Honey Bees and Veterinary Medicine

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Outline

- Introduction
- Threats to the Bee Industry
- Components of the Hive
- The Physical Exam
- Honey Bee Diseases

Why should I care about honey bees?

- Agriculture as we know it would not exist without honey bees
  - Contribute $20 billion/year
- **Honey bees are livestock!**
- Important diseases of bees managed with antimicrobials
  - Veterinary feed directive (VFD) → VPCR

US Honey Bee Industry: Pollination

- Most commonly used agricultural pollinators worldwide
  - Directly responsible for ~26% of the US diet
  - Technically an invasive species in North America!

- Honey bees also make several products, each with numerous applications:
  - Honey, propolis, pollen, royal jelly, beeswax, bee venom, and bees

- Honey bee population in the US is at an all-time high
  - ~3.8 million honey bee colonies → ~2/3 transported around US annually
  - 115 to 125K+ beekeepers – mostly hobbyists

Threats to the Honey Bee Industry

Colony Collapse Disorder (CCD)

- First identified in winter 2006 as a sudden loss of majority of adult worker bees from colony with live queen and an absence of dead bees around the colony
  - Cause unknown
  - Reported incidence declining

- Honey bee population still at risk for multiple other stressors
  - Pathogens, parasites, pests
  - Malnutrition
  - Pesticide exposure
  - Management practices
  - Lack of genetic diversity and poor-quality queens

Malnutrition and Pesticides

More diverse nectar and pollen sources = healthier, stronger bees

- Pollen provides protein, vitamins, fats, and minerals
- Decreased floral diversity and changing seasonal availability
- Artificial nutrition necessary for survival, but sub-optimal

Many insecticides toxic to honey bees

- Combination products may exhibit synergism
- Lipophilic pesticides accumulate in wax
- Lethal and sub-lethal effects
  - Reduced larval survival, altered foraging behavior, shortened lifespan
- Fungicides also implicated

Management Practices and Bee Health

- Employing best management practices often challenging and expensive
- Hive location – adequate diverse foraging sites? Close to pesticides?
- Pest control and minimizing exposure to pathogens
- Systematically replacing used comb
- Genetic modification for more resistant bees
- Sometimes what is most profitable is stressful and increases risk of spreading disease

Another Management Complication

- Only 12 antimicrobial products labeled for honey bees
  - All contain either oxytetracycline, tylosin, or lincomycin
  - Both VFD applications and prescription applications
  - All require VPCR
- Effective 2/21/2023, the USDA requires on-site visits to establish a VPCR in order to issue a VFD
  - VPCR may not be established via pictures, videos, or telemedicine
  - Telemedicine may be used once VPCR is established

Components of the Hive

Apis mellifera

- The Western or European honey bee
- 3 castes of honey bees in hive that act as a super-organism (colony)
  - Queen - often marked with a paint dot
  - Drones
  - Workers
- All colony functions (except 1) occur within the hive
  - Sheets of comb made up of a series of hexagonal cells

International Queen Marking Color

COLOR	FOR YEAR ENDING IN:
White (or Gray)	1 or 6
Yellow	2 or 7
Red	3 or 8
Green	4 or 9
Blue	5 or 0

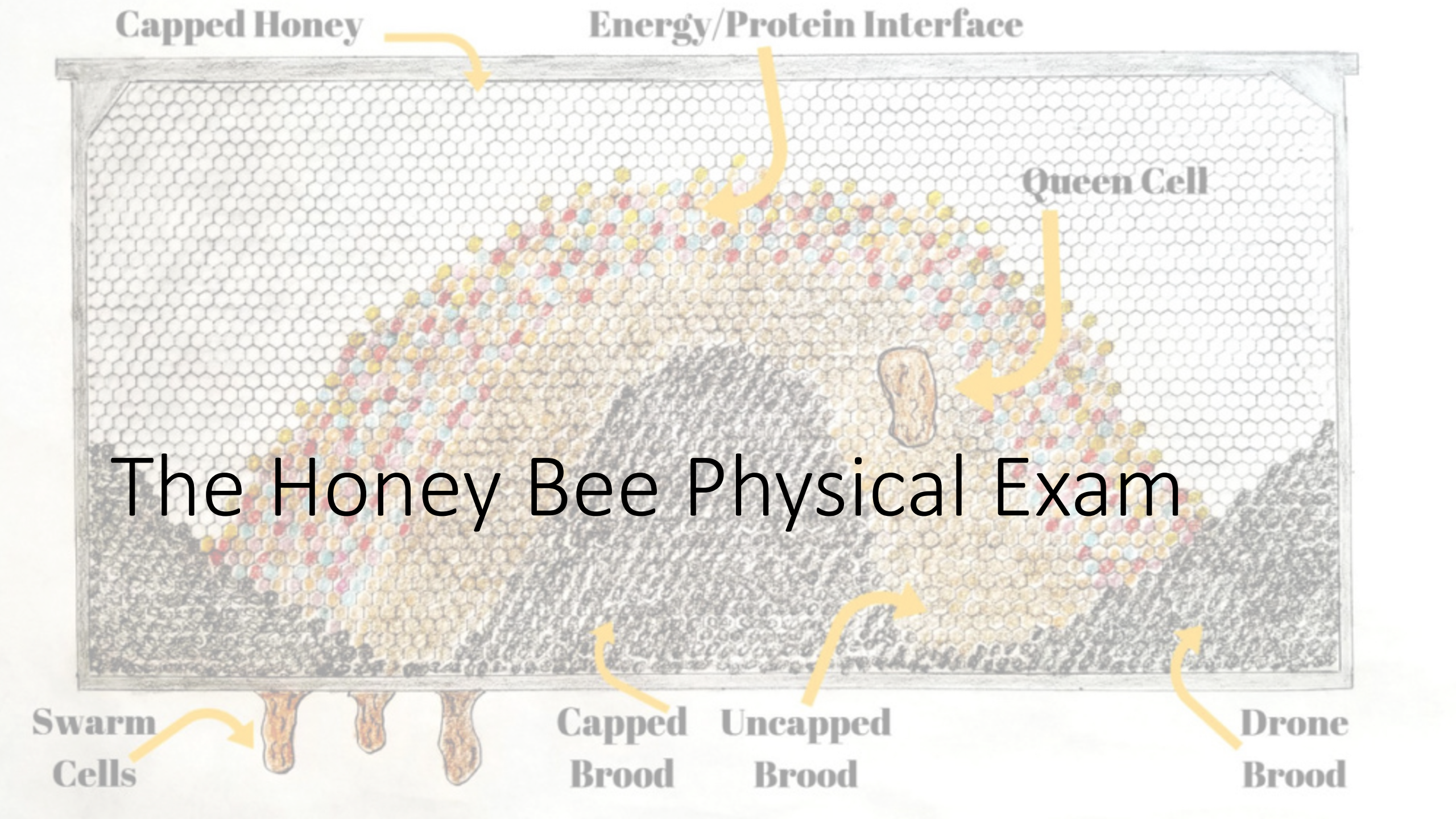
	Queen	Drone	Worker
			
#/colony	1	100s (summer)	10,000s
Diploid or Haploid	Diploid (female)	Haploid (male)	Diploid (female)
Size	Largest	Medium	Small
Lifespan	2 – 3 years	2 months or until mating	6 weeks (summer) to 5+ months (winter)
Primary function	Sole source of fertilized eggs; lays up to 2,000 eggs/day during peak production	Breeding with queen; no other function in hive	Everything else

The Queen

- Colonies only produce new queens when preparing to reproductively split (swarm), or if the old or failing queen has died or is superseded
- Many queen cells will be created → only 1 queen will survive
  - First queen to emerge will kill other queens in their cells and will fight with other emerged virgin queens
- Virgin queens go on 1 mating flight in their lifetime at ~2 weeks of age
  - Mates with 10-20 drones from other hives and stores genetic material for remainder of life
- Queen can choose to lay either fertilized or non-fertilized eggs, depending on needs of colony
- **Poor quality queens consistently cited as cause of colony loss**

Brood

- Composed of eggs, larvae, and pupae
- Housed within cells in the comb
- Colony contains brood most of the year
  - Egg laying temporarily ceases in winter or times of stress
- Total time in brood varies
  - Queen: 16 days
  - Worker: 21 days
  - Drone: 24 days

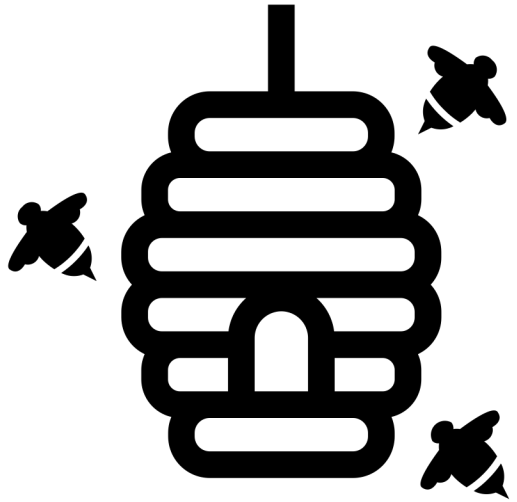


The Honey Bee Physical Exam

Collecting History

Remember biosecurity! Only use beekeeper's hive tools

- Adequate records?
- Age and source of colony and queen?
- Is the queen marked? Has she been recently replaced?
- Any recent changes – treatments, new equipment, feeding, or honey removal?
- Any changes in size or activity of hive?
- Any signs of pests or pathogens?
    - Is the beekeeper monitoring for pests and pathogens?

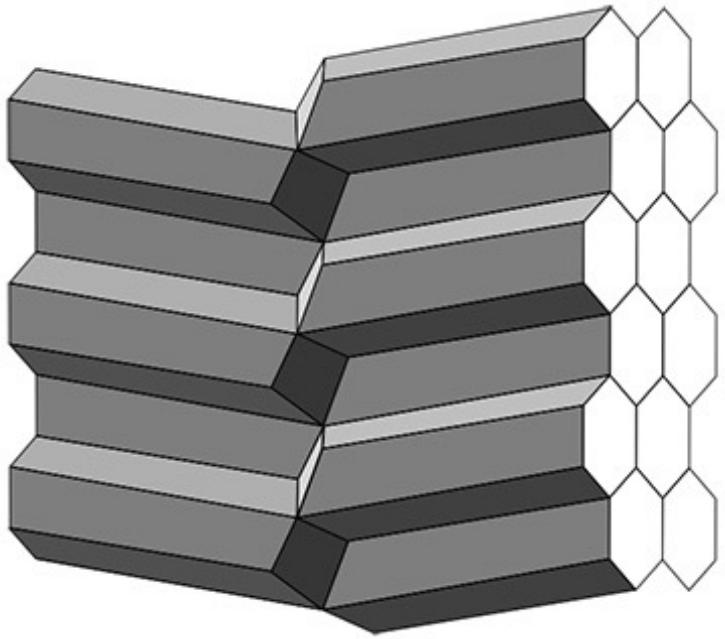


The Physical Exam – Outside the Hive

- Activity – bees should constantly be flying in and out
- Numerous dead bees in front of the hive
- Crawling/trembling bees on landing board or ground
- Hives with decreased or increased activity
  - Lower activity normal/expected if recent requeening or split
  - Markedly increased activity can be due to robbing
  - Fighting bees
  - Other species (ex: yellow jackets) entering hive

Physical Exam – The Brood

- Hold frame perpendicular to line of site to inspect brood
  - Sunlight or flashlight needed
- Color, consistency, and pattern of brood stages
  - Brood of same age should be grouped together in concentric circles with few gaps
  - Normal eggs: white, upright in the cell, attached to bottom center
- Easiest way to evaluate health of the colony!
  - Healthy brood = healthy queen and colony

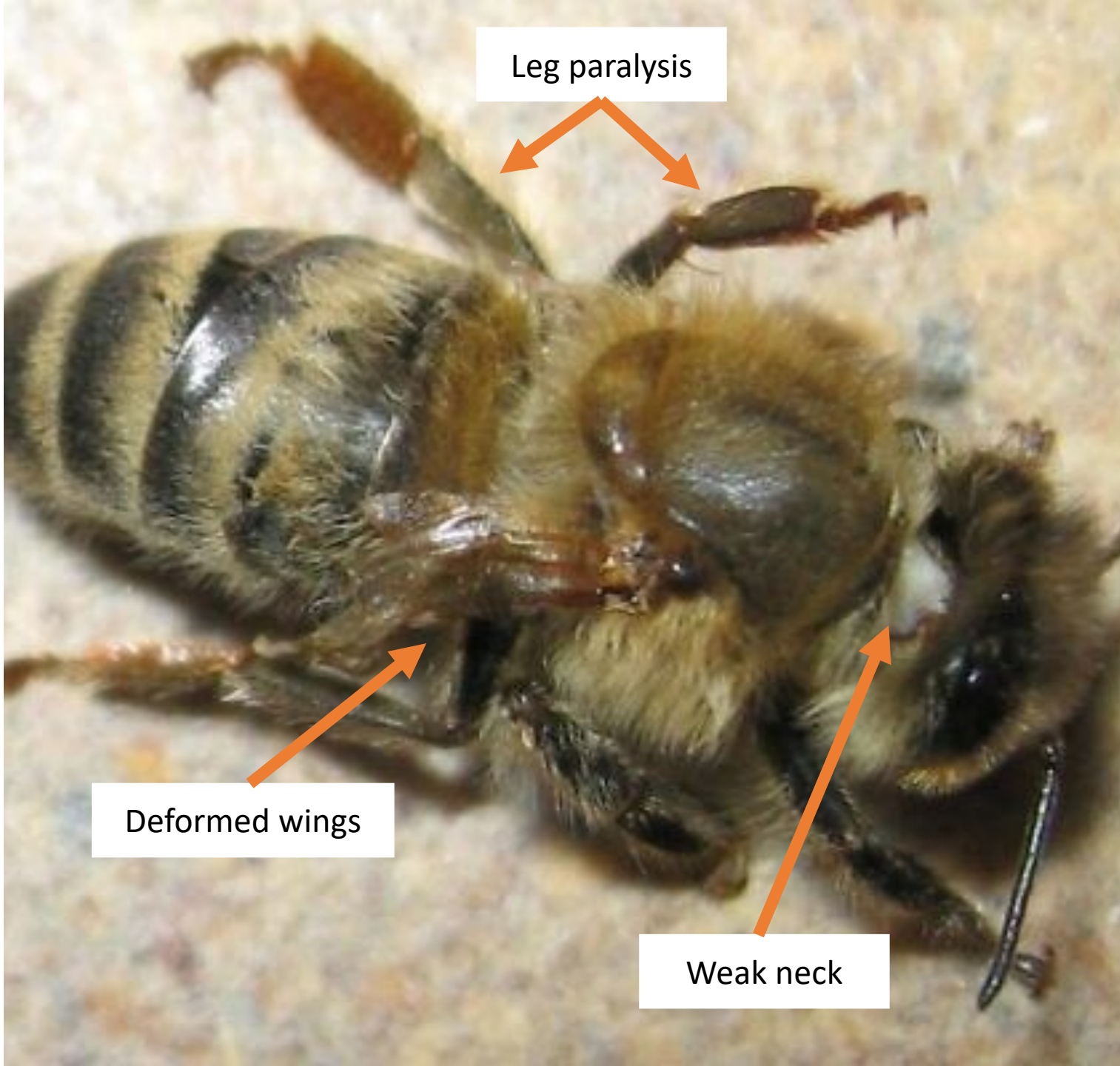


Healthy Brood

- Consistent pattern
- Larvae in pool of royal jelly
- 1 upright egg/cell in center bottom

Physical Exam – The Adult Bee

- Uniform in size, highly active, clustering appropriately, and moving throughout the hive
- Signs of disease:
  - Stunted growth
  - Shiny, hairless bodies
  - Deformed wings or wings held out at odd angles
  - Weak, trembling behavior



Queen Assessment

- Good news: generally, don’t need to find queen!
  - Normal brood likely means healthy queen
  - Abnormal brood or numerous queen cells likely means unhealthy queen
  - Numerous queen cells or swarm cells may also indicate overcrowding
    - Or may mean nothing!
- Don’t mistake queen cups for queen cells
  - Cups present throughout year
  - Base for queen cells

Honey Bee Diseases

Honey Bee Diseases

Bacterial Diseases

- ★ American Foulbrood (AFB)
- ★ European Foulbrood (EFB)

Viral Diseases

- Paralytic viruses
- Sacbrood virus

Parasitic Diseases

- ★ Varroa mite and Parasitic Mite Syndrome
- Tracheal mite
- *Tropilaelaps* mite

Other Diseases

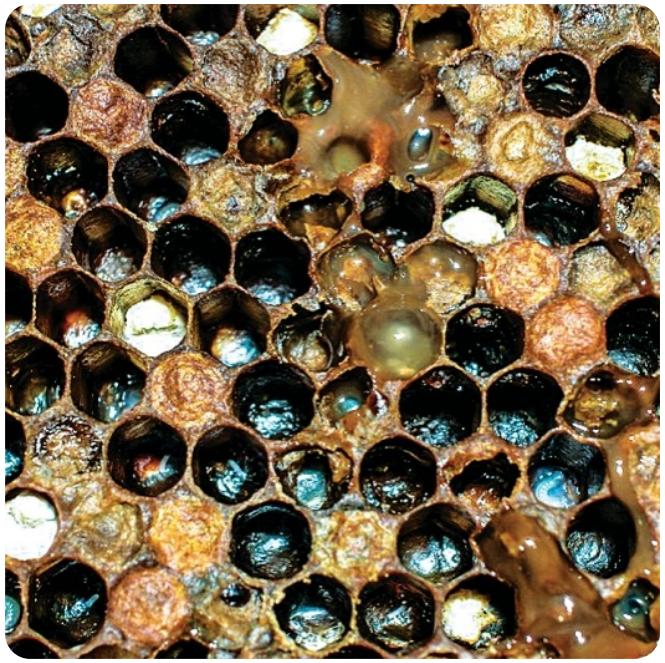
- *Nosema*
- Idiopathic brood disease (IBD)
- Chalkbrood
- Wax Moths
- Hive Beetles

American Foulbrood

Bacterial Disease

American Foulbrood (AFB)

- Devastating disease – some states require complete destruction of infected hive (incineration and burial)
- Etiology: *Paenibacillus larvae* – **spore-forming**, Gram-positive bacteria
- Vegetative stage infective and susceptible to antimicrobials
  - No treatment will kill spores; resistant, can live in honey and environment for decades
- Control: oxytetracycline, lincomysin, and tylosin labeled



AFB Clinical Signs

- All signs not always present; some signs overlap with other diseases
- **Foul odor**: characteristic—between decomposing adult bees and old gym socks
- **Pupal tongues**: characteristic – developing proboscis exposed
- **Perforated caps**: sunken, discolored caps that become dark and greasy
  - Don’t mistake for incomplete caps
- Larval scale: very hard to remove
- Shotgun brood pattern: usually first sign of any disease

AFB Diagnosis – Matchstick/Rope Test

- **Positive rope test pathognomonic for AFP**
  - Negative rope test does not rule out AFB
- Matchstick or similar object inserted into cell and slowly pulled out
  - Positive = viscous string that ropes out 2+ cm
- Other diseased larvae may look similar – but will rope only slightly or be removed as a blob

AFB Diagnosis – ELISA

- Commercial field test readily available online
- Swab taken of affected cells
- Antigen-capture ELISA
- False negatives possible
- Diagnosis should be made based on combination of physical exam findings and tests

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Bee Research Laboratory: Beltsville, MD

AFB Diagnosis – USDA-ARS

- 2x2 inch sample of affected comb collected
  - NO HONEY should be present in the sample
- Strongly encouraged to send sample even if positive it is AFB and reporting is not mandatory
  - Nation-wide statistics/trends
  - Antimicrobial susceptibility patterns

AFB Diagnosis - Sniff Test?

Bazz the beekeeper sniffs out a deadly disease that's wiping out hives.

Huffington Post

AFB – Control of Infection

- **Antimicrobials not sufficient to stop active infection**
  - Goal is to prevent or control subclinical infections
  - Spores must be removed by other methods to avoid re-infection
- Three antimicrobial classes approved for AFB control: oxytetracycline, tylosin, lincomycin
  - Oxytetracycline-resistant strains
- Control methods for AFB should be implemented if even a single infected cell is identified
  - Carefully inspect all other colonies
- Be very careful not to spread disease
- Discard all honey – may contain spores

AFB – Treatment and Control

- **If you diagnose AFB, immediately contact state apiarist**
- Many states require colonies diagnosed with AFB be destroyed
- Infected equipment may be sterilized via gamma irradiation, scorching, or boiling in lye back
  - Will also kill spores
- Burning recommended even if not required
  - Prevents spreading of spores
  - If burning is not feasible, deep burial or irradiation may be indicated

Burning the Colony

- Seal hive with tape as soon as possible during periods of low bee activity
- Depopulate colony prior to burning hive
  - One method is to sprinkle diesel fuel on bees and wait 10+ minutes
  - **Fuel is only to kill the bees → not accelerant!**
  - Ask state apiarist for appropriate management
- **FIRE SAFETY**
  - Strongly recommend contacting local fire department first: obtain burn permit
  - Cover ashes with soil

Preventing AFB

- Conditionally approved
- Administered via royal jelly to queen
- Deposited into ovaries

U.S.D.A. Approves First Vaccine for Honeybees

Dalan Animal Health's vaccine for American foulbrood, an aggressive bacterial disease, is the first for any insect in the United States.

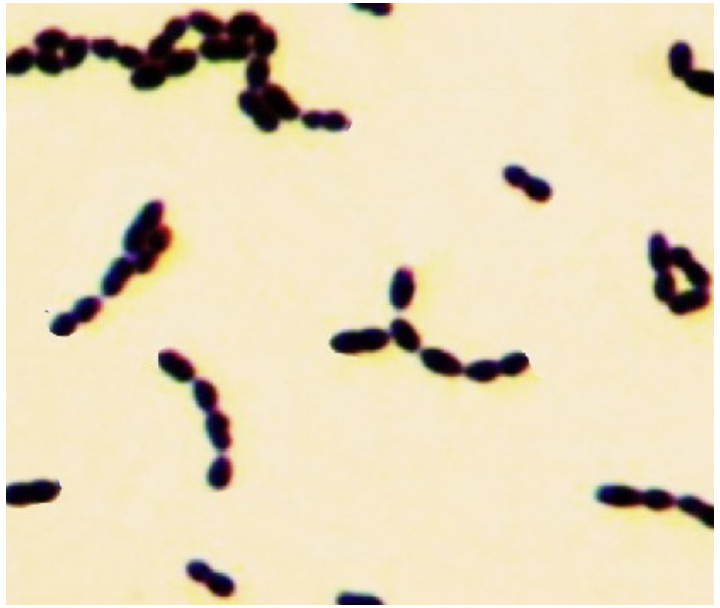
Give this article

New York Times

European Foulbrood

Bacterial Disease

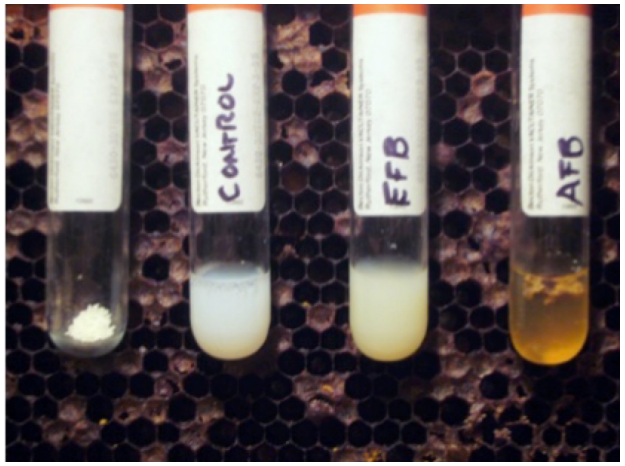
European Foulbrood (EFB)



- Etiology: *Melissococcus pluton,* **non-spore-forming**, Gram-negative bacteria
  - Other bacteria implicated
- Only affects larval stage
- More contagious but less severe than AFB
- May spontaneously resolve
  - Recent shifts in pathogenicity has made this less likely

EFB

- **Larval discoloration:** larvae become yellow or gray
  - Drone brood may be affected first
- **Larval deformation:** twisted or corkscrew appearance; sometimes appear melted, or may look deflated
- **Yellow brood food:** one of the 1st signs is a yellowing of the royal jelly/brood food



- EFB antigen-capture ELISA available
  - Recommended to send comb to USDA-ARS
- Oxytetracycline only labeled treatment

	American Foulbrood	European Foulbrood
Etiology	*Paenibacillus larvae*	*Melissococcus pluton*, others
Distribution	Worldwide	Worldwide
Larval scale	Very hard to remove	Can be removed
Pupal tongues	Present	Absent
Odor	Characteristic	Odorless
Spontaneously resolve	Never	Occasionally
Labeled treatments	Oxytetracycline, lincomysin, tylosin	Oxytetracycline
Matchstick test	Positive	Negative
Holst milk test	Positive	Negative
ELISA	AFB test positive	EFB test positive

Varroa Mites

Parasitic Disease

Varroa Mites

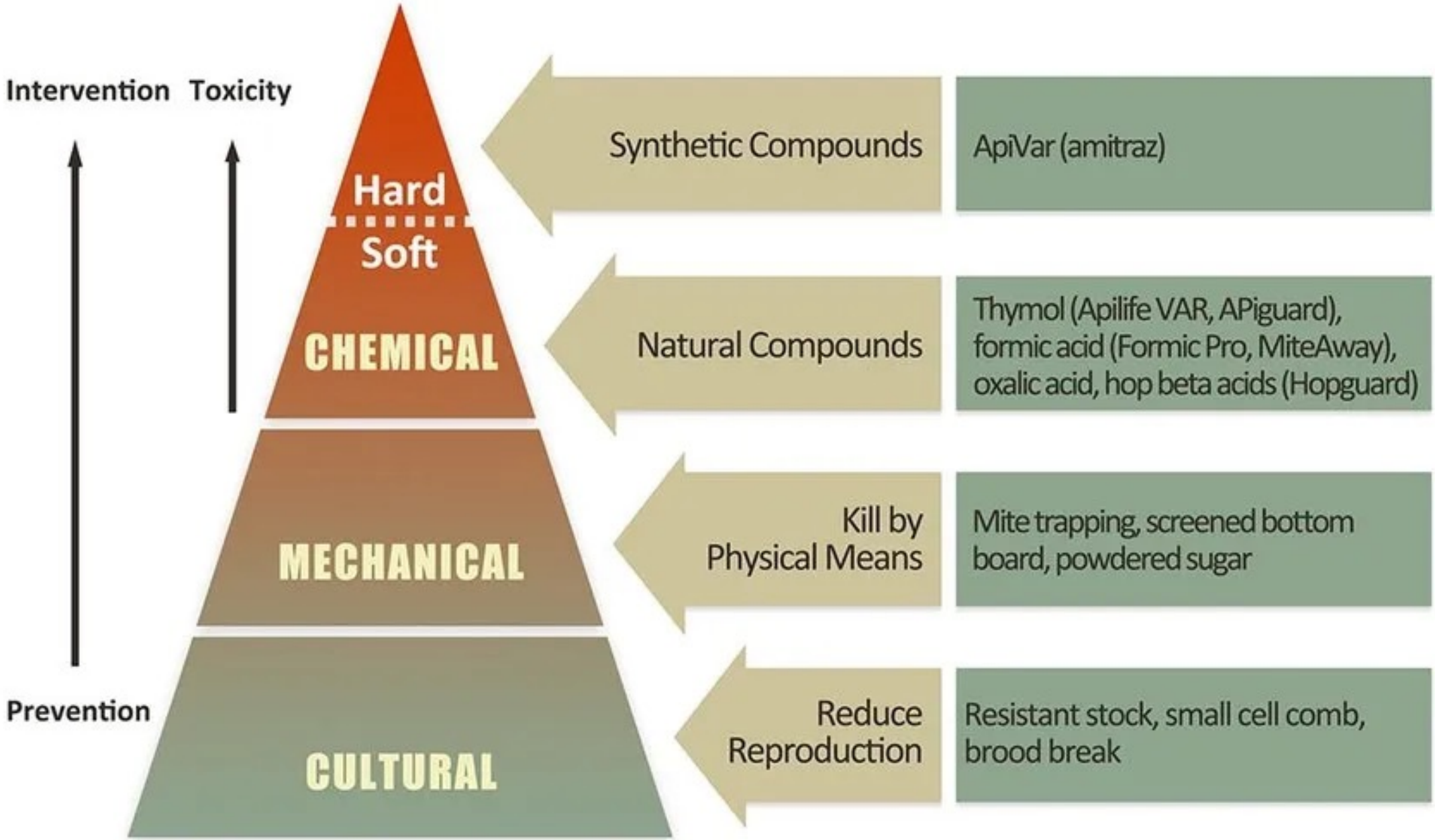
- Cause Parasitic Mite Syndrome (PMS)
- Etiology: *Varroa destructor*
  - **#1 killer of honey bees and single most important cause of colony loss in US**
  - Puncture exoskeleton and consume fat bodies of bees
- Target larvae about to be capped, feed on capped larvae
- Mites can cause larval or pupal death
- Vector for several viruses → PMS

PMS – Clinical Signs

- Clinical signs vary
- **Chewed pupae and melted larvae:** 1st sign spotty brood pattern with chewed pupae
- **Bees dying on emergence from cells**
- **Guanine deposits:** mite feces – resemble grains of coarse salt stuck to sides of cells
- **Deformed wings:** young bees with wrinkled, deformed wings
- **Varroa mites:** usually only observed in advanced infestation
- **Collapsing cluster size/absconding:** colony leaves or splits

PMS – Treatment and Management

- **Varroa mites thought to be in every hive in the country**
  - PMS can only be prevented and controlled by managing mite population
  - May not be possible to save a colony
- The beekeeper must practice integrated pest management
  - Monitor mite population
  - Employ physical, mechanical, and chemical controls
  - Amitraz alone is not sufficient → resistance developing!
- The honey bee veterinarian should know about life cycle of parasite, monitoring methods, control points, and treatment methods



Penn State Extension

Summary

- Honey bees are livestock and need to comply with regulations similar to other species
- Veterinarians can have many roles in honey bee health
- There are numerous infectious and non-infectious diseases that affect the honey bee population
- Parasitic mite syndrome is currently the most important disease affecting honey bees in the US
- Treatment of some honey bee diseases requires a VFD and veterinary intervention

Resources for Further Education

- AVMA Honey Bees: A Guide for Veterinarians
- Better Bee. http://www.betterbee.com
- Honey Bee Veterinary Consortium. https://www.hbvc.org/
- Kane TR and Faux CM. Honey Bee Medicine for the Veterinary Practitioner, 1st Ed. 2021.
- Oklahoma Apiary Act. https://ag.ok.gov/wp-content/uploads/2020/11/Oklahoma-Apiary-Act.pdf
- Purdue Extension. https://ppp.purdue.edu/resources/ppp-publications/the-complex-life-of-the-honey-bee/
- USDA NASS Survey, Honey Bee Reports. https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Bee_and_Honey/index.php
- USDA APHIS NVAP Training Module 30 https://nvap.aphis.usda.gov/BEE/bee0001.php
- Veterinary Clinics of North America: Food Animal Practice. Volume 37, Number 3 (Nov 2021)

Dr. Walker – Equine/ Food Animal

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