

Virginia Master Beekeeper Program

Study Outline - Qualified Beekeeper Level

This study guide belongs to:

Questions derived from:
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Honey Bee Biology:

A. Occupants of the hive

1. What three types of individuals are found in the honey bee colony?
 - Queen
 - Workers
 - Drones

2. How can they be distinguished? **We are assuming a cursory glance, not a dissection.**
 - Queen:
 - a. Longer, tapered abdomen (wasp-shaped)
 - b. Small eyes
 - c. Wings extend only about 2/3 of body length

 - Workers
 - a. Smallest & most numerous occupants of the hive
 - b. Small eyes
 - c. Pollen baskets
 - d. Wings extend almost to end of abdomen
 - e. Have sting

 - Drones
 - a. Largest occupant of the hive
 - b. Large eyes
 - c. Barrel-shaped
 - d. No sting

Question: Do all bees in the hive have a honey stomach?

- Worker – yes
- Queen – yes
- Drone - yes

3. How many of each type might you expect to find in a colony?

- Queen – generally one
 - Workers – few thousand to 60,000
 - Drones – zero to 1500
4. Do the numbers change during the year? Yes
- Queen – no change
 - Workers – few thousand in winter to 60,000 during spring nectar flow
 - Drones – zero in winter to 1500 in spring & summer (5000 in one publication)
- Drone titer – the ratio of drones to workers within the population that the colony attempts to maintain; changes during the year.
5. What are the **two** castes found in the colony and what are their major roles (functions).
- Queen:
 - a. Reproduction – laying eggs
 - b. Produce pheromones – regulate colony behavior
 - Workers
 - a. Food Procurement
 - b. Colony maintenance
 - c. Rearing young
 - d. Defense of colony

Question: Do laying workers produce queen substance?

- Yes - Laying workers do produce 9-oxodecenoic acid, which is **one of the components** of the queen's mandibular gland secretion (queen substance). They do not produce it in enough quantity to inhibit the ovary development of other females within the hive.
6. What is the development cycle of each (stages and times) and how do the conditions under which they are reared differ?

Brood Stage	Queen	Worker
Egg	3 (fertilized)	3 (fertilized)
Larva	5 ½ (royal jelly)	6 (RJ+nectar/pollen)
Pupa	7 ½	12
Total	16	21

All larvae are fed royal jelly exclusively during the first 3 days of their lives. Queen larvae continue to receive royal jelly, but worker larvae are also fed nectar and pollen beginning at day 4 (or day 7 if counting from first day egg is laid).

Question: Is the queen fed anything else in addition to royal jelly?

- A developing queen larva is fed royal jelly almost exclusively during development. As an adult she is fed primarily glandular secretions from workers (basically brood food secretions), although she also gets some honey, especially when she is not laying. Worker adults feed on honey & pollen. - Dr. Richard Fell, Ph.D.

Question: Your colony has swarmed and you find a newly emerged virgin queen and some capped queen cells. When did the colony begin swarm preparation?

7. What is the function of males and what are their development stages and times.

Reproduction - Mate with a virgin queen

Brood Stage	Drone
Egg	3 (unfertilized)
Larva	6 ½
Pupa	14 ½
Total	24

8. How is sex determined in honey bees?

The queen measures the cell size with her front legs. If it is a large cell, she lays an unfertilized egg. If it is a small cell, she lays a fertilized egg.

- Fertilized egg becomes female (queen or worker) **diploid**
 - Unfertilized egg becomes male (drone) **haploid**
- Diploid drone larvae are cannibalized within 72 hours of hatching since their condition is lethal. No time or food is wasted trying to rear them.**

B. Anatomy and Physiology

Workers:

1. What are the three main body sections of the adult bee and how are they specialized in terms of function?
 - Head
 1. Feeding
 2. Sensory perception – antennae and eyes
 - Thorax – contains wings (2 pair) and legs (3 pair)
 1. Locomotion
 - Abdomen – most organs
 1. Reproduction – laying worker
 2. Digestion

3. Defense - sting
2. What are the major sensory structures of the adult bee and where are they found?
 - Antennae – head
 - Eyes – head
 - Innervated hairs – throughout the body, but concentrated on the antennae
3. What organs are used for smell, taste, and touch?
 - Smell
 1. Antennae
 2. Innervated hairs
 - Taste
 1. Antennae
 2. Taste sensillae (innervated hairs) on the antennae, proboscis and tarsus of the legs
 - Touch
 1. Antennae
 2. Innervated hairs
4. What visual organs do honey bees have?
 - Three simple eyes (ocelli)
 - Two compound eyes
5. Are they all capable of seeing images?
 - No, only the compound eyes see images at lower resolutions than humans
 - bees can see fast moving objects better than we can, e.g. other bees.
6. Can honey bees hear sound?
 - Yes
7. What do bees eat and what food do they collect?
 - Pollen – collected by bees
 - Nectar – collected by bees
 - Honey – ripened by bees

8. How do honey bees carry nectar and water?
 - In their crop or honey stomach

9. How are honey bees specialized for the collection and transport of pollen?
 - Honeybees are covered in branched hairs to which pollen grains stick as they forage for nectar
 - Pollen foraging honey bees use the tongue and mandibles to lick and bite pollen from the anthers of flowers thoroughly moistening it.
 - Moist pollen from the mouth is combined with dry pollen from the body in pollen combs on the inner surface of the hind legs
 - Pollen is scraped from the pollen combs onto the pollen basket on the outside of the opposite hind leg.

10. How do they carry propolis?
 - In their pollen baskets, but other bees must unload it.

11. Where are the wax glands located?
 - Four pairs of wax glands are located on the underside of segments four to seven on the worker's abdomen

Question: Do mostly young or old bees leave with a swarm?

- As far as we know it is a mix of workers that leave with a swarm, although I know of no studies that have really done a careful study of the ages of bees. What is interesting is if you re-hive a swarm, and the colony swarms again, there is a new mix of bees (some that went the first time and some that didn't). –Dr. Richard Fell, Ph.D.
- Hoopingartner answer to be provided by Paul Kist

12. How do honey bees produce brood food?
 - Nurse bees eat bee bread and produce brood food in their hypopharyngeal glands.

Question: Where are the hypopharyngeal glands located on the bee's head?

- First let me comment on the hypopharyngeal glands versus the pharyngeal glands – they are the same glands and the correct name is hypopharyngeal gland. The term pharyngeal gland is a misnomer, and the reason is that the glands open on the basal plate of the hypopharynx, a structure at the base of the mouth. When the glands produce brood food it is discharged from between the mandibles (not through the proboscis). Also, the brood food secretion is a combination of

hypopharyngeal gland and mandibular gland secretions. (Royal jelly is a 50:50 mix, work jelly starts as a 60:40 mix [H:M] and progresses to an 80:20 mix as the worker larva gets older) – Dr. Richard Fell, Ph.D.

13. What is the basic structure and function of the sting?

- The stinger is similar in structure and mechanism to an egg-laying organ, known as the ovipositor, possessed by other insects. In other words, the sting is a modified ovipositor that ejects venom instead of eggs. Thus, only female bees can have a stinger.
- The sting, a hollow needle, actually has three sections. The top section is called the stylet and has ridges. The bottom two pieces are called lancets. When the stinger penetrates the skin, the two lancets move back and forth on the ridges of the stylet so that the whole apparatus is driven deeper into the skin. The poison canal is enclosed within the lancets

14. What happens when a bee stings?

- When a honey bee stings a mammal, the stinger becomes embedded. In its struggle to free itself, a portion of the stinger is left behind. This damages the honey bee enough to kill her. The stinger continues to contract by reflex action, continuously pumping venom into the wound for several seconds. Arizona State – information sheet 2

Question: What happens when a bee stings another insect?

- She can sting repeatedly.

15. How long does a bee live?

- The life span of the worker during summer is about 6 weeks. Workers reared in the fall may live as long as 6 months, allowing the colony to survive the winter and assisting in the rearing of new generations in the spring before they die. MAAREC – The colony & its organization

Queens:

1. Why are queens larger than workers and why does queen size change during the year?
 - Queens contain developed ovaries, which make them larger.
 - Queens change size during the year as their ovaries change size depending on whether they are laying eggs or not.
2. Where are the ovaries located and how do queens store sperm from mating?

- The ovaries are located in the queen's abdomen.
 - The sperm is stored in a special organ known as the spermatheca.
3. When does a queen mate and with how many drones?
 - **About one week after emerging from a queen cell**, the queen leaves the hive to mate with several drones in flight.
 - The queen mates, usually in the afternoon, with **seven to fifteen drones** - MAAREC
 4. Where do queens mate?
 - In Drone Congregation Areas at an altitude above 20 feet
 - If bad weather delays the queen's mating flight for more than 20 days, she loses the ability to mate and will only be able to lay unfertilized eggs, which result in drones.
 - After mating, the queen returns to the hive and begins laying eggs in about 48 hours.- MAAREC
 5. How many eggs does a queen lay in a day?
 - During peak production, queens may lay up to 1,500 eggs per day.
 6. Does the number vary?
 - Yes, from zero in the winter to up to 1,500 in the spring and summer.
 7. How does a queen know whether to lay a fertilized or an unfertilized egg?
 - The queen measures the cell size with her front legs. If it's a small cell, she releases sperm from her spermatheca and fertilizes the egg. If it's a large cell, she does not fertilize it.

Question: If cell size determines the sex of the bee, who determines the ratio of drones to workers? Workers

Question: How many sperm does the queen release when fertilizing an egg? She releases several sperm from the spermatheca each time she lays an egg destined to become either a worker or queen.

8. What are the main functions of a queen, other than egg laying?
 - Pheromone production. The honey bee queen produces pheromones that function in both releaser and primer roles such as attracting a retinue of workers around her, attracting drones on mating flights, preventing workers from reproducing at the individual (worker egg-

laying) and colony (swarming) level, and regulating several other aspects of colony functioning.

9. Does a queen ever leave the colony after mating?

- Yes, swarming or absconding

10. Can there be more than one queen in a colony?

- Yes.

Question: What percentage of colonies have more than one queen?

- As best we can determine between 1 – 3% of colonies will have more than one queen. I have found as many as 3 queens in a hive, all laying on different frames. – Dr. Richard Fell, Ph.D.

11. Under what conditions are new queens reared?

- New queens are raised under three different circumstances: emergency, supersedure, or swarming.- MAAREC

Drones:

1. How does a drone differ from a worker in appearance?

- Larger, rounder, larger compound eyes, no pollen baskets

2. Why don't drones have a sting?

- The sting is a modified ovipositor, which is only present in females

3. How many days after emergence does a drone reach sexual maturity and initiate mating flights?

- Drones become sexually mature about 10 days to 2 weeks after emerging and die instantly upon mating
- Drones take their first flights between five and eight days post-emergence (Ruttner 1966). These first flights are short, possibly for orientation, and are followed by longer potential mating flights approximately 10 days later which can last more than 30 minutes (Witherell 1971).

4. How many times does a drone mate?

- Once

5. Why?
 - Drones die when their reproductive organs are snapped off during mating.

6. What two senses do drones use to locate queens for mating?
 - Drones are able to find and recognize the queen by her chemical odor (pheromone). MAAREC
 - Sight

7. When are drones reared?
 - Drones are generally present only during late spring and summer in a queenright hive. - MAAREC
 - Any time of year in a queenless hive

Question: Will introducing drone comb to the colony induce drone rearing at other times of the year?

The answer is yes and no depending on the time of year and the colony condition. For example, it is difficult to get bees to raise drones in the winter when they normally do not rear them. It is possible to get them to rear drones a little earlier than they normally would in the spring. Also, most young colonies do not rear drones, but adding drone comb can get them to do so. – Dr. Richard Fell, Ph.D.

C. Colony Organization

Social System:

1. What are the basic labor activities performed by workers (i.e. nurse activities and brood care, attending queen, nest construction, cleaning, guarding, etc.)
 - Answered in the question

2. How is the labor system organized and how do tasks change as a function of age?
 - Day 1 - 3. Cell cleaning & brood incubation.
 - Day 4 - 6. Feeding older larvae (honey + pollen).
 - Day 7 - 12. Feeding young larvae (brood food).
 - Day 13 - 18. Processing nectar into honey (water evaporation), wax making, pollen packing.
 - Day 19 - 21. Guarding and orientation flights.
 - Day 21 - 6th week. Foraging for nectar, pollen, water & propolis.
 - Duties depend on the maturity of the brood glands, wax glands (day 12) & sting gland (day 18) - bees can revert to earlier duties if required. Other duties included ventilation, humidity and temperature control.

3. When (age) do workers forage and what four things do bees collect?
 - Day 21 to 6th week.
 1. Nectar
 2. Pollen
 3. Water
 4. Propolis

4. What is the function of each?
 - Nectar – ripen into honey – bees' carbohydrate source
 - Pollen – bees' protein source
 - Water – thermoregulation
 - Propolis – seals cracks, disinfects hive

5. What is a pheromone and why are they important to colony functioning?
 - Pheromones are chemical regulators that act to either induce behavior such as mating or stinging or prevent behavior such as egg-laying by workers.

6. Which bee produces the pheromones most important to normal colony functioning?
 - Queen

7. What are the basic functions of the bee dances?
 - The bee dance delivers messages from the forager to other foragers which includes:
 - Direction
 - Distance
 - Source
 - Quality

Natural Nest:

1. Where do honey bees naturally nest?
 - Tree cavities

2. What does a natural nest look like?
 - Nest cavities are vertically elongate and approximately cylindrical. Most are 30 to 60 liters in volume and at the base of trees. Nest entrances tend to be small, 10 to 40 cm², and at the nest bottom. Rough bark outside the entrance is often smoothed by the bees. Inside the nest, a thin layer of hardened plant resins (propolis) coats the

cavity walls. Combs are fastened to the walls along their tops and sides, but bees leave small passageways along the comb edges. The basic nest organization is honey storage above, brood nest below, and pollen storage in between. Associated with this arrangement are differences in comb structure. Compared to combs used for honey storage, combs of the brood nest are generally darker and more uniform in width and in cell form. Drone comb is located on the brood nest's periphery.

3. What materials are used to construct the nest?
 - Propolis to smooth the entrance and walls and to seal cracks
 - Beeswax to build combs
 - A darkened enclosure is needed for efficient wax secretion – worker wax glands secrete more wax and bees build more comb in darker sites compared to bees exposed to light. – MAAREC Basic Bee Biology for Beginners.

Question: What materials are used to cap brood cells?

- The workers cap the cell with wax, but the larva spins a partial cocoon underneath giving the capping a different appearance. __Richard Fell, Ph.D., Professor and Interim Department Head, Department of Entomology, Virginia Tech
4. What is the basic structure of the comb (cell shape and structure)?
 - The cells are six-sided (hexagonal) and have a three-part bottom pyramid shape. Cells are horizontal facing both directions from a central midrib that provides important comb strength. The cells slope slightly upward. __MAAREC
 5. Is there a natural pattern to comb utilization in the nest?
 - Yes
 6. For example, where is brood reared and pollen stored?
 - The basic nest organization is honey storage above, brood nest below, and pollen storage in between
 7. Where do they store honey?
 - Above the brood nest
 8. How do we take advantage of this natural organization in our management?
 - Brood boxes on the bottom of the colony

- Honey supers above the brood boxes

Colony Life Cycle:

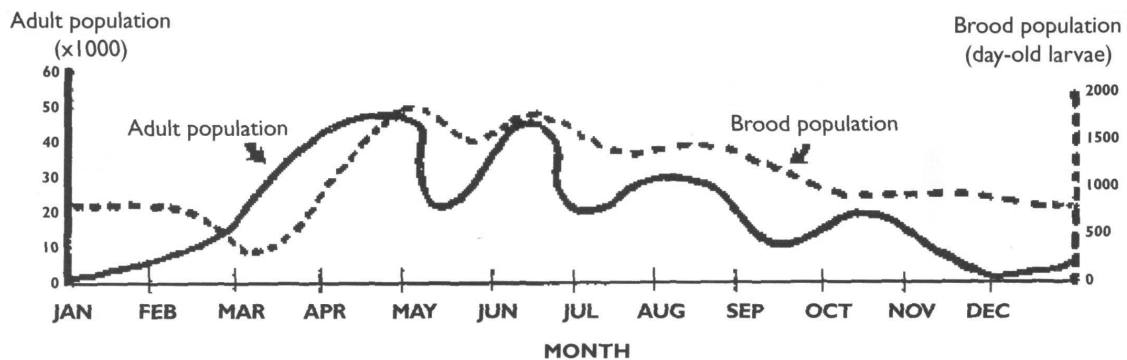
1. What does a honey bee colony do in the winter?
 - As temperatures drop, the bees draw closer together to conserve heat. The outer layer of bees is tightly compressed, insulating the bees within the cluster. As the temperature rises and falls, the cluster expands and contracts. The bees within the cluster have access to the food stores. During warm periods, the cluster shifts its position to cover new areas of comb containing honey. An extremely prolonged cold spell can prohibit cluster movement, and the bees may starve to death only inches away from honey.
2. Spring?
 - During early spring, the lengthening days and new sources of pollen and nectar stimulate brood rearing. The bees also gather water to regulate temperature and to liquefy thick or granulated honey in the preparation of brood food
 - Later in the spring, the population of the colony expands rapidly and the proportion of young bees increases. As the population increases, the field-worker force also increases. Field bees may collect nectar and pollen in greater amounts than are needed to maintain brood rearing, and surpluses of honey or pollen may accumulate).
 - As the days lengthen and the temperature continues to increase, the cluster expands further and drones are produced. With an increase in brood rearing and the accompanying increase in adult bees, the nest area of the colony becomes crowded. Combined with crowded conditions, the queen also increases drone egg laying in preparing for the natural division of the colony by swarming.
 - In addition to rearing workers and drones, the bees also prepare to rear a new queen so that the colony can reproduce by swarming
3. Summer?
 - During the early summer, the colony reaches its peak population and concentrates on the collection of nectar and pollen and the storage of honey for the coming winter. After reproduction, all colony activity is geared toward winter survival. Summer is the time for storage of surplus food supplies. The daylight period is then longest, permitting maximum foraging, although rain or drought may reduce flight and the supply of nectar and pollen available in flowers. It is during the summer that stores are accumulated for winter.
 - During hot summer days, the colony temperature must be held down to about 93° F. The bees do this by gathering water and spreading it on the

interior of the nest, thereby causing it to evaporate within the cluster by its exposure to air circulation.

4. Fall?

- In the fall a reduction in the amounts of nectar and pollen coming into the hive causes reduced brood rearing and diminishing population. Depending on the age and egg-laying condition of the queen, the proportion of old bees in the colony decreases.
- Propolis collected from the buds of trees is used to seal all cracks in the hive and reduce the size of the entrance to keep out cold air.
- When nectar in the field becomes scarce, the workers drag the drones out of the hive and do not let them return, causing them to starve to death. Eliminating drones reduces the consumption of winter honey stores

5. How does a colony population change during the year?



6. When do colonies reproduce?

- Colonies reproduce by swarming in April – June. Swarming is associated with congestion in the brood nest, ample nectar flows and a period of good weather following a period of bad weather.

7. How?

- When preparing to swarm, bees build large numbers of queen cells along the bottom of the comb. Shortly before a new queen emerges, the bees stop their field work. The swarm bees, usually at least half the bees in the colony, engorge with honey. They leave with the queen, fly a short distance, and cluster on a bush or tree limb. They wait there while scout bees locate a satisfactory living place.

- In addition to raising several queens, colony preparations for swarming include decreased feeding of the queen, the rearing of more drones, and a reduction in foraging activity by the field force. As the workers feed the queen less royal jelly, her egg laying is reduced and her abdomen shrinks. In order to accompany the primary swarm when it leaves the hive, she must reduce her body weight by 50 percent or more. Normally, the primary swarm consists of the old queen, a few drones, and 50–60 percent of the workers. Just prior to emerging from the parent hive, the workers engorge themselves with honey. Swarms normally emerge from their hives on sunny, calm days, usually between 10:00 a.m. and 2:00 p.m., and initially settle nearby on a tree limb, shrub, post, or building. They may remain minutes to several days at this initial location before moving to a new cavity selected for them by scout bees. Occasionally, other smaller swarms may follow (afterswarms) with one or more newly emerged virgin queens.

Beekeeping Equipment and Assembly

A. Hive Types

1. What is the most widely used type of hive?
 - Today most beekeepers in the United States use the Langstroth or modern ten-frame hive.
2. What are the main features of a Langstroth hive?
 - Moveable frames which respect bee space.
3. What is a nuc, or nucleus colony?
 - A nucleus colony, or nuc, is essentially a smaller hive, sometimes in a smaller box, consisting of bees in all stages of development, as well as food, a laying queen, and enough workers to cover from three to five combs

B. Components of the Langstroth hive

Basic components:

1. What is bee space and why is it important in the design of a modern hive?
 - Bee space—1/4 - to 3/8-inch space between combs and hive parts sufficient to permit unhindered passage of adult bees but too small for them to build comb or deposit propolis.
 - Bee space allows for the construction of moveable frames which the bees to not adhere to each other or the other hive components. Moveable

frames allow for hive inspection and honey harvesting without destroying comb.

2. What is the purpose of a hive stand?
 - The hive stand, actually an optional piece of equipment, elevates the bottom board (floor) of the hive off the ground. In principle, this support reduces dampness in the hive, extends the life of the bottom board, and helps keep the front entrance free of grass and weeds. Hive stands may be concrete blocks, bricks, railroad ties, pallets, logs, or a commercially produced hive stand. A hive stand may support a single colony, two colonies, or a row of several colonies.

3. What is a landing board?
 - The 2 inches of the bottom board that extend in front of the hive upon which the bees land.
 - A landing board is a small, angled platform at the entrance of the hive on which bees descend and settle after flying, also referred to as an alighting board. Some refer to a landing board's frame as a "hive stand", but this is not a correct use of the term.

4. Describe the advantages and disadvantages of a solid and screen bottom board.
 - Solid Bottom Board
 - Keeps colony interior darker
 - Less chance of brood chilling on bottom frames
 - More places for SHB to hide
 - Does not allow Varroa mites to fall outside hive during normal grooming behavior by bees
 - Reduces ventilation

 - Screened Bottom Board
 - Useful in Varroa Control using IPM – powdered sugar or FGMO
 - Aids ventilation
 - Less places for SHB to hide
 - Chilling of brood on bottom frames more likely
 - Lets more light into colony
 - Useful in FGMO applications

5. What are the dimensions of a deep, medium, and shallow hive box?
 - All boxes have an inside width is 14 - 1/16 inches and the inside length is 18 - 5/16 inches. Outside dimensions may vary based on

construction materials. Polystyrene boxes are typically larger because the material is thicker.

Type	Inside Depth
Deep	9 1/2 inches
Medium (Illinois)	6 5/8 inches
Shallow	5 11/16 inches
Comb	4 1/2 inches

6. Which hive box (es) may be used as a brood chamber?

- All

7. Honey supers?

- All

8. Describe the parts and proper method for nailing a frame together.

- Locate Top Bar and remove the thin 1/4" x 1/2" x 17" Foundation Anchor/ Wedge Cleat.
- Locate 2 End Bars and Top Bar. Insert End Bar into Top Bar, do not force pieces together. Locate 4- 1 1/4" wire nails and drive 2 nails through top bar into end bars on each end
- Locate Grooved Bottom Bar, insert bottom bar into grooves in the end bars
- Locate 4- 1 1/4 " Wire Nails and drive 2 Nails through the Bottom Bar into end bars on each side
- Nail one nail from each end through end piece into top bar under frame rest.

9. What are the dimensions of a frame for a deep and medium hive box?

Type	Size
Deep	9 1/8 inches X 19 inches (top bar) 17 5/8 inches (bottom bar)
Medium	6 1/4 inches X 19 inches (top bar) 17 5/8 inches (bottom bar)

10. When should crimped wire foundation be used?

- In areas where heat is a factor to prevent foundation from sagging.
- In comb for use in a honey extractor
- In comb to be reused repeatedly.

11. Thin surplus foundation?

- Comb honey production – when the foundation is to be eaten in the finished product

12. Duragilt foundation?

- Duragilt is a sheet of very thin Smooth clear plastic that is coated with beeswax and has metal edges. The hexagonal worker cells are embedded in the wax.
- No wiring needed.
- Use in frames for brood boxes or extracted honey

13. Pierco foundation?

- This is a piece of plastic, approximately 1/8 inch thick and has the hexagonal worker cells embedded in the plastic and coated with beeswax
- Use in brood comb and honey supers for extraction.
- It is VERY durable. You can scrap the comb off with a hive tool and never damage the cell.
- Wax moths & mice cannot destroy it.
- It is very easy to spot eggs against the black brood sheets.
- You can spin it in an extractor at any speed and never blow it out.
- It doesn't droop in a hive or bow out no matter what the temperature.
- Open the box and drop the frame into the hive – no assembly
- You can store it in any temperature.
- It is much more cost effective than constantly replacing damaged foundation.
- It can be shipped without damage in any temperature.

14. Describe how to wire a frame, include any specialized equipment for this procedure.

- Step 1 - Insert Eyelets to prevent the wire from cutting into the soft white pine end bars. Eyelets fit into the 2 or 4 holes located in the end bars.

Step 2 - Drive 1- 5/8" wire nail in to the end bar just above and slightly to the side of bottom most #1 eyelet, do not drive the nail completely in as this nail is the anchor point for your foundation wire.

Step 3 - With the Spool of wire sitting next to the frame pull out enough wire to make two passes starting at the # 1 eyelet and continuing on through the #2 eyelet coming out next to the wire spool. On the frame opposite the spool at the # 1 eyelet pull enough wire out to allow the wire to be threaded thru the # 3 eyelets and emerging out the #3 eyelet next to the spool of wire, again at the #1 eyelet opposite the wire spool pull enough wire through to allow threading the wire on thru the #4 eyelets ending with the wire coming out on the wire spool end of the

frame. Drive an anchor nail above the #4 eyelet and wrap the end of the wire two or three turns then drive the nail flush with the end bar. Using a pair of needle nose pliers, pull the wire tight starting at the top (#4 eyelet) and work down to the bottom (#1 eyelet) and finish by anchoring the wire around the nail and drive the nail flush with the end bar surface.

Step 4 - Cut any excess wire off that is sticking up next to the nail heads and tap any wire left, flush into the end bars.

- Specialized equipment
 - Eyelets
 - 28 oz. tinned wire
 - Eyelet driver
 - Tack hammer
 - Needle nose pliers

15. Why is an inner cover used in a beehive?

- It prevents the bees from gluing down the outer cover to the super with propolis and wax. It also provides an air space just under the outer cover for insulation. During summer, the inner cover protects the interior of the hive from the direct rays of the sun. During winter, it prevents moisture-laden air from directly contacting cold surfaces. **The center hole in the inner cover may be fitted with a Porter bee escape to aid in removing bees from full supers of honey.**

16. What are the basic types of outer covers?

- An outer telescoping cover protects hive parts from the weather. It fits over the inner cover and the top edge of the uppermost hive body.
- Migratory lids fit flush with the sides of the hive body and may or may not extend over the ends. In addition to being lightweight and easy to remove, these covers allow colonies to be stacked. Tight stacking is important in securing a load of hives on a truck.

17. What materials are used to construct a hive?

- Wood such as pine, cypress or redwood
- Plastic
- Polystyrene
- Metal – telescoping top cover

18. Frame?

- Wood
- Plastic

Additional hive parts:

1. What is a queen excluder and how is it used?
 - A queen excluder is constructed of a thin sheet of perforated metal or plastic with openings large enough for workers to pass through, but too small to allow the queen or drones to pass through.
 - The queen excluder is used over the brood nest under the first honey super to confine the queen and her brood as well as stored pollen to the brood nest.

2. Describe three (3) types of sugar syrup feeders and list advantages and disadvantages of each.
 - Division board feeder
 - Pro – bees will feed from it during cold weather
 - Con – bees drown in it easily, must open hive to access syrup level or to refill
 - Hive top feeder
 - Pro – bees will feed from it during cold weather
 - Con – must open hive to check feed level or to replenish syrup
 - Boardman Feeder
 - Pro – can see syrup level without opening hive, can change feeder without opening hive, bees do not drown in syrup
 - Con – can induce robbing, bees will not feed from it during cold weather

3. What is a fume board?
 - Fume board—a rectangular frame, the dimensions of a super, covered with an absorbent material such as burlap, on which is placed a chemical repellent to drive the bees out of supers for honey removal.

4. What are the reasons for using an entrance reducer?
 - Keep out rodents
 - Make the hive easier to defend (reduce robbing)

5. When would a ventilated inner cover be used?

6. What is the function of a frame spacer?

- A Frame Spacers is a device to space 8 or 9 frames evenly in a 10-frame hive body.
 - Frame rest spacers
 - Comb type tool

Discussion ended here March 17, 2009

7. What is a drone trap?

- A Varroa mite control device, which consists of frames of drone brood. The frames are removed when the drone brood is capped and then frozen for 1 to 3 days, killing the drone pupae and varroa mites inside the cells. The frames are returned to the bees where the dead pupae and mites are removed and the process repeated.

8. Beetle trap?

- A device for trapping Small Hive Beetles. There are several types on the market
 - Small Beetle Trap - 4" square corrugated pieces of plastic used with Check Mite Plus . To use; cut a strip of Check Mite in half, staple both halves to the bottom side of the black corrugated plastic and slide to the back of Bottom Board with strips facing down. Remove after 7 days.
 - Hood SHB trap - Attach this trap to the bottom bar of a frame and fill with apple cider vinegar or mineral oil. Place in the #1 or # 10 frame position in the brood box in the summer or a top super in the winter. The beetles will enter and die.
 - West Beetle Trap - This trap sits on the bottom board of your hive, which you must modify by installing some wooden spacers. You fill the trap with vegetable oil, you must level your hives or the mixture will pour out the front.
 - AJ's Beetle Eater - Place it between the top bars and fill it half way up with vegetable oil. Place the trap where the beetles congregate.

C. Safety equipment

1. What color clothing is best for working in and around an apiary?
 - White or tan clothing is most suitable when working bees. --MAAREC
2. Name three (3) types of veils.
 - Open at the top to fit over a hat
 - Hatless veils
 - Veils that form part of a bee suit. --MAAREC

3. Why are most veils dark color?
 - To reduce the sun's glare and improve visibility.

4. What is a hive tool?
 - The hive tool is a metal bar essential for prying apart frames in a brood chamber or honey super, separating hive bodies, and scraping away wax and propolis. --MAAREC

5. List the advantages and disadvantages of canvas, leather, and plastic coated gloves.
 - Canvas
 - Pro – inexpensive, cool
 - Con – not sting-proof
 - Leather
 - Pro – Sting-proof
 - Con – Expensive, not washable, hot, poor dexterity
 - Plastic coated
 - Pro - sting proof and moisture proof, inexpensive
 - Con – hot to wear

6. What is the function of a smoker?
 - Calms the bees by blocking the receptors for alarm pheromones with smoke.

7. What materials may be used for fuel in a smoker?
 - Suitable smoker fuels include burlap, corn cobs, wood shavings, pine needles, cardboard, punk wood, bark, sumac bobs, cotton rags, dry leaves, and bailer twine.
 - Do not use any material treated with rodenticides or fungicides.

STOP HERE FOR MARCH 17, 2009 CLASS

Yearly Management Cycle

A. Spring

Describe the general annual growth cycle of a bee colony.

1. What are the main objectives in spring management?
 - Early spring management is primarily concerned with sufficient food stores and secondly with disease and mite control.

- Inspect and clean up colonies
 - Feed light colonies to prevent starvation
 - The equipment from colonies lost during the winter should be removed from the apiary
 - Swarm Management
2. Describe a good brood pattern.
 - A healthy brood pattern has very few empty cells; and the cappings are uniformly brown or tan in color, with a decidedly convex appearance.
 3. What are the characteristics of a good apiary site?
 - Ample forage
 - Sun
 - Dry ground
 - Water source
 - Windbreak
 - Vehicle access
 - No pesticide application in immediate area
 - Out of sight to prevent vandalism
 4. What are signs that a queen is present in a hive?
 - Eggs & young larva
 - Bees are calm on the frames
 - No 'roaring' sound when the box is opened
 5. What are indications in the hive of a failing queen?
 - Scattered brood pattern
 - Multiple queen cells started
 - Much drone brood mixed in with worker brood

Question – Why is the brood pattern scattered when the queen is failing?

- Queen brood pattern - it typically becomes spotty due to an increase in non-fertilized and non-viable eggs. As a queen ages her sperm reserve decline, making it more difficult to lay fertilized eggs. A good number of these are probably removed by workers. It is also possible she produces non-viable eggs. I do not believe there is any correlation to spreading brood pheromones. I have seen cases where queens produce a good pattern of eggs, but a large percentage are gone by the time the cells are capped, suggest a problem with the queen regarding the eggs/larvae produced. ___Richard Fell, Ph.D., Professor and Interim Department Head, Department of Entomology, Virginia Tech

Swarming

1. What is swarming and why is it a concern?
 - a. Swarming is the natural instinctive behavior of honey bees to reproduce.
 - b. Colonies that swarm rarely recover in time to produce a significant honey crop. Therefore, swarm control is essential to successful honey production.

2. Describe two management techniques that can be used to prevent swarming.
 - Reversing hive bodies can be a valuable aid in swarm prevention; move the brood nest (if in the top box) to the bottom and place the empty box from the bottom on top.
 - One of the best ways to prevent strong colonies from swarming is to split them or take divisions from them in April or early May
 - Demareeing involves separating the queen from the brood and allows for the continuation of rapid colony growth. However, it requires a great deal of labor and time. First you must examine all frames of brood in the colony and destroy the queen cells. In addition, you must locate the queen and place her in the lower brood chamber with frames of capped brood. Then, collect frames of uncapped brood (eggs and larvae) and place them in a new upper brood chamber. Next, place a hive body of empty drawn comb above the box with the queen and open brood. Place a queen excluder on top of the second hive body and put the box of uncapped brood above the excluder, creating the new upper brood chamber. The colony is now at least three boxes in height with the first hive body containing the queen, empty combs, and frames of capped brood. The middle hive body contains empty drawn combs and perhaps a frame or two of capped brood; the top box (above the excluder) contains the young, uncapped brood frames. The Demaree method creates the following conditions: the uncapped brood in the top super will attract most of the young nurse bees away from the brood nest in the bottom hive body, thus relieving crowding; the addition of empty drawn comb below the excluder in a second hive body provides sufficient space for the queen to continue laying eggs. More space for egg laying will be available as the capped brood emerges. In 7 to 10 days, you should return to inspect the colony and destroy any new queen cells that may have developed in the lower or (more likely) upper hive bodies. A second round of moving capped brood into the upper hive body (transfer frames above that are now empty of brood to the box below) will produce an even stronger colony. Be sure the queen stays in the lowest chamber as you transfer frames. You can remove the queen excluder once the nectar flow begins; the

frames you elevated above the queen excluder will become honey storage frames once the brood emerges.

3. What are signs that a hive is ready to swarm?

- They are building queen cells

4. Has swarmed?

- Population drop
- No queen or new queen
- Capped or uncapped queen cells

B. Summer

1. What is the difference in top and bottom supering and when would each be appropriate?

- a. With top supering, each new super is placed on top of the last one.
 - i. you need only look into the top of the hive when deciding if more supers are needed. – extracted honey.
- b. With bottom supering, new supers are inserted between the brood nest and the partially filled supers.
 - i. partially filled supers at the top draw the bees up into the empty one.
 - ii. produces less travel stain to newly capped honey cells since fewer bees have to walk over the combs in the upper supers. – comb honey.- MAAREC

2. Why is it important to keep the queen separated from honey supers?

- To keep brood and pollen out of the honey supers
- Don't want to accidentally remove queen when pulling honey

3. Describe the configuration of a hive for production of extracted honey.

- Extracted honey supers are added above the existing brood area of a colony using a queen excluder or not, according to personal preference.
- You should add excess super space to colonies early in the season (oversupering) to maximize honey storage.

4. List two (2) indications that a honey flow is in progress.

- Nectar drips out of the cells when the frames are examined
- New white wax is deposited in the hive

5. What characteristics of the hive are used to evaluate queen quality?
 - Temperament
 - Disease resistance
 - Honey production
 - Comb building
 - Brood nest size (change w/ food supply)
 - Rate of spring build-up
 - Tendency to swarm
 - Over wintering ability

6. When should a queen be replaced?
 - Most queens have a maximum reproductive period of approximately 2 years, so replacing the queen at regular intervals or when there is any sign of failure is important.

Honey removal

1. What is a bee escape?
 - An escape is a device placed between the brood chamber and the honey supers; it functions as one-way door, allowing bees to move down but not back up into the supers once they are below the escape.

2. List two (2) bee repellants.
 - benzaldehyde (oil of almond)
 - butyric anhydride (Bee-Go®)
 - oil/herb mixture (Fishers Bee-Quick®).

3. Describe how bee repellants are used to remove honey supers.
 - Sprinkle a few drops of the chemical on a fume board, which is made by stretching a heavy piece of cloth over a frame that is the size of the inner cover. Cover the top with a piece of sheet metal to reinforce it and paint it black so that it absorbs heat from the sun. Place the fume board over the full supers. The fumes drive the bees downward. The board should remain on the super only long enough to get the bees out, usually 3 to 5 minutes under ideal conditions.

4. What are other methods for removing bees from honey supers?
 - Brush bees from individual frames using a bee brush
 - Bee blower

- Bee escape

Extraction

1. What are the two (2) main types of extractors?
 - a. Tangential
 - b. Radial

2. How are cappings removed?
 - Cappings scratcher
 - Knife – heated or not
 - Power uncapper

3. How is a capping scratcher used?
 - Fork that is raked across the comb opening each cell

4. Describe the general steps you would use to clean and bottle honey.
 - Strain honey through nylon filter to remove debris and wax
 - After straining, keep the honey in a settling tank for 2 to 3 days to allow most of the air bubbles and small foreign particles to rise to the top.
 - Skim foam off the top
 - Bottle from a gate in the bottom of the settling tank or bucket

5. How should honey be properly stored to prevent crystallization?
 - Storage temperatures and the length of storage can affect honey quality. Changes in processed honey are kept to a reasonable level if the honey is stored at temperatures of 70°–75°F (21°–24°C). Unprocessed honey is best stored below 50°F (10°C). Even at room temperature, honey gradually becomes darker and changes flavor and composition. Differences will be visible in less than one year. Both sunlight and artificial light further affect honey stored in clear glass bottles. For long-term storage, keep liquid honey in a freezer at 0°F (–18°C).

6. What is the appropriate range of water concentration in honey?
 - 15.5% to 18. 6% __State Fair of Virginia – Open Honey Competition

C. Fall

1. List the main hive preparations for winter.
 - Treat for mites by August to ensure Winter bee development
 - Feed bees to ensure 60 lbs. of stores per colony

- Consolidate brood in lower brood chamber with honey above
 - Remove excess equipment
 - Ensure adequate ventilation
 - Combine weak hives with strong colonies
 - Install mouse guards
2. What colony population (bee numbers) is recommended for good winter survival?
- I usually use the figure of 30,000 bees going into the winter. That number equates to a full-depth hive body that is pretty well filled with bees. It gives a nice large cluster that is more efficient with regard to food utilization and heat production and conservation. ___Richard Fell, Ph.D., Professor and Interim Department Head, Department of Entomology, Virginia Tech

There are 4000 bees in 1-pound of bees

3. What is Fumidil-B and how is it applied in a bee hive?
- Fumidil-B® is a powdered medication for nosema which is mixed into heavy sugar syrup and fed to each colony at a rate of 2 gallons of medicated syrup during mid-fall
4. Describe the proper configuration for preparing a hive for winter.
- Brood in bottom brood box
 - Honey above
 - Entrance reduced
 - Top propped open for ventilation
5. How much honey should a colony have going into winter?
- At least 60 lbs.
6. What concentration of sugar water is used to increase honey stores?
- 2:1 Two Parts Sugar to One Part Water.
 - 1 pound sugar to 1 cup water or 5 pounds sugar to 5 cups water
 - a. Bring water to a boil and stir in sugar. Continue stirring over heat until all crystals dissolve. Remove from heat and cool.

D. Winter

1. What adaptations do honey bees have that allow them to survive winter?
- a. Clustering

- b. Shivering wing muscles
 - c. Honey storage
2. What is/are the primary cause/s for winter losses?
 - Starvation
 - Moisture
 3. When should a hive be checked in winter and why?
 - To determine if it is still alive
 - To determine adequate food stores

STOP HERE FOR MARCH 24, 2009 CLASS

Major Bee Pests

A. Diseases

1. What is the disease of major concern for beekeepers?
 - AFB – American Foul Brood (Bacterial)
2. What stage in the life cycle does it attack
 - Larva less than two days old
3. How is it spread?
 - Nurse bees feed spores to larvae
 - Housekeeper bees cleaning out dead infected larvae in cells
 - Beekeeper using contaminated equipment
 - Robbing bees bringing infected honey to healthy colony
4. Who should you contact if you think your colony might be diseased?
 - State Bee Inspector (Tidewater area – Brenda Johnson)
5. Name two other common brood diseases of honey bees
 - Chalkbrood
 - Sacbrood
 - Stonebrood
 - European Foulbrood
6. What is Nosema and why is it important?
 - A fungal disease that causes dysentery-like illness in bees. (Nosema was demoted from being a protozoan into being a fungus in 2006)

- Causes late spring dwindling
- Severe cases may lead to queen supercedure

B. Honey bee pests

1. What is the major mite pest of the honey bee?
 - *Varroa destructor* (formerly *Varroa jacobsoni*)

2. How does one determine if they have a mite problem?
 - Sugar or ether roll
 - 48-hr. mite count with sticky board
 - Examine drone pupae
 - Bees with deformed wings

3. What is done in the way of treatment for these mites?
 - Formic Acid
 - Sucrose Octonate
 - Soft Chemicals
 - ApiLife Var (Thymol)
 - Apiguard (Thymol)
 - Chemical controls:
 - a. Coumophos (Checkmite) Organophosphate
 - b. Fluvalinate (Apistan) Pyrethroid
 - Powdered Sugar (Dowda Method)
 - Requeen with hygienic or mite-resistant queen
 - Cage queen and break brood cycle

4. What is a wax moth and what damage does it cause?
 - Moth that completes its life cycle within the hive, its larvae eat pollen, cast skins and cocoons.
 - a. Larvae tunnel through wax combs leaving webbing and debris behind
 - b. Larvae damage wooden ware (boxes and frames) when preparing to pupate.

5. How can one avoid problems with wax moths?
 - In the hive: Keep strong colonies
 - Outside the hive:
 - a. Store all equipment with Paradichlorobenzene (PDB) crystals – five or fewer stacked supers
 - b. Freeze equipment and store in well-lit area with good ventilation

c. B401 (Certan) *Bacillus thuringiensis* product (not approved in the U.S.)

6. What is the Africanized honey bee?
 - *Apis mellifera scutellata*
 - The Africanized Honey Bee (AHB) is a result of mating between African bees and European honey bees of North and South America.

7. Why is it a concern?
 - Africanized Honey Bees are dangerous because they attack intruders in numbers much greater than European Honey Bees. Since their introduction into Brazil, they have killed some 1,000 humans, with victims receiving ten times as many stings than from the European strain. They react to disturbances ten times faster than European Honey Bees, and will chase a person a quarter of a mile. Other concerns with Africanized Honey Bees are the effects on the honey industry (with an annual value of \$140 million dollars) and general pollination of orchards and field crops (with an annual value of 10 billion dollars). Interbred colonies of European and Africanized honey bees may differ in pollination efforts, be more aggressive, excessively abandon the nest, and not survive the winters. Further, beekeepers may not continue their business of honey production if faced with aggressive bees. The packaged bee and queen rearing industries are in the southern United States, which would affect the honey industry across the continent.

8. If someone discovers a very aggressive hive, what should be done?
 - If Africanization is suspected, contact your state apiarist or the local bee inspector for help.
 - Re-queen with a line of bees bred for gentleness

STOP HERE FOR MARCH 31, 2009 CLASS

Practical Hive Inspection – What is involved?

1. Knowledge of how to light and use a smoker.
2. Be properly dressed and have proper equipment for a hive inspection.
3. Be able to show how to open a hive.
4. Demonstrate proper techniques for hive inspection.
5. Be able to recognize different stages of brood (eggs, larvae, pupae) and the cells for workers, drone and queens (including queen cups).
6. Be able to differentiate emergency, swarming and supersedure queen cells.

7. Be able to recognize cells with pollen, honey and discuss the normal arrangement of brood, pollen and honey on a comb and in the hive.
8. Be able to give an overall evaluation of colony condition (is the hive, strong or weak, does it need feeding, does the colony appear healthy).
9. Is the queen present and is she doing an acceptable job?
10. How much brood and honey is in the hive?
11. Is there any management needed?
12. Be able to discuss and demonstrate two methods for feeding a colony
13. How would you evaluate the site where the hives are located?
14. What factors should be considered in locating an apiary site?
15. In an urban area?