for any opening into the hive. Since it lies its eggs in locations that are sealed would be difficult for bees to attack it. The eggs develop to be broods, then they seal and hatch into wax moth. Bee less hives with waxes are

major opportunities for the reproduction of wax moth. Wax moth starts the damage at its larvae stage. At this stage, the moth larvae starts feeding on the comb of the honey, bee brood and comb wax. In the process the moth larvae starts moving around destroying the comb and its contents. Regular functions of the colony are disrupted when bees do not have the strength to protect themselves and if a colony is outnumbered, it absconds.

Among the insect pests of the honeybees, the greater wax moth, *Galleria mellonella* is the most serious pest next to ants in Ethiopia. In addition to greater wax moth, comb damage is also caused by lesser wax moth (*Achroiagrisella*) unless controlled at an early stage. The severe damage due to the larvae of these moths occurred in high temperature areas and during long warm season. Normally wax moths are not a treat to well managed normal colonies. Combs occupied by bees are rarely attacked by wax moths since strong colonies can defend themselves against wax moth. However, weakened colonies can be easily affected.



Figure 2.18: Combs devastated by wax moth with clearly seen debris.

Damages they cause:-The larvae of both moths feed on wax, pollen, cocoon of the bee larvae. They can also cause damage to frames and even on hive bodies under serious infestation.

c. Termites (Kuchach)

Termites are found in places that are free from ants. They prefer dry areas. Kuchach consumes honey and in doing so it moves inside the hives and this disturbs the bee colony.



Figure 2.19:- Termites on honeybee broods

d. Small Hive Beetle

The small hive beetle (SHB), *Aethinatumida* Murray, is a honeybee (*Apismellifera* L.) colonies pest native to sub-Saharan Africa. The adult beetle is dark brown to black in colour. Its larvae are similar in appearance to wax moth larvae but smaller than wax moth larvae. But anyone can differentiate the hive beetle from wax moth larvae by looking at their legs. Both species have three sets of legs on the thoracic segments, but small hive beetle larvae lack the series of paired prolegs that run the length of the wax moth larva's body. Small hive bee keeper is not limited to consuming honey, but it disturbs the colony and reduces the capacity of the colony to produce honey. If the problem is serious, colonies abscond. Colony absconding as a result of small hive beetle interference usually happens in the beetle's reproduction seasons. The population of the beetle increases making it difficult for bee colony to defend itself. Making hive entrance

narrower helps to prevent beetle invasion. Some experienced beekeepers place queen excluders at the entrance of hives as this prevents entry.

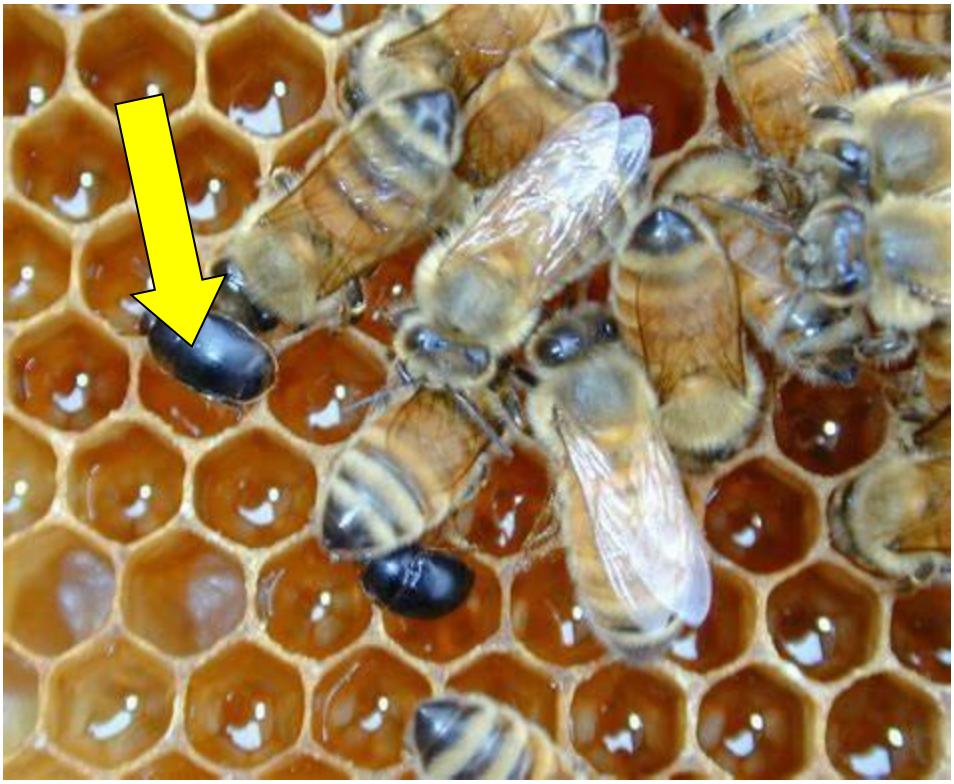


Figure 2.20: Small hive beetle in honeybee hive

e. Honey badger (Mellivoracapensis)

Honey badgers the animal known by the names 'Hama or Hamakosi or Hamagota or Kefodefi' in different localities of Ethiopia. It is a serious pest of honeybee because it consumes everything found in the hive and does extensive damage to equipment, especially in the areas where it is more common. It pushes the hive until it falls and spill out the content. Either by inserting its hairy tail into hives or by scratching at the entrance, a honey badger tempts bees to come out of the hive, or as the bees crawl out, the honey badger eats them. As a result, the apiary could become devastated in a short period of time if the beekeeper does not take some counter measure to protect colonies. Repeated attacks result in colony absconding.

Damages it causes:- It feeds the whole hive content (bees, brood, honey & nectar: and destroy hive and hive parts.



Figure 2.21: Honey badger

f. Honey bee Eater Birds

There are birds that eat bees. They do so when they cannot find other feed. Bee eating birds attack colony during the rainy season when bees have shortage of feed and are at their weakest times. The birds sometimes land in front of hives entrances and this enables them to capture and eat bees coming in and out.

It is possible to reduce the population of bee eating birds but very difficult to eradicate them. Birds prey upon many insect species and honeybees are among these insects. The level of damage caused by bee eating birds varies. An attack by a single bird or by a few together seldom causes a serious problem. But when in a large mass on a few colonies or an apiary, causes substantial decline in the bee population. Attack is more serious during cool and wet season, windy and cloudy days. Under these conditions they attack bees not only by landing on the entrance but also pick them while they are collecting nectar, pollen and at water collecting areas.



Figure 2.22: Bee eating bird

Mankind, being the biggest bee predator, takes and uses the honey produced by bees. Mankind, apart from using pesticides which kill bees and which have serious side effects, spreads bee diseases by using contaminated equipment, utensils and implements.

There are other bee predators (like lizards, bee lice and wasp) Bee lice are parasites. The parasites position themselves on the head and thorax of the bee and share its feed. The damage of the parasites is, nevertheless, minimal. The parasite become nuisance and disrupts normal function. Tobacco smoke is used to control bee lice. Tobacco smoke does not harm bees but it suffocates bee lice and causes them to drop from the bees. Bees collect the dead insects and take them out of the hives. Beetles and wasps eat honey and brood. Lizards do not cause harm to bees except they disturb colonies and create inconveniences. Damage they cause: They cause honeybee population decline under mass attack.

g. Frogs and toads

Frogs and toads aren't a widespread issue for beekeepers, but in sufficient numbers, they can be a real problem for weak colonies. Amphibians will happily feed on honey bees at night, so be

vigilant for droppings around the hive. To deter toads and frogs, spray all the areas around the hive with vinegar. This acts as an excellent deterrent. You may also want to remove wet areas and erect physical barriers to keep your hives safe.



Figure 2.23:- Frogs and toads which keep trapping adult honeybee

h. Mice & Other Rodents

Mice are one of the most damaging animals to bee hives. Just like our homes, they tend to come into hives in the fall.

Here's what they can do to a hive:

- Cause extensive damage to comb.
- Destroy wooden wires
- Eat the pollen, honey, larvae, brood, and even the bees!
- Pee and poop everywhere, leaving a big irritation to the hive colony.

This is why it's also important to keep mice out of your hive storage room. They are so destructive and easily preventable with a few different strategies:

- **Insects as pests of honey bee**

  - ✓ **Dragonfly**: - can catch bees in the yard or hive entrance, and will take them back to their nest and eat them.



Figure 2.24 dragon fly

  - ✓ **Yellow-Jackets**: - Are attracted by the sweet honey smell. They will try to rob the sugar water from the feeders. They will attempt to find cracks in the hive structure and rob their honey or sugar syrup.
  - ✓ **Wasp**:-When a wasp nests being to break up the adults go foraging for sugar. The best defence is attack. Find the wasps' nest and kill them.



Figure 2.25:- wasps on adult honeybee

- ✓ **Wax Moths**: - It spins a cocoon in the space between frames. The main damage is to stored comb. The brood is particularly at risk. Two brood chambers can be destroyed in fourteen days.

2.6 Collecting and shipping samples of honey bee to laboratory

Bee diseases and their characteristic signs can be very confusing to the average beekeeper. Wrong diagnosis can be a major problem, particularly when serious brood diseases are involved. Beekeepers can obtain accurate diagnoses by sending samples of suspect material to the Veterinary Laboratory. Three types of samples can be submitted larvae (smears and 'mummies'), adult bees or comb sample containing diseased brood, according to the disease suspected.

2.6.1 Sample Collection and label

Prior to collecting samples the center will contact sampling personnel with instructions on the appropriate type of samples and numbers of honey bee needed. Partners collecting specimens needed to provide at least one-week advance notice of sample collection. If advance notice is not given lab personnel may not be available to receive and process the submission after it is collected and shipped. All samples submitted for diagnosis should include as much supporting information as possible including:

- Reason(s) for submitting the sample

- History and origin of the honey bee date of transfer and source location(s) of apiary site. This information will help to speed up diagnosis, risk assessment, and husbandry management and treatment recommendations.

Samples used for bee diseases: Diseased brood is samples used for the laboratory diagnosis of bee brood diseases. Site for sample collection of bee disease It is directly collected from areas around apiary site (brood and weak honey bee fall down nearest to the hive), and from combs. Send at least 20-130 bees in a sample but vary up on the disease type.

- ✓ If possible, select bees that do not appear normal but that died recently.
- ✓ Decayed bees are not satisfactory for examination.
- ✓ Bees submitted for the diagnosis of diseases or pests should be placed in 70 % ethyl alcohol as soon as possible after collection. In some cases if a suspected insect pest has to be sent it should also be placed in 70 % ethyl alcohol.
- ✓ All samples should be in leak proof containers.

2.6.2 Samples collection of adult honey bee and brood

Brood samples are taken by removing a piece of brood comb that shows abnormalities. This should be wrapped in paper and placed in a box for transport to the laboratory. Hive debris may be collected for examination, preferably on a sticky board to trap mobile parasites. The diagnostic accuracy of any bee disease depends on the condition of the sample. Adult bees, either dead or moribund, may be collected in the vicinity of the colonies. The diagnostic accuracy of any bee disease depends on the condition of the sample.

Live bees should be killed by freezing. Adolt honeybees are samples used for the laboratory diagnosis of honey bee diseases.

2.6.3 Labeling sample

Contact the laboratory to confirm packing arrangements and to obtain current laboratory fees before submitting samples. In a covering letter include information on the nature of the sample, and what the problem is, as well as the following information.

- The age of bees affected (sealed or unsealed brood, young or old workers).
- Anything unusual about the shape, position or colour of the dead bee larvae (for example a ‘C’ shape or stretched out).
- Anything unusual about the adult bees.

- Did dead larvae rope or string out when touched with a match?
- Any unusual odor, either from the dead brood or the match used to rope the larvae. • Date you took the samples.
- Number of hives infected.
- Your address and contact detail

2.6.4 Packing and transportation of sample

Samples should be transported in sealed, unbreakable, containers. It is usual to double pack samples (*i.e.* an unbreakable container within a second unbreakable or well-padded container). Mail the sample in a wooden or heavy cardboard box (eg. match box). The sample can be loosely wrapped in a paper bag, newspaper, and so on, but avoid wrappings such as plastic bags, aluminum foil, waxed paper, tin, or glass because they allow fungi to grow on the samples. Many postal services and transport companies (especially air couriers) have strict regulations regarding shipping chemicals, including preserved samples. The laboratory accepts samples from anyone and most samples are processed. The carrier should be consulted before samples are collected to ensure they are processed and packed according to shipping rules.

- Containers should be clearly labeled with the information described for specimens
- The name and telephone number of the person responsible for picking up the package, or receiving it at the laboratory, should be clearly indicated
- Where possible, ship early in the week to avoid delivery at the weekend, which may lead to improper storage and loss of samples
- Inform the contact person as soon as the shipment has been sent and provide the name of the carrier, flight number, waybill number and estimated time of arrival, as appropriate.

Self-Check – 2	

Name_____ ID_____signature_____ date_____

Directions: Answer all the questions up on the instruction

Part I. Choose the best answers (1pt each)

1. Among the following pets and insects which one is less important for honeybee?
   a)Termites b) ants c) spiders d) all
2. The most serious of the brood diseases is

A. American foul brood B. European foul brood C. Varroa mite D. Chalk brood

3. The causative organism for European foul brood disease is

A. *Peenibacillus larvae* *B. Ascosphaeraapis* *C. Streptococcus pluton* *D) none*

4. Which one of the following is caused by chilling?
   A. Chilled brood B. bald brood C. European foul brood D. Chalk brood
5. Which one of the following is the task of worker bee?

A) Build cells B) tend to queen C) care for larvae D) All

6. The main objective of monitoring honey bee infections and infestations are
   a) to check efficacy of treatment b) to check efficacy of control programmes
   c) coordinate information to develop future risk mitigation measures d) all
7. which one is the best option of for prevention and control of bee eating birds
   a) Strengthen bee colony b) Identify and destroy nests of bee eating birds around apiary c) Use slings and whips d) all of the above
8. Which one is/are ways of controlling honey badger?
   a) Fence and place thorns around apiary b) Reduce the size of bee entrance c) a& b d) none
9. Of the following one is the best prevention and control for ants
   a) Hang the beehive with ropes b) burning infected materials c) Trapping d) none
10. The basic components of an IPM programme are:
    a) prevention and awareness creations b) observation and monitoring c) Intervention d) all

Test II Short Answer Questions (2pts each)

1) Enumerate and describe those insects as pests of honey bee?
2) Write the three reactions of stings?
3) Write the factors affecting the sting of a worker honey bee?
4) List the three main risks specific to beekeeping?
5) Write the information that should be incorporate while labeling the sample?

Note: Satisfactory rating – 20points Unsatisfactory - below 20 points
You can ask you teacher for the copy of the correct answers.

Operation Sheet -2

2.1 Procedures for collection of adult honeybee samples

A. Tools and equipments

I. Required PPE (gown, boots, gloves, head cover, apron, and veil).

II. Hive with full colony of honey bee, ½ cup measure

B. Steps for adult bee sample collection

I. Wear clean and sterile PPE

II. Remove one of the central frames from the hive

III. Shake the bees off the frame into a rectangular dishpan.

IV. Gently tap the bees that were shaken into the tub into one corner to more easily scoop them up and prevent them from flying away.

V. Use a ½ cup measure (for baking) to scoop a sample of bees out of the tub.

VI. Place the bees into a sample jar and immediately screw the lid on.

VII. Pour the remainder of the bees back into the hive

VIII. Replace the frame to its original location in the hive.

LAP TEST-2	Performance Test

Name_____ ID_____ Signature_____-Date_____

Time started: 2:30 Time finished: 3:30 local time

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 1 **hour**. The project is expected from each student to do it.

Task-1: collect adult honeybee sample

LG #4 LO3 # Prevent and control of diseases and pests of honey bee colony

Instruction sheet 3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Prevention and control of honey bee diseases and pests
- Maintaining and using PPE
- Drugs and chemicals for treatment and control of disease and pastes
- Treatments for infestations and infections
- Biosecurity measures and plans
- Remedial action to ensure health and productive condition of honey bee colony
- Legislatives in the use of restricted chemicals in bee keeping environment
- Notifiable diseases of honey bee colony
- Maintaining records

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify and apply prevention and control methods of honey bee colony diseases and pests according to the organizational guideline.
- Provide, use and maintain appropriate PPE clothing and equipment in accordance with enterprise procedures and OHS requirements.
- Identify and handle drugs and chemicals used in the treatment and control of diseases and pests of honey bee colony according to the organizational guideline.
- Apply infestations/infections are monitored and treatments according to OHS standards principles, business requirements, veterinary guidelines and sound bee keeping practice and enterprise procedures.
- Implement biosecurity measures according to enterprise biosecurity plans and instructions from appropriate authority.

- Record and use results of inspections and any remedial action taken as the basis for future beekeeping operations
- Modify treatment programs where necessary and when dictated by progress.
- Obtain appropriate approval for use of restricted chemicals.
- Notify senior personnel promptly of significant changes to treatments and/or when business implications dictate.
- Identify and compile notifiable diseases and regulatory requirements with the industry requirement.
- Maintain records as required by industry and enterprise guidelines.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 3

3.1 Prevention and control of honey bee diseases and pests

1.1.1. Introduction

Strong beehives are essential for preventing the development of diseases. Weak and dead beehives allow 'robber' bees, which may carry diseases and pests, to enter beehives. Source bees and beekeeping equipment from disease free apiaries. Make regular inspections of honey and brood frames for signs of endemic and exotic bee diseases and pests.

They are complex and sometimes difficult to understand, yet it is important that all beekeepers are aware of the diseases and pests that can afflict a colony. All livestock suffers from a range of problems, and bees are no exception. The only difference with beekeepers is that, by and large, they can't call in the vet. It is up to them to do something about their colonies, and the best way to go about this is to develop what is known as an integrated pest management (IPM) system. This is the management of pests employing a combination of methods that include economic, ecological and toxological factors while emphasizing biological (as opposed to chemical) controls and economic thresholds.

Generally, preventing and controlling the threats posed by these diseases and pests requires risk management including the application of legislative and regulatory measures to prevent their introduction (for exotics) and spread (endemic ones). In all cases, one of the strategies for limiting the presence and spread of these diseases and pests is observance of good husbandry practices in beekeeping. Beekeepers also may spread diseases by moving equipment and colonies from contaminated hives to healthy ones. Thus, there should be a communication system to alert the occurrence of outbreak or endemic honeybee diseases and pests to take a measure at early stage. The basic components of an IPM programme are:

- prevention and awareness (by regular inspections and thorough knowledge);
- observation and monitoring; and
- Intervention (where necessary).

Understanding the biology and life cycle of a pest is the foundation for disrupting its reproduction and limiting the damage it can cause. Also, determining the level of pest or disease present, as well as where it is most likely present, is important for making treatment decisions.

a. **Cultural controls** include beekeeping practices that reduce stress and improve bee health. This begins with placing hives in a suitable environment. Also, management decisions to split combine, or requeen hives will affect the brood population, and ultimately the mite population. Diseases that affect only larvae can also be disrupted by breaking the brood cycle in a colony.
b. **Physical and mechanical controls** include any improvements or modifications to hive equipment that prevent or exclude pests, or actively trap pests that have entered the hive. These include screen bottom boards to eliminate fallen mites, and various in-hive traps for small hive beetles. Activities such as drone-trapping of varroa mites, and keeping hives in good physical repair to prevent the ingress of beetles, wax moths, and robbing bees are also important components of physical control.
c. **Biological control** includes the selection of genetic stock that can tolerate or resist mites or diseases, as well as nematodes to control small hive beetles pupating outside the hive. Biological control research for mites has focused on fungal and microbial pathogens and the use of mite predators, but delivery and application of these organisms is often difficult. Unfortunately no practical biological control agent for varroa mites has yet been found.

1.1.2. Prevention and control (protective methods) for diseases

- **Prevention and control of Nosema**

Since the disease can be caused by stress, maintaining strong, healthy colonies is the best means of prevention.

- ✓ Use good colony management practices including
  - Provide fresh water and
  - feed to individual colony
- ✓ Locate hives at sunny sites, sheltered from piercing cold wind but with good ventilation
- ✓ Maintain adequate stores of pollen, honey or cured sugar syrup or bees should be fed with heavy sugar syrup (2:1 sugar to water)

- ✓ Keep only clean combs; replace combs with new foundation sheets seasonally

- **Prevention and control of Amoeba**
  - ✓ Maintaining hygienic conditions in the apiary and at the water source.
  - ✓ Replace those combs that are contaminated with fecal materials as in Nosema.

- **Prevention and control Varroa mites**

The control of *Varroa destructor* is one of the most difficult tasks facing apiculturists and beekeepers throughout the world. The mite is a highly successful parasite, whose life history is well synchronized with that of its host. Two principal approaches to its control are currently available: chemical control and hive manipulation techniques, sometimes referred to as 'biological control'. At the moment, there is some treatment to cure the disease. It can be both cured and controlled. Beekeepers in some African countries use tobacco smoke to suffocate varroa which makes it drop off from the bees and this can reduce its number. But there is nothing which can be done to control varroa sealed in the cells of the brood. There have been successful attempts to stop the spread of the disease by disrupting its reproductive cycles. Preventing queens from laying eggs, and removing broods can stop the reproductive cycle of varroa.Use the following hive manipulation methods to minimize mite population:

- ✓ Trapping: Look for empty drone frames and give to infested colonies so that they will be used for drone brood rearing. This will help the mites to rear in the broods. Remove the frames, containing the mites trapped inside the cells, when the cells are sealed. Destroy the broods.
- ✓ Trap the mites in worker brood frames by using vertical queen-excluders:
  - Confined a queen between two excluders and allowed to lay eggs in one frame only.
  - Female mites in the colony will be attracted to this brood frame start to breed, meanwhile the cells become sealed.
  - Remove the frame from the hive.
  - Destroy the brood cells infested by the vorroa mites.
  - In the long run look for mite tolerant stocks.

- **Prevention and control of bee louse: -** The application of nicotine (tobacco) smoke has a certain effect on defense of these pest insects.

- **Prevention and control of Chalk brood: -** Chalk brood is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best preventive way of the disease. Chilling may also increase chalk brood, so ensure that there is an adequate adult population to keep the brood nest warm during cold weather. Moves hives to sunny location, with plenty of air ventilation, and dry conditions. Take out infected combs and melt them; replace with new foundations. Keep bottom board dry throughout the year.
- **Prevention and control of AFB:** It is by burning infected materials and area, irradiation, and using the bacteriostatic oxytetracycline as chemoprophylaxis.
- **Prevention and control of EFB:** Remove the cause of stress and management practices for chalk brood are as follows:
  - ✓ Provide good ventilation in your hives. Research has shown a possible link between chalk brood and CO2 levels in hives. „
  - ✓ Add young adult bees to your hives. „
  - ✓ Do not force your bees to spend the winter in a hive that is over superseded. This will lead to chilling.
  - ✓ Avoid opening your hives in cold weather. „
  - ✓ Try not to stress your colonies (for example, by moving them too much).

1.1.3. Prevention and control (protective methods) for pests

Beekeepers in areas vulnerable to ants attack need to protect their honeybee colonies.
The following are some of the protective methods.

- **Prevention and control for ants**

i. Hang the beehive with ropes or with other materials on trees or on poles.



Figure 3.1: Protect colony by hanging and: Place local hive on tree branch

ii. Attach a smooth and sliding metal sheet to the stem of the tree or pole. Like rodent trap
iii. Tie straw or grass to the tree or pole.
iv. Plaster the hive stand with cone shaped smooth iron sheet or used inner tube of a tyre of a vehicle.
v. Place the legs of the hive in open tins filled with used engine oil.
vi. Place a thick coat of engine grease on legs of the hive.
vii. Sprinkle hot ash around the hive.
viii. Spot the location of the ant colony, dig the area and destroy the queen, the eggs and all the brood.
ix. Clean hive area and cut down grass. This enables to detect from a distance if there are any ants swarming.

x. Do not dispose any honey and wax around the hive as they can attract ants to enter the area and eventually to the hives. Bees wax attracts ants and doing so may attract ants to the area and eventually to the hives. Among the suggested preventive methods, nine of them are temporary solutions while the eighth one is a permanent one.

- **Prevention of wax moth: -** Maintain strong and healthy colonies, and inspect weak colonies is most effective method of fighting against wax moth. In addition to employ all management practices like provision of adequate food, reducing supers and unoccupied combs and reducing the hive entrance can effectively minimize the wax moth if applied during dearth period; the following are ways used for prevention of wax moth:
  i. Remove old and discoloured honey combs. These create favourable conditions for wax moth.
  ii. Remove hives from which a colony has totally migrated. Collect and melt the wax from the hive and keep it away.
  iii. Do not discard pieces of wax around the apiary.
  iv. Remove combs infected by wax moth and melt the wax.
  v. In post-harvest seasons, feed colony and make sure they are strong enough to fight wax moth. Try to grow honey plants that flower during post-harvest season so that they provide feed to the colony.
  vi. Remove super during feed shortage seasons so that wax moth does not enter the hive and start reproduction.
  vii. Repair any cracks in hives with wax or propolis.
  viii. To reuse hives that are contaminated by wax moth, deep them in boiling water and wash them thoroughly.
  ix. Use the traditional method of building bone fire in front of the hives. The light attracts wax moth and it usually burns itself.
  x. It is also possible to use chemicals like sulphur dioxide smoke to prevent wax moth. The chemicals, however, may not be available when needed and it may be beyond the economic reach of the beekeeper.

- **Ways of controlling honey badger**

i. Fence and place thorns around apiary.



Figure 3.2 minimize the risk of honey bargirl attack

ii. Some beekeepers use guard dogs to scare away honey badger



Figure3.4 badger protection by watch dog

iii. Tie hives onto firm objects so that they do not fall when badgers push and brush against them.

iv. Reduce the size of bee entrance so that a badger is not able to insert its tail.
v. Hang hives on a tree or on two poles.
vi. If hives are on trees, place smooth iron sheet around the tree so as it is slippery and badgers are not able to climb.
vii. Some beekeepers trap and kill honey badgers.
viii. Shooting and trapping is a possible way but very temporary control measures.

- **Prevention and control of bee eating birds**

Complete eradication of bee eating birds is very difficult. However it is possible to reduce the effect of birds on honeybee population through reducing bird number using different prevention methods.

The following methods can be used to reduce Bee Eater Birds population.

i. Strengthen bee colony: when colony is strong, bees can fly faster. Birds cannot easily capture them.
ii. Identify and destroy nests of bee eating birds around apiary. This may force the birds to settle elsewhere.
iii. Use slings and whips (giraf) to scare and drive away the birds.
iv. Prepare bird feed and place it further away from apiary. This gives alternative feed source and it diverts their focus.
v. Some beekeepers kill bee eating birds and hang the dead one in front of beehives. They believe that when the birds see the dead one, they fly away and settle elsewhere. This practice is not acceptable and is illegal.

- **Prevention and control of Small Hive Beetle (SHB)**

The best defense against hive beetles is to maintain strong, healthy colonies. Strong colonies can defend themselves against this pest, whereas weak colonies cannot. In areas where this pest is found, keep your honey house clean; do not store full supers for long or leave honey filled wax capping exposed. Use small hive trapping to suppress its population. Traps baited with pollen dough conditioned by allowing male SHB to feed on it for 3 days are effective in capturing SHB if the traps are located in a shade closer to the apiary.

3.2 Maintaining and using PPE

Maintaining PPE

Storage & Maintenance of PPE is simple, yet proper care & precautions while doing it must be taken care of. Proper maintenance & care of PPE will ensure its longevity & better safety. As PPE plays a vital role in avoiding major injuries & infections, they must be maintained properly. PPE maintenance is vital. It includes keeping a check on expiry dates, keeping the PPE kit clean, and a basic understanding of legal work for PPE kits. Depending upon the equipment, the maintenance may differ. High quality protective cloth comes with an integrated zippered hood, elastic cuffs, and pockets. The protective clothing is generally light colored (but not color full). And smooth materials. Avoid wearing black or other dark clothing as bees will feel threatened by dark colors. Proper handling of PPE is washing on time, not to spray while approaching to hive. PPE must be properly looked after and stored when not in use, for example in a dry, clean cupboard. If it is reusable it must be cleaned and kept in good condition.

Think about:

- using the correct replacement parts, following the manufacturer's replacement schedule
- keeping replacement PPE available
- who is responsible for maintenance and how they should do this

Providing (Preparing) a Complete Protective and Safety Gear

After a beehive is opened for inspection bee stings and other inconveniences should not interrupt work progress. Protective and safety gear that have been used for previous colony inspections may carry the scent of bee venoms that bees can smell from a distance. This makes bees to react causing disturbances. Always, gear has to be washed after use and should be free from such smell. In addition, the color of protective gear should not be black or red. These colors irritate bees. Instead, white and off white colors are preferable.

3.3 Drugs and chemicals for treatment and control of disease and pastes

There are various types of chemicals and drugs that used for prevention and control of honey bee diseases; however it can vary up on its accessibility due to its cost, and distribution. The following table shows few of the most common used drugs and chemicals in beekeeping industry.

Table 3.1 Types of drugs and chemicals used in beekeeping

Brand name	**Type(s) of chemical**	Varroa mites	Tracheal mites	Nosema	AFB/ EFB	Wax moths	SHB
Apigaurd	Thymol, an essential oils	X	X	-	-	-	-
Apilife VAR	Blend of essential oils, particularly thymol	X	X	-	-	-	-
Apistan	Fluvalinate, a synthetic pyrethroid	X	-	-	-	-	-
Apivar	Amitraz, a synthetic miticide	X	-	-	-	-	-
Checkmite+	Coumaphos, an organophosphate	X	-	-	-	-	X
Fumadil-B	Fumigilin, an antibiotic	-	-	X	-	-	-
GardStar	Pemethrin, a synthetic pyrethroid	-	-	-	-	-	X
Mite-a-thol	Menthol, an essential oil	-	X	-	-	-	-
Mite-Away II	Formic acid, an organic biopesticide	X	X	-	-	-	-
Paramoth	PDB crystals, a fumigant	-	-	-	-	X	-
Terramycin	Oxy-tetracycline, an antibiotic	-	-	-	X	-	-

- **Handling drug and chemicals**

Many drugs can be harmful if they contaminate other medications, and some can be accidentally absorbed through the skin. This is why safe handling is vital for protecting both bees and your staff. If you've already kept your storage areas clean on a daily basis, it should be relatively easy to extend daily cleaning to the rest of your pharmacy. However, there should be much more cleaning involved in maintaining the dispensing area.

There are numerous best management practices that drug users can employ to use regulated products safely and effectively in beekeeping, including:

- ✓ Diagnose the problem(s) before applying any regulated product.
- ✓ Seek professional advice on when and how to use regulated products.

- ✓ Use regulated products only for those species and indications listed on the label (exception - some drugs may allow extra-label use if specifically prescribed by a licensed veterinarian).
- ✓ Read and follow the product label directions for use.
- ✓ Use the proper dosage, amount, or concentration for the species, area, and/or specific condition; apply the full exposure regimen regardless of whether the signs which led to treatment are diminished.
- ✓ This is especially important when administering antibiotic and other compounds to which resistance could develop.
- ✓ Use the correct method and route of application or administration (e.g. spraying apiary site, in hive, brood combs).
- ✓ Do not use restricted chemicals (pesticides and herbicides) for disease and pest suppression.
- ✓ Be aware of requirements concerning personal safety measures and proper procedures for bee keepers and pesticide applicators that handle or apply regulated products.
- ✓ Consider the economic consequences, both short- and long-term, of treatment before using a regulated product.

- **Drug and/ or chemical usage suggestions in bee keeping**
  - ✓ Before treating:
    - Determine time for treatment carefully (night is preferable to approach to hive)
    - Accurately determine (estimate) the total number colony (large vs. small colony)
    - Confirm the identity, expiration date, and active ingredient concentration of the regulated product to be applied.
    - Double-check treatment calculations. Beware of confusion from mixing metric and standard units.
    - Check for devices and PPE ready for use if needed.
  - ✓ When treating:
    - Dilute the drug and chemicals for treatments (follow product directions for appropriate ratio).

- Ensure that the regulated product is well-mixed and evenly applied in the rearing units.
- Observe the honey bee closely and frequently during treatment for signs of distress.
- Discontinue treatment and restore normal culture conditions if the distressed.

✓ After treating:

- Observe the honey bee and brood condition frequently prior to treatment.
- Do not stress the treated honey bee.
- Recheck the honey bee to determine the efficacy of the treatment and recovery
- Modify treatment for those who are not recovered.

3.4 Treatments for infestations and infections

- **Treating AFB**

Treating AFB is difficult and, in some countries, beekeepers are not permitted to treat it themselves. Treatments for AFB include, however, the following:

✓ **Burning:** Burning the hives and bees is one way of ensuring an end to the matter, but this is not as easy as it may appear. Chemical used here is petrol and sodium hypochlorite. Use gloves and overalls is must for proper handling of these chemicals and to employ this method. You have to wait until all the bees are in the hive in the evening when you shut the entrance, open the lid and pour petrol into it. This kills the bees almost immediately and the hive can then be burnt. You must be careful, otherwise petrol is accidental. The UK and New Zealand have a markedly reduced the incidence of AFB because of their policies of burning. Burning the frames and bees and then sterilizing the scraped hive parts with sodium hypochlorite is also effective. The hive parts should be cleaned before they are soaked in a solution of sodium hypochlorite for at least 20 minutes.

✓ **Irradiation**: - Irradiating the hive parts and combs is effective but is not practical for most beekeepers. It is also expensive.

✓ **Using the bacteriostatic oxytetracycline**: - The bacteriostatic oxytetracycline (which goes under several trade names, such as Terramycin), can be an effective treatment and prophylactic. Its use, however, is fraught with the danger of the bacteria becoming

resistant, and so it should never be employed without expert advice. Many states and countries have banned its use except by the authorities, and some have banned it altogether. Care should be taken for the use of this drug and just another chemical that will contaminate honey, wax and bees. It appears that AFB is becoming resistant to oxytetracycline, and the inexperienced use of oxytetracycline may contaminate the honey. Careful reading of leaflet of manufacturers and precaution measures written on the drug containers should be followed for handling.

- **Treating EFB**

Treatment may not be necessary in an otherwise healthy colony, although an infestation may be reported to the statutory authorities in the area. The bacteriostatic oxytetracycline will prevent and cure the problem and many texts advocate this, but its use is not really recommended unless a bee-inspection officer advises it and then only under their direct guidance. Its overuse can cause resistance and, without doubt, it can contaminate the honey. Try to remove the cause of stress, and boost the colony's efforts to build up, perhaps with a frame of brood and bees, if possible. If the disease is not too far gone, then all should be well. There is no need for chemicals.

Remember that, because this disease is caused by the starvation of the larvae, it can be hidden in, for example, queen-rearing colonies where high levels of feeding are undertaken. If this is the case, the larvae are able to overcome the parasitic nature of the bacteria. The name EFB bears no relationship to its geographical spread, and very few areas of the world have escaped it. At the time of writing, New Zealand has no EFB.

- **Treating of sac brood**

Strong colonies and regular re-queening seem to be the best means of combating this disease. No antibiotic is effective at preventing or controlling it. Colonies suffering from this virus usually recover spontaneously when the honey flow starts because, at this time, there are fewer adults in the hive to pass on the disease.

- **Treating and preventing chalk brood**

There is no chemical cure or treatment for chalk brood although, in recent years, many patent liquids have been marketed as cure-alls. Management practices that reduce the stress on the hives and, thus, that reduce the number of chalk brood spores, are probably the best way to prevent and

manage the disease. Maintaining strong, healthy colonies is also important in the management of chalk brood.

Other management practices are as follows:

- ✓ Provide good ventilation in your hives. Research has shown a possible link between chalk brood and CO2 levels in hives. „
- ✓ Add young adult bees to your hives. „
- ✓ Do not force your bees to spend the winter in a hive that is over supered. This will lead to chilling.
- ✓ Avoid opening your hives in cold weather. „
- ✓ Try not to stress your colonies (for example, by moving them too much).

- **Treating Nosemaapis**

Good colony management, as well as chemicals, can keep nosema at bay:

- ✓ Make sure the colony goes into the winter with a young and prolific queen and with many young bees (another reason for autumn re-queening).
- ✓ Ensure that the colony going into winter has adequate stores of honey and pollen.
- ✓ Feed fumagillin as sold under the trade name Fumadil B. If fed in sugar syrup to overwintering colonies, this can markedly reduce the incidence of nosema the following spring. Follow the manufacturer's instructions carefully because under or overuse can negate the effects. If feeding this medicated syrup, do not then feed bees with non-medicated syrup because this will dilute the beneficial effects of the chemical.

- **Treating and protecting against varroa destructor**

The timing of the treatment is important. Treat bees in the spring when large amounts of brood provide the ideal conditions for varroa infestation. Use an authorized miticide, such as Apistan or Bayvarol. For protection of colony against a varroa invasion, treat it in the early autumn, after the harvest is best time. For this, use an organic product, such as oxalic or formic acid. This will slow down the mites' resistance to miticides and the formic acid will penetrate the wax to kill the mites capped in the cells. Many treatments are available, including ones suitable for organic honey production (although, these are more difficult to use). Legislation restricted the chemicals

and methods should be employed in the fight against varroa. The following are some of the treatments commonly available: Chemical controls, Organic' controls, and Biotechnical controls (manipulations).

Chemical controls (miticides) include: Bayvarol, Apistan, Apivar, Check Mite and Apitol are proprietary treatments produced and designed to kill varroa. These comprise synthetic chemicals. They are usually reliable and effective when the mites are not chemically resistant. They are also quick and easy to use. '

Organic' controls: Thymol, formic acid, lactic acid, oxalic acid and other essential oils are 'soft' chemicals that are reliable to varying degrees but, for good effect, they must be employed at the right time and in the right circumstances. Some, however, are very temperature dependent. The biggest problem with essential oils compared with such chemical treatments as fluvalinate (used in Apistan) is the small difference between the amount of the substance that will kill the mites and the amount that will kill the bees. Fluvalinate, for example, is 800–1000 times more toxic to varroa than to bees, whereas the best essential oils are only two to four times more toxic. This doesn't apply to all oils, however. Thymol is not toxic to bees, for example. Be careful, therefore, using these treatments. Devices for the efficient use of oxalic and lactic acids are also commercially available. One of these is simply a heated spoon that contains crystals of oxalic acid. The spoon is plugged into a car battery, inserted into the hive's entrance and turned on. The crystals then vaporize in the hive. This process takes about two minutes.

Biotechnical controls (manipulations): If carried out correctly and at the right time, drone-brood trapping can dramatically reduce the number of varroa and will not affect the colony as much as worker-brood trapping. This method is based on the fact that, as mentioned earlier, varroa mites are more attracted to drone brood than worker brood.

The frames of drone brood (in which the varroa mites prefer to live when starting their reproductive cycle) are removed from the hive and destroyed. This method may hence affect the number of drones in the area and thus queen mating.

Nevertheless, this method can be carried out as follows:

- ✓ Place a drone frame in the colony. These can be purchased from bee-supply shops or you can put drone foundation wax-sheets into the frames yourself.

- ✓ The workers will now clean the cells in these frames and the queen will recognize that they are drone cells from their size. She will therefore lay unfertilized drone eggs in the cells. „
- ✓ In about 10 days the drone cells are sealed with the mites inside them. „
- ✓ You should now remove the sealed drone-brood frame and put it in a freezer to kill the drone brood and mites. Alternatively, you could open the drone brood cells with an uncapping fork (available from bee-supplies shops) and lift out the larvae.

Researchers say that, if there is no worker brood in the colony, this method can remove over 90% of the mites with a single treatment. If there is worker brood in the colony, they will compete with the drone brood in 'trapping' the mites, and so the efficiency rate will be lower. There is now even a device that will kill the mites in the cells without having to remove the frames. The Saartan 'mite zapper' was developed in the USA and comprises heated wires embedded in a drone brood frame. When the cells are sealed, an electrical current is passed through the frame and thus the mites and drone larvae are killed. The house bees will then clean out the cells. If done correctly, worker-brood trapping is very effective in reducing varroa numbers but it affects the colony because you are removing your future foragers.

- **Treating of Tropilaelapsclarae**

Treatment is similar to that used in varroa control. *Tropilaelapsclarae* has, however, one major weakness in that it cannot exist outside the cell for long. Brood-less periods will therefore clean the hive of mites. Remember the following points about *T. clarae*:

- ✓ It can cause colony collapse faster than varroa. „
- ✓ It can mate outside cells as well as inside cells (unlike varroa).
- ✓ It cannot live outside cells for very long, and this is a major weakness. This means that, during brood-less periods such as cold winters, the mite cannot survive in a colony and will be cleared out.
- ✓ All beekeepers – even in areas without *T. clarae* – should keep an eye out for it.

- **Treatments with acarines**

Treatments of acarines (which are still touted) include 'Frow mixture' which was devised by a Lincolnshire beekeeper and which consisted of nitrobenzene, saffron and motor-car petrol. It seemed to work – or at least it was used when the problem was passing, and Frow was rightly honored for his efforts. The thought of putting something like Frow mixture in a hive today

would, rightly, fill anyone with horror, yet some texts still advocate its use. Doesn't use it. Certain evaporative treatments, such as those using menthol or formic acid and which are used for varroa control, can be employed for the treatment of this mite, but it is bestto obtain expert advice.

Certain evaporative treatments, such as those using menthol or formic acid and which are used for varroa control, can be employed for the treatment of this mite, but it is bestto obtain expert advice.

3.5 Biosecurity measures and plans

3.5.1 Biosecurity measures

Biosecurity is a set of measures designed to protect an animal population from transmissible infectious agents at a national, regional and individual farm level. Biosecurity measures in beekeeping are all the operational activities implemented by beekeepers to reduce the risk of introduction and spread of specific honeybee disease agents. Biosecurity measures can differ between different regions due to local factors such as climatic conditions, beekeeping equipment used, or bee races, and the prevalence, virulence and importance of the honeybee diseases. The adoption of Biosecurity measures is the foundation of all disease control programmes, irrespective of the animal species. If biosecurity measures are properly implemented, it is possible to reduce the incidence of disease and, hence the need to apply treatments, to an absolute minimum.

3.5.2 The honey bee industry biosecurity plan

In developing the biosecurity plan the honey bee industry has considered the following key factors:-

- Understanding the targeted diseases and parasites,
- Their modes of transmission,
- Key risk factors for each mode,
- Key factors to exclude the disease and parasites,
- A system to ensure the program is carried out,
- Joint on-going surveillance of colony health.

- Jointly maintain state response teams to assist government in the event of an incursion of an exotic disease or parasite.

Targeted diseases and parasites include not only exotic diseases but also endemic diseases that have a significant impact on production or trade. In essence the biosecurity plan aims to minimize the risk of introducing pathogens into the bee colony. It ensures a rapid response to stop disease and parasites spreading within or between colonies in industry's quality assurance initiative. It recognizes that the entry of new pathogens, or new strains of existing pathogens, can devastate performance and profitability. It encourages beekeepers to implement management practices that reduce the potential for the introduction, production and spread of disease and parasites.

Advantages of biosecurity plan for the honey bee industry are: -

- Reducing the possibility of entry and spread of disease and parasites.
- Lessening the social and financial impacts of an outbreak.
- Reduce the possibility of substantial losses being incurred in a disease and/or parasite outbreak.
- Reduces the beekeeper's liability

In the present context, biosecurity measures are one of the main ways of minimising and managing threats to honeybees from diseases and pests. The regulation and control of honeybees reflects the common application of animal health controls at different stages. In this regards the different countries has a proclamation on apiculture resource development. As stated in their proclamation there is a clear regulation on the importation of live bees, raw bee products and used bee equipment to protect indigenous honeybee species from exotic honeybee diseases and pest threats:

a) Importation of live bee species or used beekeeping or processing equipment or materials shall be prohibited.
b) Importation of raw honey, beeswax or other bee product shall be accompanied by hygiene inspection certificate signed by the appropriate authority of the country of origin.
c) Hygiene certification may be requested or inspection may be required on any used beekeeping equipment in transit to the country unless the packaging requirement is recognized.

These regulations at pointy of entry by themselves may not be enough to prevent and control threats. Additionally, post-entry controls including surveillance and inspection measures to detect the presence and status of diseases and pests, or movement restrictions to contain a disease and/or a pest should be the crucial part of the system. For instance in the event that the disease or pest existence is confirmed, and treatment or destruction measures to manage or eradicate the disease or the pest is also very important**.**

3.5.3 Biosecurity during honeybee colony transfer

Transferring a honeybee colony is the process of moving bees from one hive to another. This is usually done when the bees have outgrown their current hive or when the beekeeper wants to change the type of hive. Transferring a honeybee colony can be dangerous and should only be done by experienced beekeepers. Transferring a honeybee colony is a delicate process that requires some preparation. Here are the general steps to follow:

- Choose the right time of year to transfer the colony.
- Prepare the new hive.
- Move the old hive to the new location.
- Wait for the bees to settle down.
- Transfer the bees to the new hive.

It is important to note that transferring a honeybee colony can be dangerous and should only be done by experienced beekeepers.

Biosecurity is an important issue to consider when transferring honeybee colonies. Here are some tips to help minimize the risk of spreading diseases:

a) Use clean equipment.
b) Inspect the colony for signs of disease before transferring.
c) Quarantine the colony if necessary.
d) Use proper protective gear.
e) Follow local regulations and guidelines.

3.6 Remedial action to ensure health and productive condition of honey bee colony

A disease-modifying treatment, disease-modifying drug, or disease-modifying therapy is a treatment that delays or slows the progression of a disease by targeting its underlying cause.

They are distinguished from symptomatic treatments that treat the symptoms of a disease but do not address its underlying cause.

The following condition needs remedial action and treatment modification in the treatment of bee diseases. These are:

Failure of treatment therapy

There are many reasons for this. The selected drug may be inappropriate because of misdiagnosis, poor drug diffusion at the site of the infection, inactivity of a given drug at the site of infection, failure to identify the etiological agent including inaccurate results of laboratory tests, resistance of pathogens, metabolic state of the pathogen, or errors in sampling. Other factors that may contribute are inadequate dosage or the use of drugs with low bioavailability, failures of drug pharmacodynamics, pharmacokinetics drug metabolism, and using drugs from unknown sources (illegal and expired drugs). When failure occurs, diagnose must be reassessed and proper samples collected for laboratory analysis. It is important also to ensure that persons medicating their own animals comply with dosing instructions. Modification of previous treatment is possible by:

- Re assesses and diagnoses the honey bee disease again.
- Correction of sampling error.
- Putting accurate results of laboratory tests (conducting technique many times), so that the true diagnosis known.
- Using other treatment options in beekeeping
- Search for best treatment and control options
- Following dosing instructions carefully for correct route of administration
- Treating with risk free cultural treatment techniques like smoking tobacco for honey badgers, firing around hive etc.

Select based on the toxicity of the chemical to the honey bee

Drugs that are sufficiently non-toxic to the bees are used as in the treatment of the bee diseases, parasites and pests. It is important for the beekeeper to report adverse drug events to legal authorities. Checking for drug authorization to prevent failure of treatment therapy by:

- European Agency for the Evaluation of Medical Products (EMEA)
- Committee for Veterinary Medical Products (CVMP)and honeybees included

3.7 Legislatives in the use of restricted chemicals in bee keeping environment

The use of agricultural chemicals, such as pesticides makes bees vulnerable to poisoning and death. Most bee poisoning events occur because of an illegal use of restricted chemicals and lack of communication and coordination between the chemical user and beekeepers. Use of unapproved drugs or misuse of approved drugs in honey bee poses a potential health hazard. These substances may be toxic, allergenic, or carcinogenic, and/or may cause antibiotic resistance in pathogens that affect humans. To control this hazard, drugs for use in honey bees, whether they are for direct medication or for addition to feed, generally must be approved, conditionally approved or index listed by FDA (Federal Food, Drug, and Cosmetic). Drugs on the Index of legally marketed unapproved new drugs for honey bee may not be used. Reasons for the uses of drugs in honey bee include the need to treat, prevent and control disease, parasites, and pests of adult bees and brood.

When a drug is approved by center for veterinary medicine (CVM), the conditions of the approval are listed on its label. These conditions specify the species for which the drug is approved for use; indications (disease or other circumstances) for use; dosage regimen; and other limitations, such as route of administration and withdrawal time. Only a licensed veterinarian may legally prescribe a drug under conditions that are not listed on the label (extra-label use). This includes: use in species not listed on the label; use for indications (disease or other conditions) not listed on the label; use at dosage levels, frequencies, or routes of administration other than those stated on the label; and deviation from the labeled withdrawal time. A veterinarian is a person licensed by a state, territory, or foreign government to practice veterinary medicine. Common sense and good culture practices can reduce the need for regulated products and increase the efficiency and/or restricted chemicals for the use of honey beekeeping and disease control and treatment are:

- Herbicides
- pesticides

- **Pesticides and Herbicides**

Pesticides and Herbicides are chemicals used to control plant pests and weeds. Bees are poisoned when they collect nectar and pollen from plants to which chemicals are applied. Water contaminated by the chemicals poisons the bee colony. Mostly, pesticides are spread by aircrafts and this has the most damaging effect. Mostly when pesticides are sprayed, many bees are out collecting pollen and nectar are poisoned and killed.

- **Adverse affects of pesticides and herbicides**

Bees poisoned by these chemicals show the following symptoms.

- ✓ Many dead worker bees are seen in and around the hive.
- ✓ The mouth mainly proboscis of the bees hangs out.
- ✓ Dead broods are seen out of hives.
- ✓ The colony size of a hive decreases suddenly.

Current studies indicate that the amount of damage on bee colony caused by unplanned and irresponsible yearly chemical usage is increasing. As a result of this the honey production of those areas that are formerly known as major honey producers, has decreased. In fact those who used to produce honey for their own in house consumption are being forced to purchase. The intensity of chemical usage is higher in areas that produce pulse crops, coffee and chat. The problem is aggravated more by those who are illegally involved in the chemical trading as they distribute huge amount of inappropriate chemicals. Another problem is many farmers have neither the skills nor the training on safe handling of the chemicals. There is chemical residue in honey harvested from areas that use a huge amount of chemical more than the set acceptable limit in the product and such honey cannot be exported to international markets, especially to EU countries.

It is essential to use insecticides and pesticides so as to increase productivity in agriculture. On the other hand, bees play important role in cross pollination which increases productivity. If using chemicals is unavoidable, a system should be designed to regulate chemical applications in such a way that they do not cause damage to bees. Users should be informed about when and how to use the chemicals.

Users of such chemicals should be obliged to cooperate with the beekeepers to safe guard bee colony. The sector of Agriculture along with those concerned is expected to come up with directives on ways of responsible usage of chemicals.

- **Use leaflet and label of the chemicals and drugs**

All pesticide users have the legal responsibility to follow the pesticide label to ensure that the use of a pesticide will not result in an adverse effect to humans or honey bees or an unreasonable risk to the environment. Misuse or "off-label use" (use not in accordance with the label) of a pesticide is a violation of federal and/or state law. If you are applying any product to control pests, ensure that it is a currently labeled legal product. Many state agriculture departments have more information to help facilitate dialogue between beekeepers and pesticide applicators in order to reduce exposure to pesticides. A pesticide label consists of various sections:

- ✓ The ingredient statement contains information on the active ingredient.
- ✓ Specific language of the environmental hazard section protects non-target organisms; these advisory statements are based on the environmental fate and toxicity data for the active ingredient(s).
- ✓ Specific language to protect applicators can be found in precautionary and first aid statements.
- ✓ Directions for Use (DFU) contain mandatory restrictions on how the pesticide must be used under specific circumstances.

To reduce pesticide exposure to bees, beekeepers can also communicate the following to growers and applicators:

- Comply with pesticide label requirements rigorously.
- Follow the best management practices in state and tribal managed pollinator protection plans.
- Alert nearby beekeepers in advance when a pesticide application is planned.
- Spray pesticides when temperatures are cooler or apply early or late in the day to avoid times when bees are actively foraging.
- Avoid spraying flowering weeds upon which bees forage.

- Mow flowering weeds near the crop prior to an application or reduce them in some other manner, so bees will not be attracted.

3.8 Notifiable diseases of honey bee colony

Notifiable' diseases are animal diseases that you are legally obliged to report to the Animal health organization (OIE), even if you only suspect that an animal may be affected. A beekeeper must report the detection or suspicion of any notifiable disease to their relevant state or territory authority by the quickest practicable means. Verbal reports should be followed up in writing (for example, by e-mail, text message (SMS), fax or letter). A beekeeper must have knowledge of the pests and diseases that are notifiable diseases in the state or territory where their hives are located.

Bees suffer from a number of diseases but the major and most common threats to your hive are listed below. When hundreds of bees die there is something wrong. Honey bee diseases can be divided into two types: those that affect the adult bee, and those that affect the brood.

- **Brood Diseases**

✓ **American Foul Brood**:-The causing organism is Bacillus larvae. As its name suggests it is a spore forming bacterium. The spores are fed by nurse bees to larvae. The bacillus remains dormant until the cell is sealed and the larva is lying along the cell. American Foul is the only disease the hive is burned.

✓ **European Foul Brood**: - This is a very different disease from American Foul Brood. The disease is caused by Streptococcus pluton a very small non-spore forming bacterium. The bacterium is in the brood fed to larvae by the nurse bees. Upon entering the stomach the larva proliferates and fills the gut, feeding on food in the larva's stomach. It does not penetrate into the body cavity. The larva may die by starvation.

Field diagnosis is therefore the death of unsealed larvae still in the curled up position. However, this disease may be in the hive for some time without visible symptoms.

✓ **Sac Brood**:-Not a bad as other brood diseases, normally only a few larvae become infected. The virus appears to affect the process of molting, preventing the separation of

new and old exoskeleton. There is no cure. Some evidence suggests it may be inherited. Requeening has been successful at correcting the problem.

- ✓ **Chalk Brood**:-This disease is the result of larvae eating the spore of the fungus *Ascosphaeraapis.* These germinate in the larvae and the mould grows until they have completely interwoven the whole body of the larva. The appearance is fluffy white pieces of cotton. Some will change from white to blue / black. Re-queening may correct the situation.

- **Adult honey bee diseases**

Adult honey bees are susceptible to a variety of pests, disorders and infections. However the most devastating and when suspected by owners, vets or laboratories must be reported within a defined time frame is Nosemosis.

- ✓ **Nosema: -** Caused by the protozoan, *Nosema apis* or *Nosema ceranae*. The latter has largely displaced the former over the last few decades so that *Nosema ceranae* is the most prevalent. There is no single symptom of the disease. Adults may have distended abdomens and defecate within the hive rather than take cleansing flights. There is no exact means of prevention for nosema. Since the disease can be caused by stress, maintaining strong, healthy colonies is the best means of prevention. It is normally only a problem when the bees cannot leave the hive to eliminate waste (for example, during an extended cold spell in winter or when the hives are enclosed in a wintering barn). When the bees are unable to void (cleansing flights), they can develop dysentery. *Nosema* disease is treated by increasing the ventilation through the hive. Some beekeepers treat hives with agents such as fumagillin

3.9 Maintaining records

3.9.1. Bee keeping Records

A record is a source of documentary evidence and a piece of proof which has been captured on some fixed medium, which was created and kept, to support a government, organization, or individual to perform activities, remember events or information, and provide proof of decisions

or actions. Recordkeeping is keeping records, or "units of preserved information in some permanent form (written documents, photographs, recordings, etc.)." Beekeepers must maintain records of biosecurity related actions and observations Good record keeping is essential to good biosecurity as it allows for tracing the source of a disease outbreak or pest incursion. While it is important that enough data be captured, this does not need to be a difficult or time consuming process.

Record keeping is an essential component of effective disease management. Apiary Records for honey bee should be recorded on a regular basis. Record keeping is essential for long term planning and comprehensive evaluation of honey bee health and honey production. It generates data which can indicate trends, and aids traceability of events and their impacts. Such information are necessary to have a data based approach to improving bee health management, recognition of health or production issues and ensuring quality assurance of farm product particularly with respect to food safety. Beekeepers should maintain a record system of their hives, apiaries, locations, and seasons. Record keeping in this context includes:

- Disease prevention methods
- Diseases and pests signs and symptoms
- Diagnostic results
- Economic loss due to death of honey bee, treatment and control
- Treatment
- General population
- Brood pattern
- Presence or absence of a queen
- The state of the brood and honeycombs etc.

3.9.2. Importance of Beekeeping records

Good record keeping is essential as it means we can trace the source of a disease outbreak or pest incursion from one hive to the next, or one hive to a group of hives. It's important to record information on the health status of your hives, but also for the productivity of your hives and overall business. The benefits of keeping records as a beekeeper are:

i. Tracking inputs into the beekeeping operation

ii. Tracking yields of the beekeeping operation
iii. Tracking equipment and tools
iv. Usability state of tools and equipment
    - Record the tools and equipment you lend out
    - Recording damaged and broken tools and equipment
v. Progressively tracking growth and progress
vi. Calculating profitability of the beekeeping operation
vii. Justifying value to financial institutions
viii. Accurately informing relevant authorities
ix. Sharing data and information with other beekeepers
x. Diagnosis of problems, diseases, and any errors

Self-Check – 3	Written test

Name_____ ID_____signature_____ date_____

Directions: Answer all the questions below according to the instruction

Test I: write true for correct statement and false for incorrect one (1pt each)

1. _____Record keeping is an essential component of effective disease management.
2. _____Mite is transmitted very easily by direct contact from infested to healthy bees.
3. _____Perfumes or cosmetics irritate bees which causes aggressiveness of honeybees.
4. _____European foul brood disease is usually introduced through husbandry activities but can also be transmitted by the varroa mite

Part II. Matching (1pt each)

A	B
1. misdiagnosis of honey bee disease_____	a. Fence and place thorns around apiary
2. Prevention and control of ants_____	b. Trapping
3. Prevention of badger_____	c. Sprinkle hot ash around the hive.
4. Prevention and control of mites _____	d. By failure of treatment therapy
5. Modification of previous treatment	e. Correction of sampling error
6. defecation in the hive	f. symptoms of Amoeba in honey

Test III Short Answer Questions (2pts each)

1) What are the factors considered in developing the honey bee biosecurity plan?
2) List down notifiable disease of honey bee?
3) Write the control and prevention options for the following honey bee diseases and pests

i. Chalk brood
ii. Bee louse
iii. Nosema
iv. Varroa mite
v. Ants
vi. Small hive beetles
vii. Honey badger
viii. Bee eating birds

4) What are the benefits of keeping records as a beekeeper?

Note: Satisfactory rating – 32 points **Unsatisfactory - below 32 points**

You can ask you teacher for the copy of the correct answers.

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Beekeeping tools and equipments, Available at:-Beekeeping Equipment's | Apiculture Tools | Beekeeping Tools and Equipment - YouTube accessed on: - May 19/2023

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