



# Bees and Resistance

**Kasie Raymann Ph.D.**

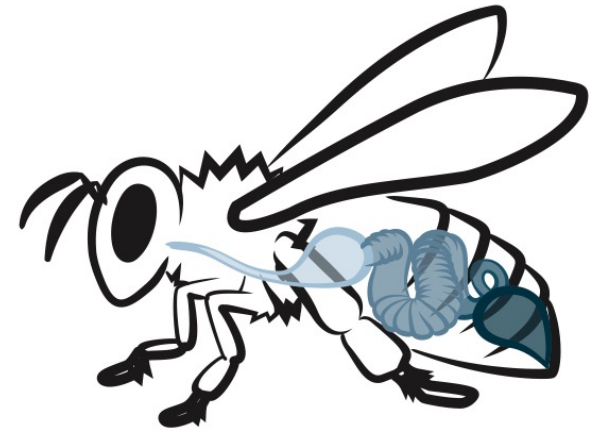
Assistant Professor

University of North Carolina at Greensboro



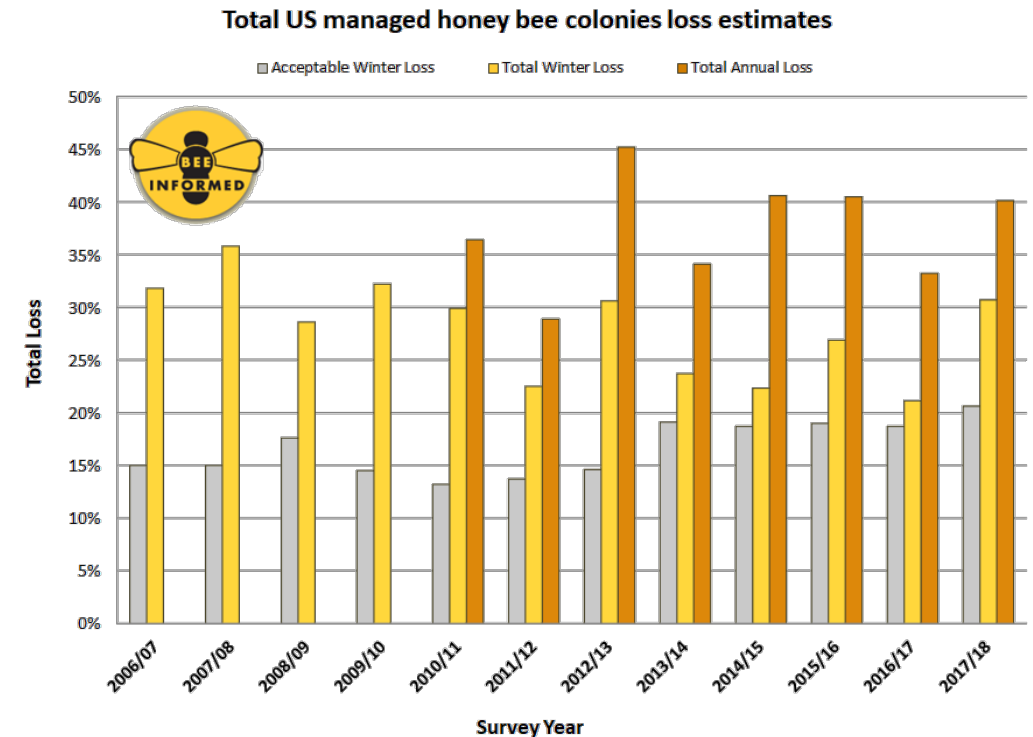
# Why I am here and where I am coming from

- **Microbiologist** (Ph.D. Institute Pasteur 2014)
- **Honey bee researcher**
  - Postdoctoral Fellow at UT Austin (2014-2017)
  - Assistant Professor at UNCG (2018- present)
- **Impact of antibiotic treatment on:**
  - the gut microbiome (beneficial bacteria) of honey bees
  - honey bee health
  - spread of resistance
- **Biology Department of UNCG specializes in Environmental Health Science**



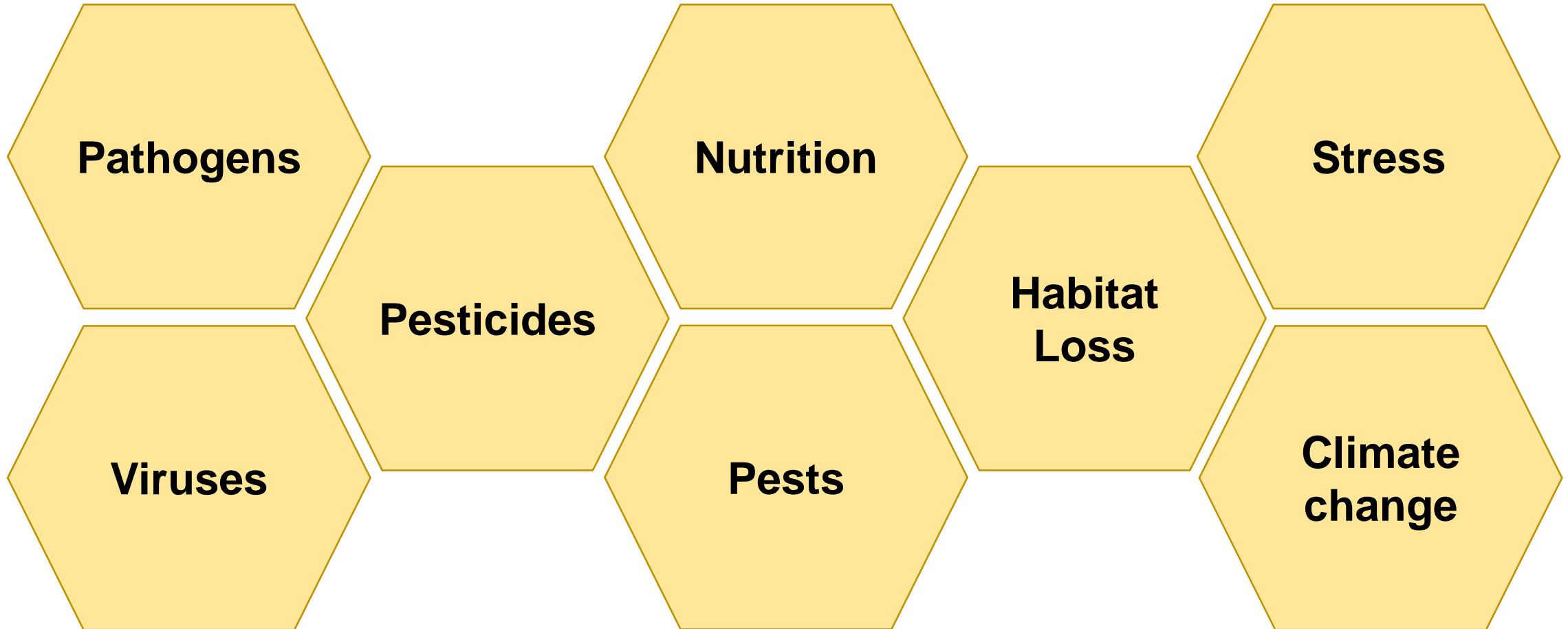
# Why should we care about honey bees?

- Honey bees pollinate ~\$15 billion of crops each year in United States
  - More than 1/3 of all crop production (>90 crops)
- Since 2006, honey bee populations have undergone huge decline
- Number of honey bee hives has decreased from 6 million (1940s) to about 2.5 million today



# Why are honey bees dying?

- **Multiple** factors have been attributed to honey bee loss



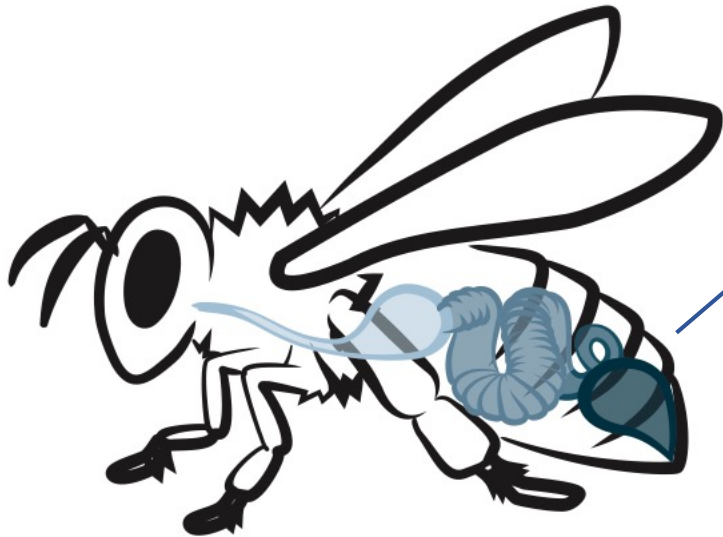
# How are beekeepers combating disease?

- Food supplementation
- Miticides/pesticides (Varroa mites)
- Fungicides
- **Antibiotics** (disease treatment/prevention and growth promotion)



# Why are antibiotics harmful to bees?

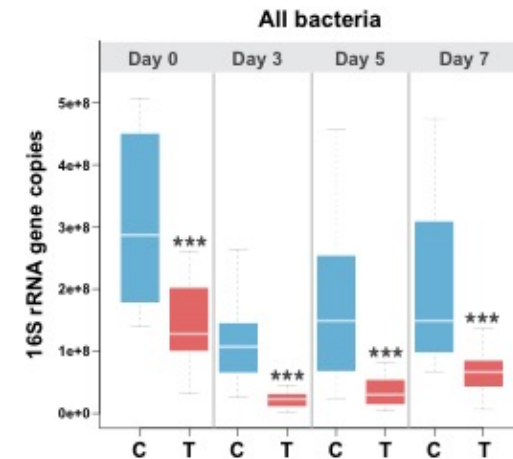
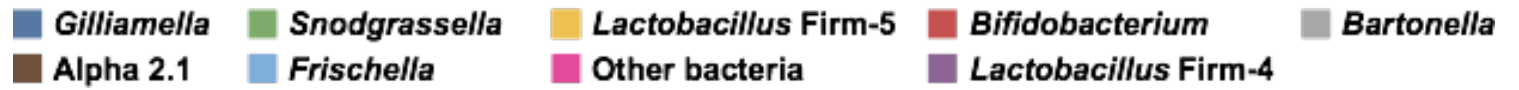
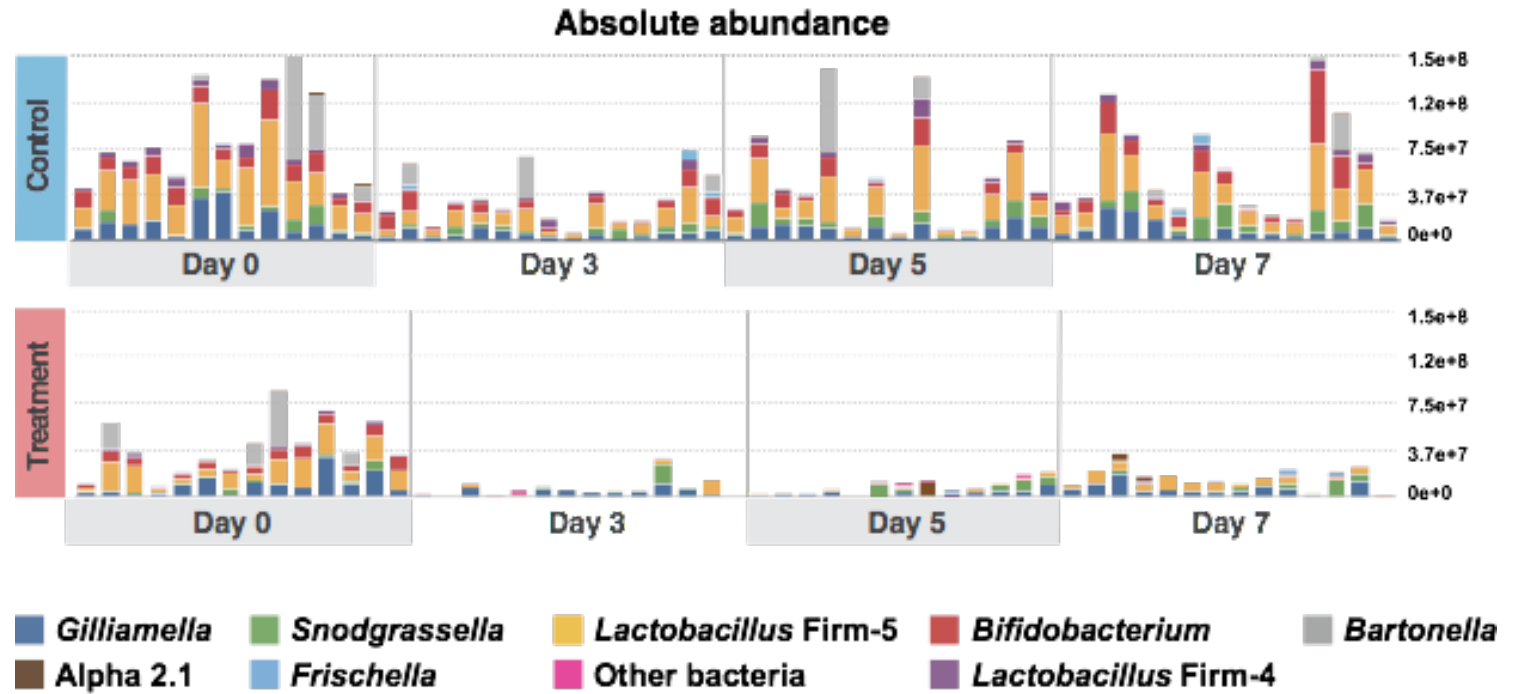
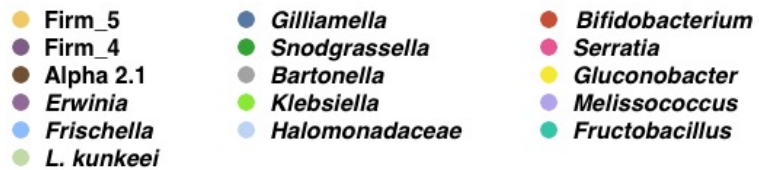
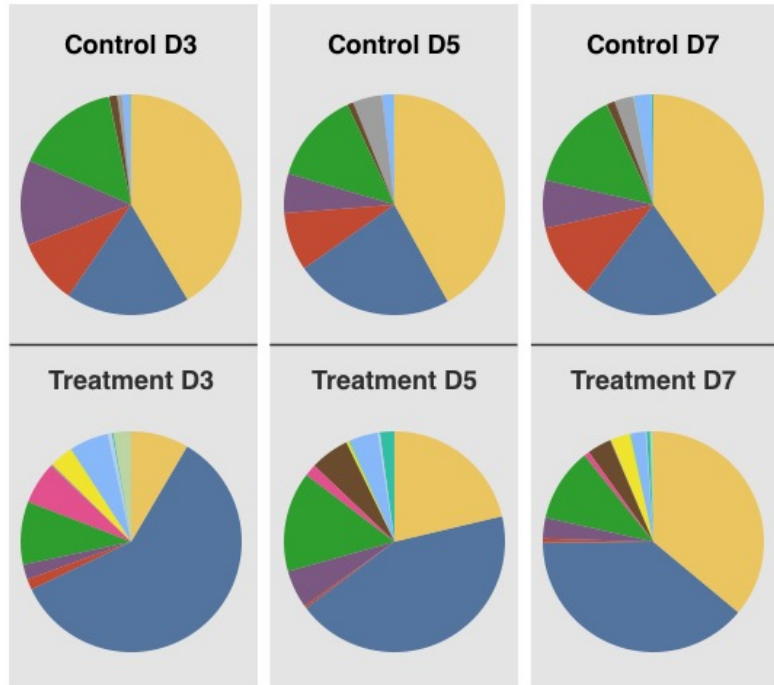
- Microbiome (bacteria that live inside gut) is extremely important for bee health
- Antibiotics used in beekeeping for >50 years
  - 2017 FDA regulations require prescription from veterinarians
- Antibiotics kill beneficial bacteria in the bee gut



## **Bee microbiome important for:**

Immune function  
Metabolism  
Hormones/behavior  
Removal of toxins  
Growth/development  
Pathogen susceptibility

# Tetracycline treatment alters the honey bee gut microbiome



# Tetracycline treatment decreases bee survival

Survival rate was evaluated three days post tetracycline treatment

## In the hive

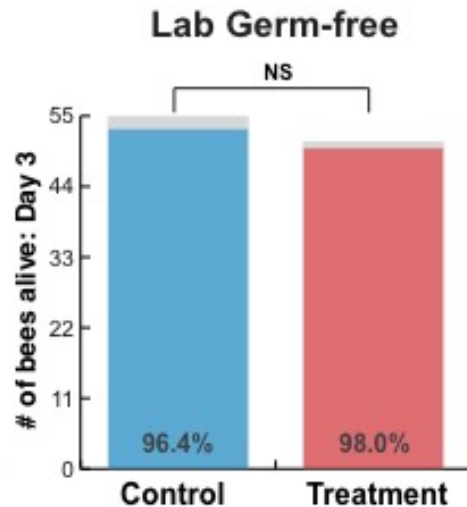
- Tetracycline resulted in decreased survival rate

## Lab exposed and lab sterile recovery conditions

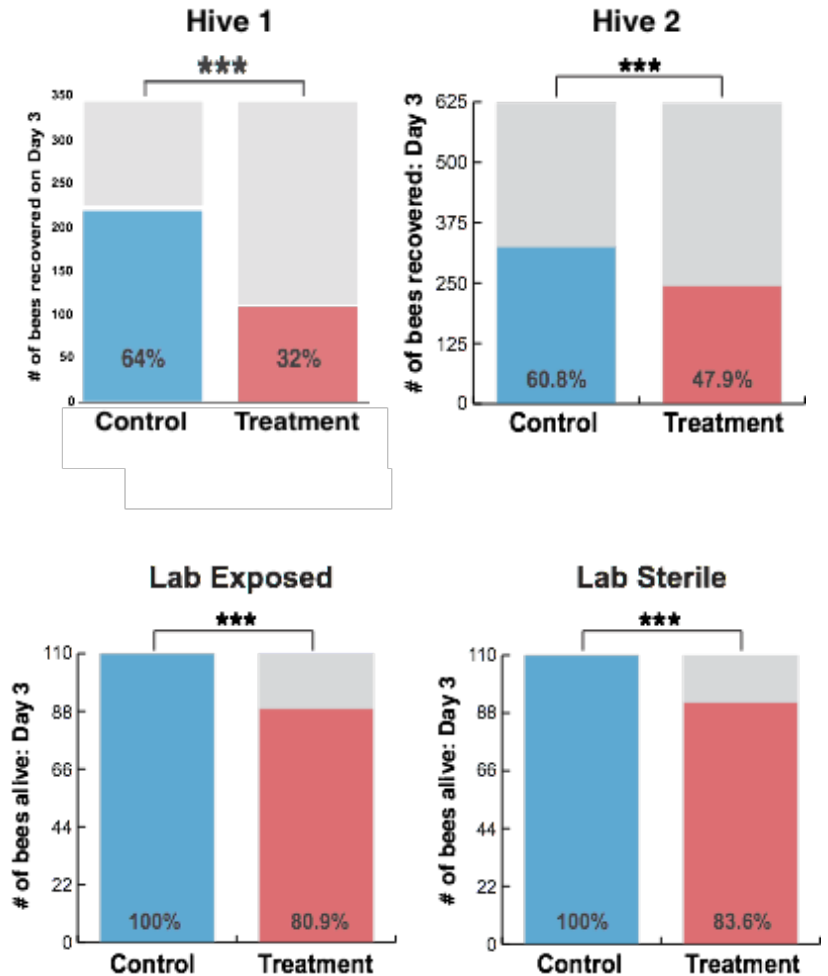
- Tetracycline resulted in decreased survival rate

## Lab germ-free bees

- Tetracycline did not affect survival



**Microbial perturbation, not the antibiotic itself, causes increased mortality in honey bees**

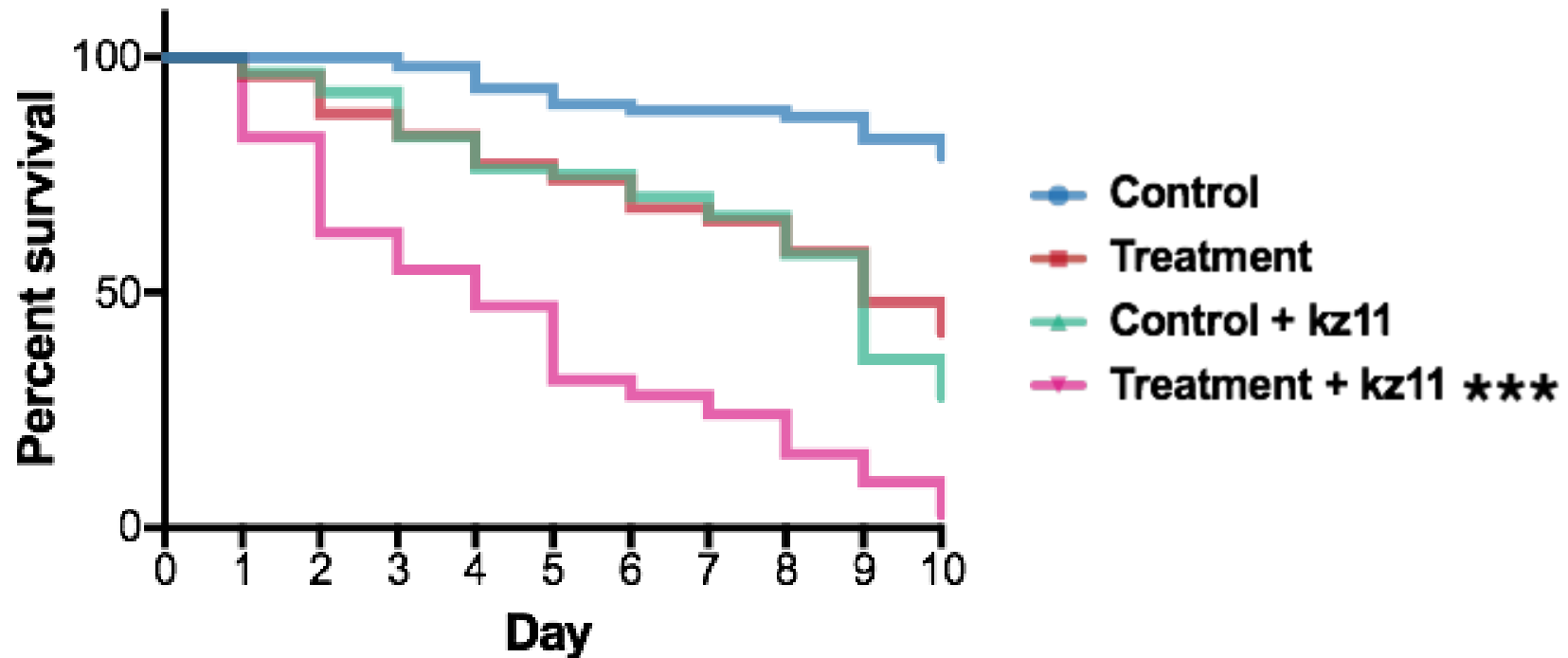




# Tetracycline treatment increases susceptibility to pathogens

## Exposed worker bees orally to *Serratia*

- Control bees and bees recently exposed to tetracycline
- Monitored survival over 10 days



**Bees treated with tetracycline are highly susceptible to *Serratia* infection**  
**100% morality of bees treated with tetracycline after 10 days**

# Antibiotic resistance in honey bee gut bacteria

- **United States:** increased presence of resistance genes in gut bacteria of honey bees compared to countries that do not use antibiotics
  - Good for gut bacteria, but bad for spread of resistance

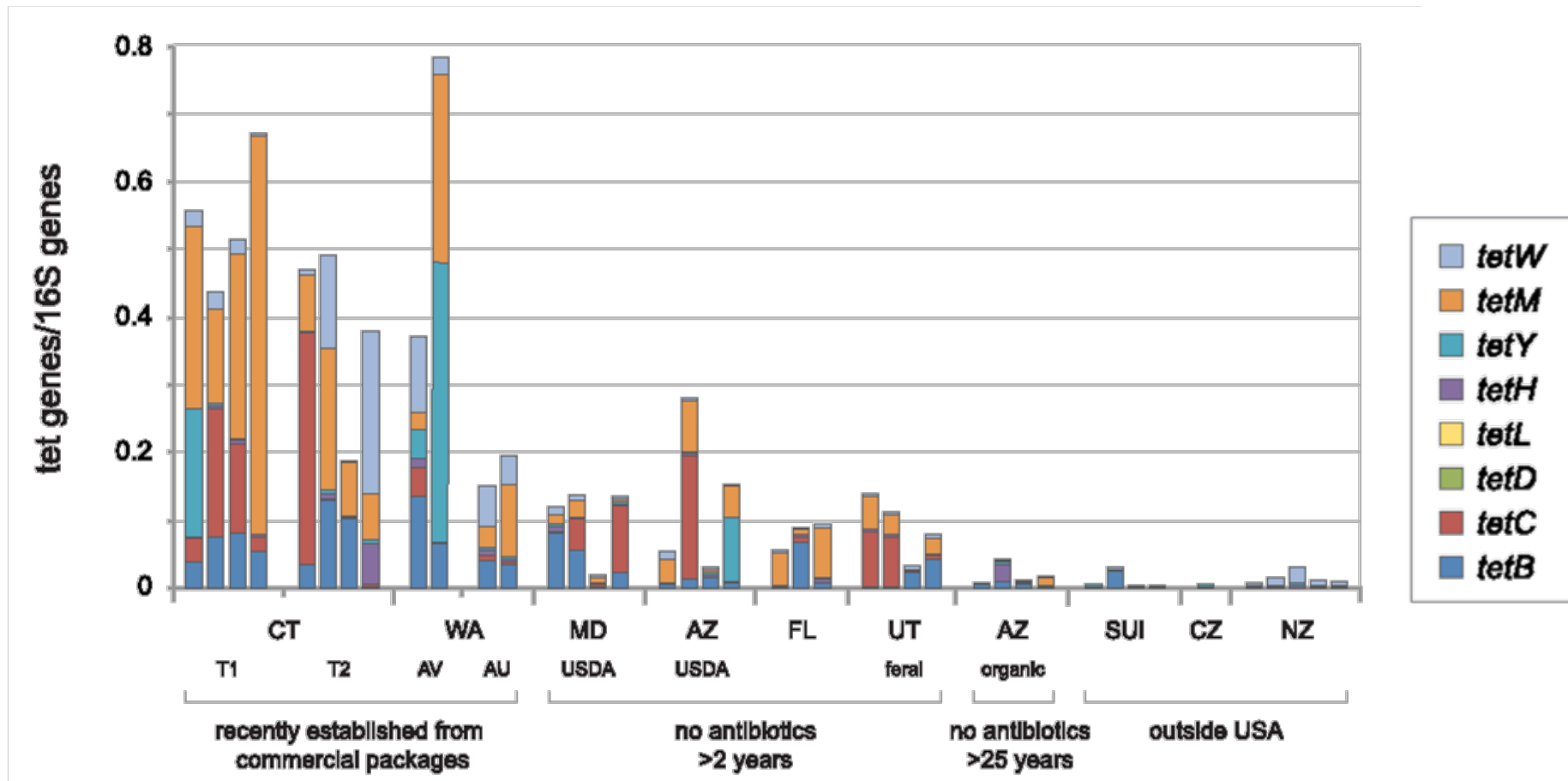


Figure from Tian et al. (2012) mBio

# Antibiotic resistance is spreading to bee pathogens

- Two most common bacterial pathogens (infect larvae)
  - *Paenibacillus larvae*: American foulbrood
  - *Melissococcus plutonius*: European foulbrood
- Acquired resistance to antibiotics
- **Result:** introduction of new antibiotics in beekeeping



# Antibiotic residues persist in hives

- Studies have shown that antibiotics can be detected in hives up to 1 year after treatment
  - Pollen
  - Wax
  - Honey
  - Propolis
  - Royal jelly



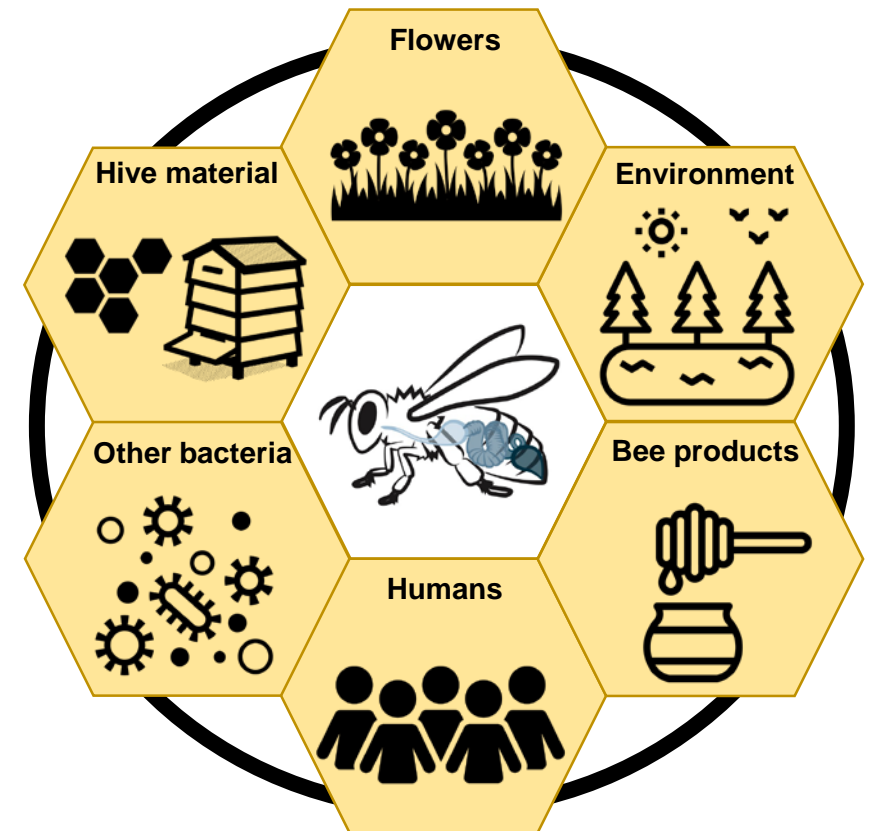
# Honey bee products can contain antibiotic residues

- Bee products are commonly consumed and used by humans
- In the US, there are no residue limits established for veterinary drugs particularly in honey and bee products
- Bacteria can acquire resistance even at extremely low concentrations



# What does this mean for the spread of resistance?

- Antibiotic residues from hive can be spread to flowers and the environment → residues in the environment can be picked up and spread by bees
  - Resistance acquired and spread to bacteria in environment (e.g. pathogens)
- Residues in bee products can cause resistance spread in humans
  - Beneficial bacteria and pathogens

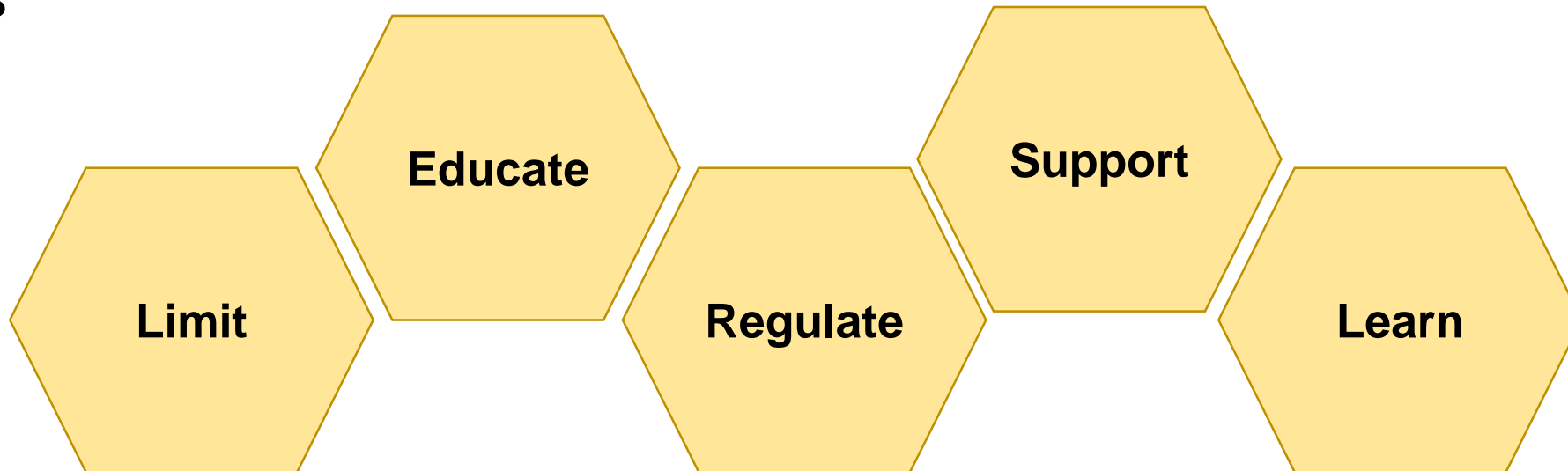


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# How can we combat the spread of resistance?

- Only use antibiotics as last resort in beekeeping
- Make sure veterinarians are aware of the appropriate usage and negative impacts of antibiotics in beekeeping
- Educate beekeepers and the public
- Push for regulations on antibiotic residues in bee products
  - In US products and imported products
- Support and incentivize research on alternative non-antibiotic treatments for bee diseases



# Acknowledgements

Thank you for your attention!



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