



# Physiological and behavioral immunity in the honey bee

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Association

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**Tufts**  
UNIVERSITY

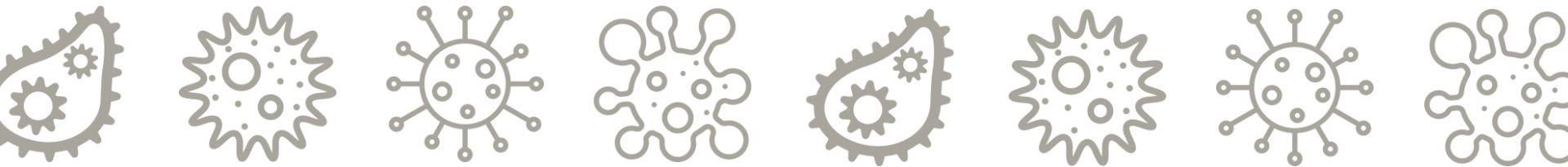
# What is immunity?

*medical* : “the power to keep yourself from being affected by a disease”

Merriam-Webster

Two types of immunity in humans:

1. Innate
2. Adaptive

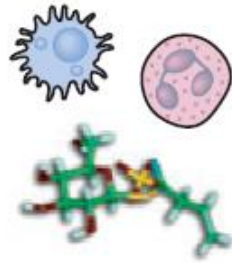


# Disease resistance in honey bees

Genetic

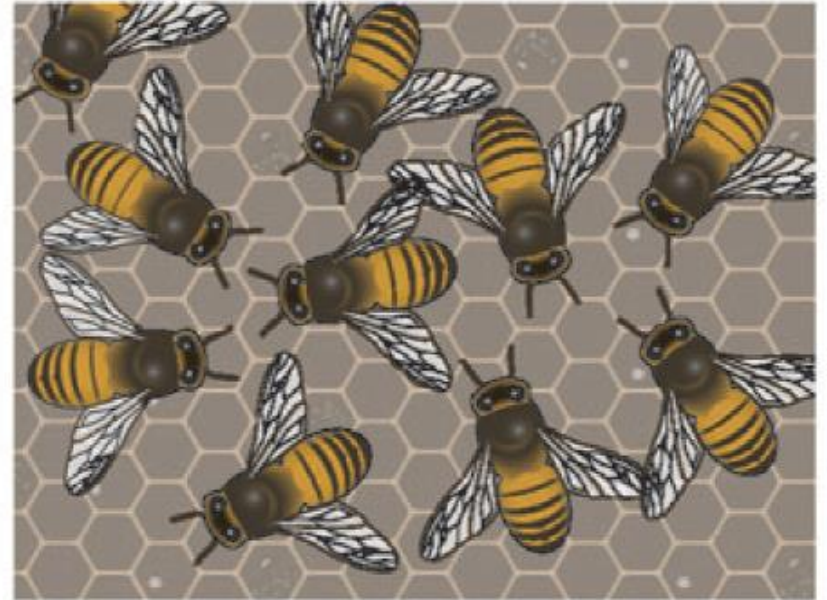


Physiological



Individual Behavior

Group Behavior



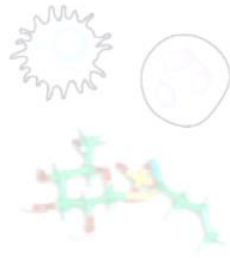


# Disease resistance in honey bees

Genetic



Protein/cell physiology



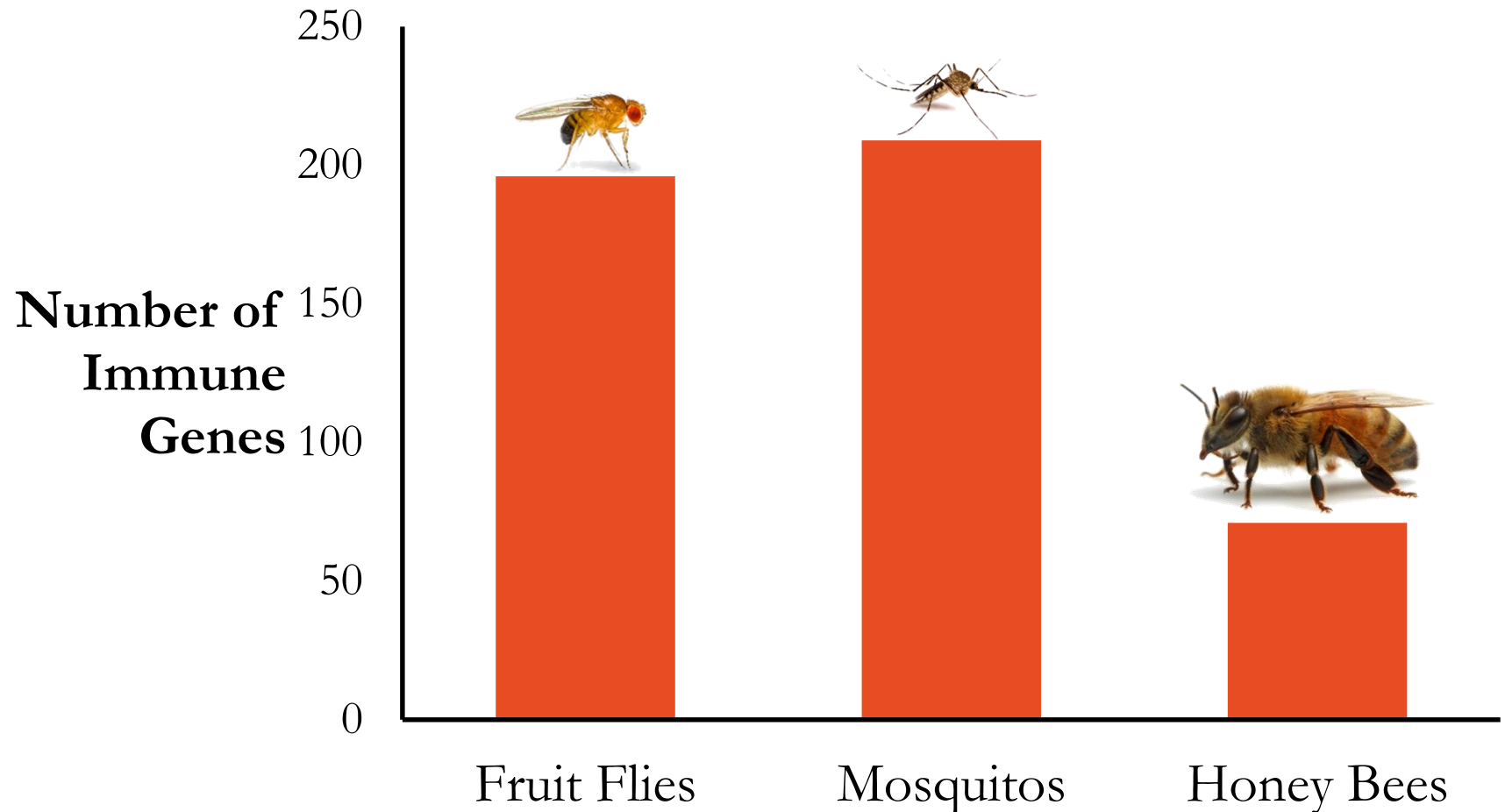
Individual behavior



Group



# Honey bees have few immune genes



Data: Christophides et al. 2002

Honey bee photo: Alex Wild

# Multiple mating = genetic diversity

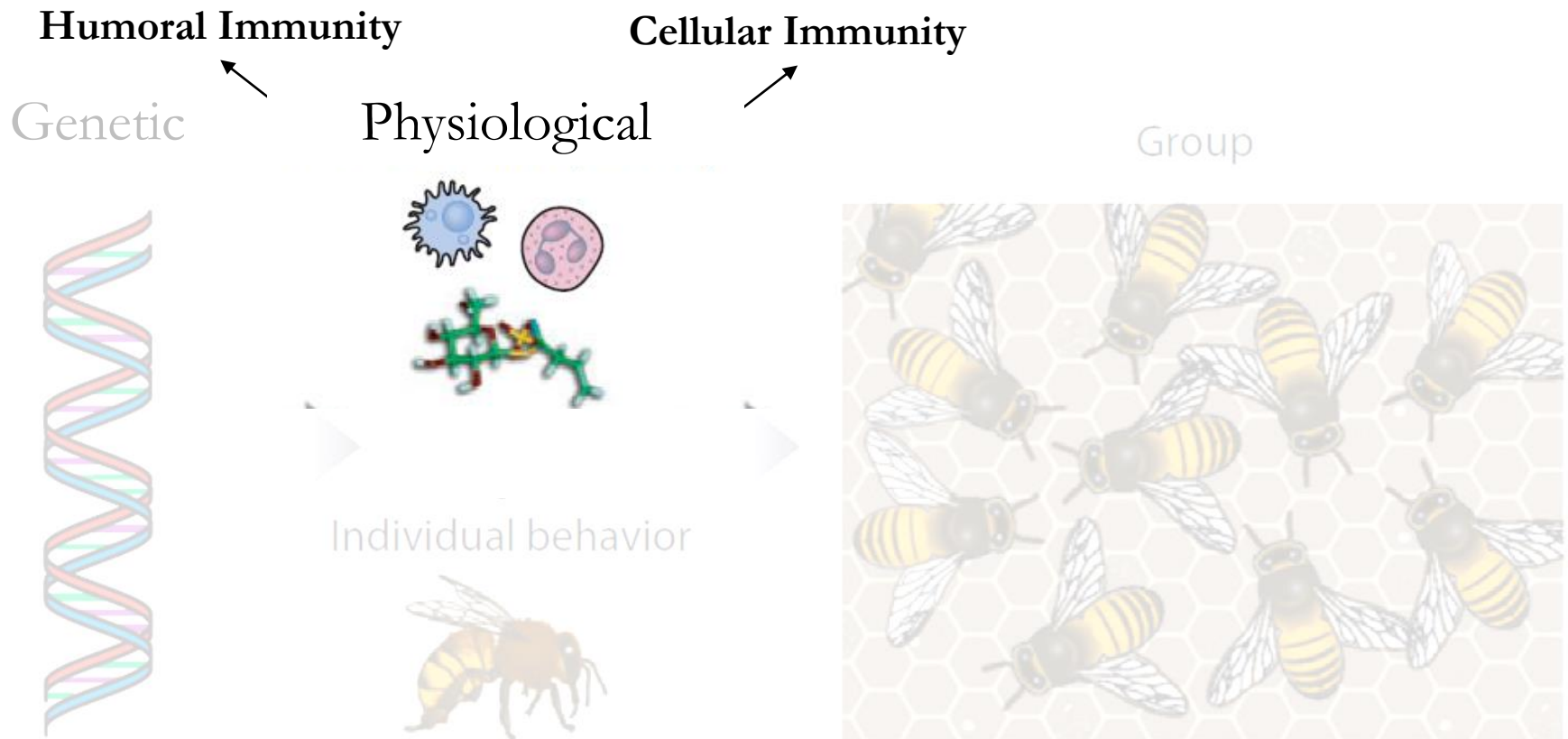




**Genetic diversity = population-level resistance**



# Disease resistance in honey bees

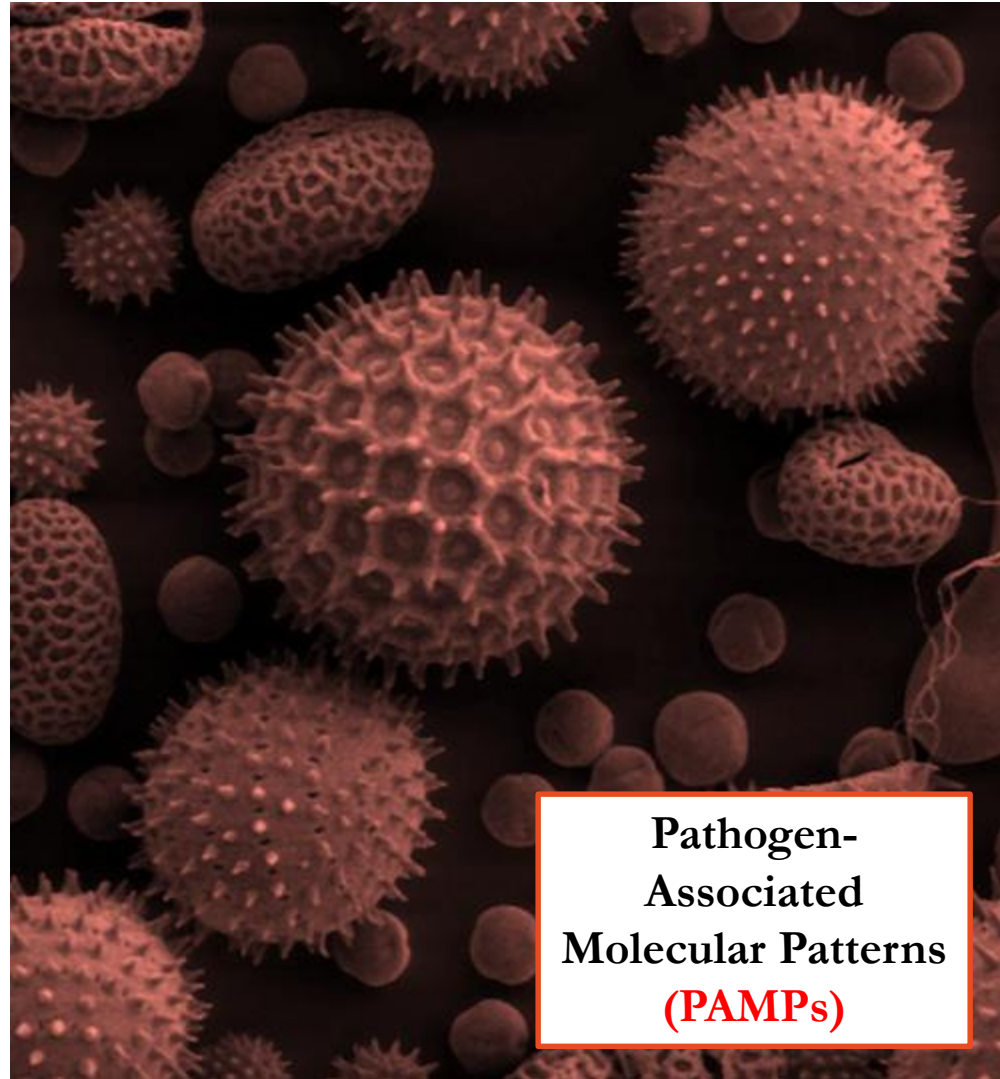




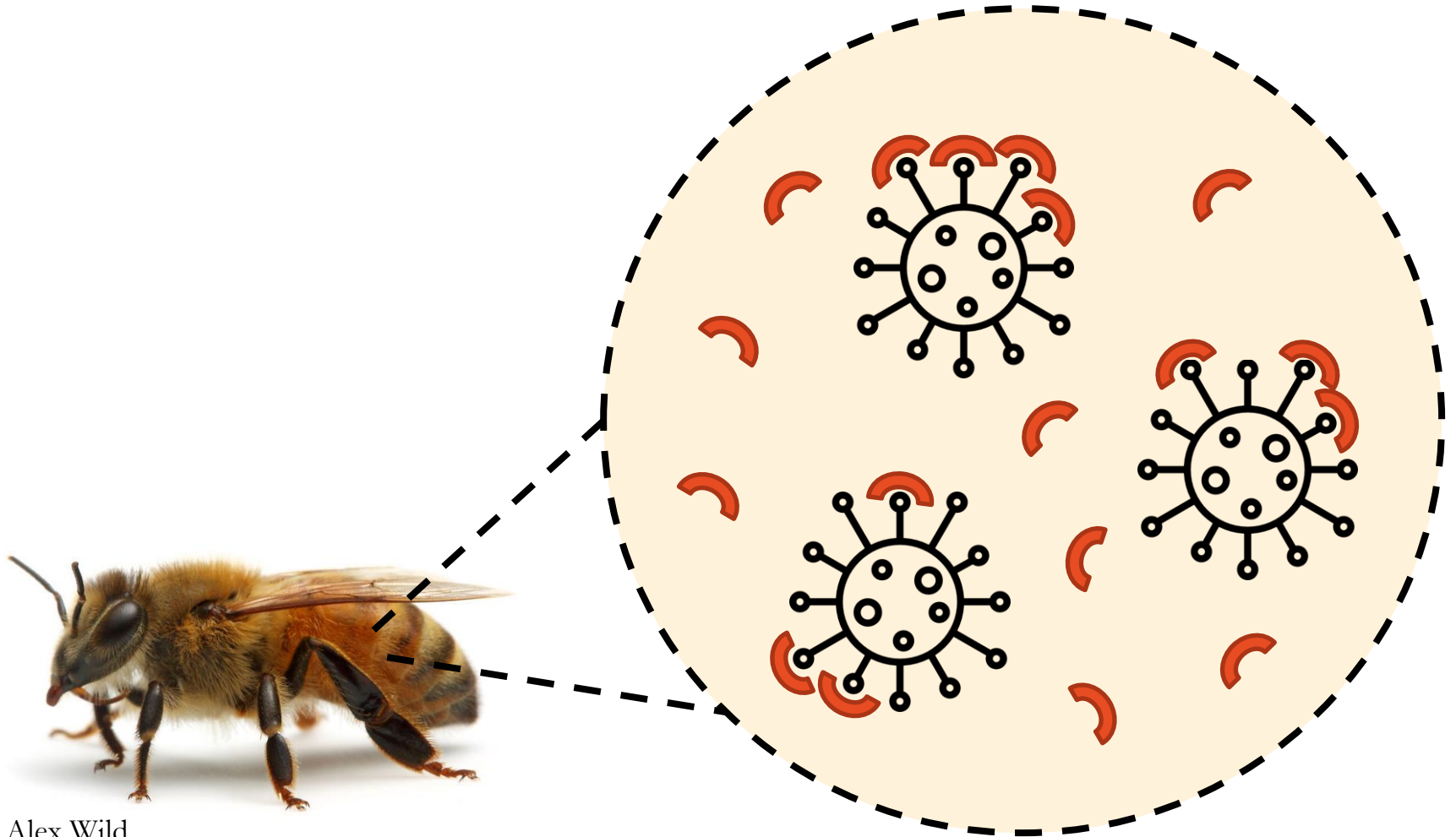
# Humoral immunity

## Antimicrobial Proteins

1. Recognize different classes of invaders
2. Bind to invaders  
*(virus, bacteria, fungus)*
3. Activate other proteins which get rid of invader via various pathways



# Humoral immunity & *Nosema ceranae*



Alex Wild



# Cellular immunity

“Blood” cells = Hemocytes

## 1. Plasmatocytes

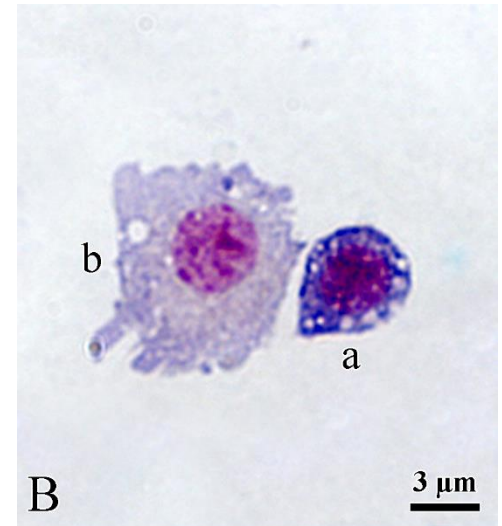
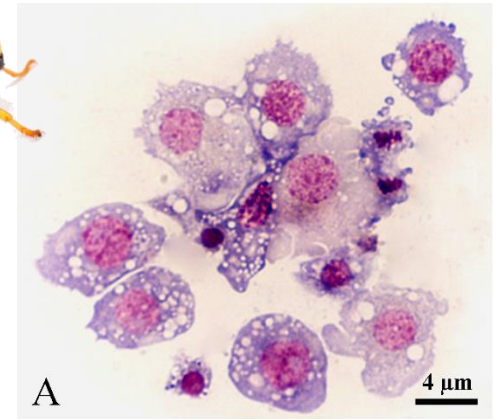
engulf small invaders  
mark large invaders for isolation

## 2. Granulocytes

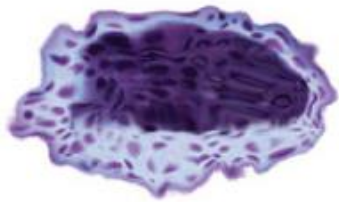
aid in clotting, healing wounds  
attract plasmatocytes

## 3. Prohemocytes

differentiate into the other two  
hemocytes



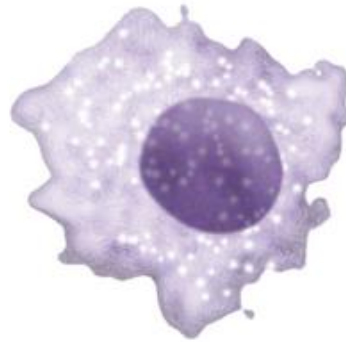
# Cellular immunity



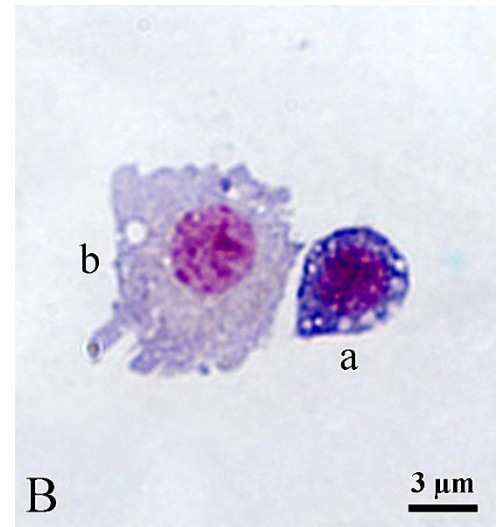
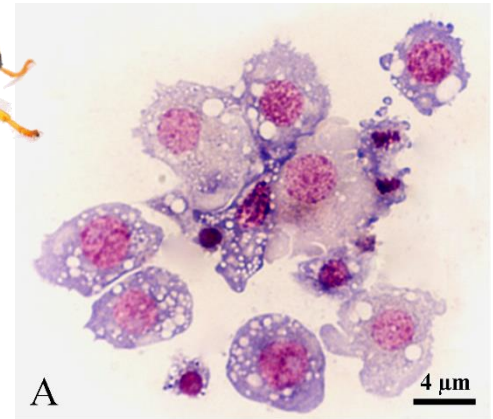
Mast cell



Natural killer cell



Macrophage





# Cellular immunity

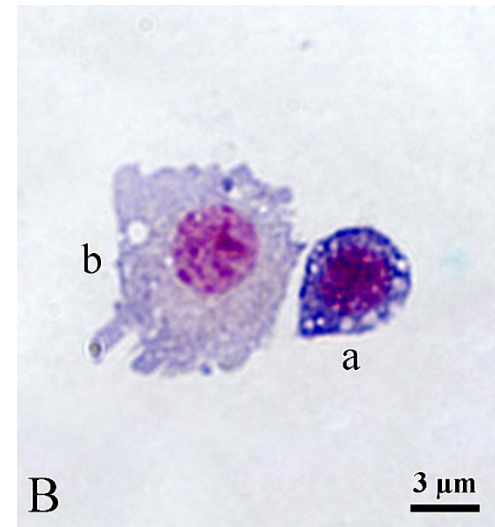
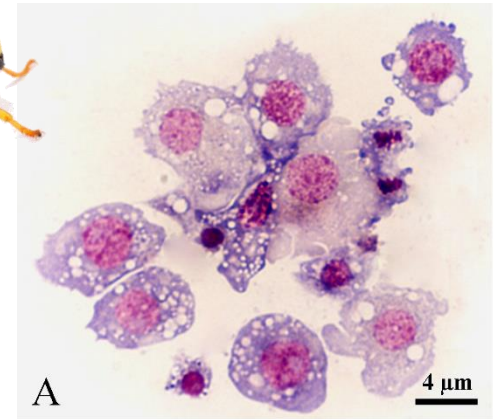
## Cellular Processes

### 1. Nodulation

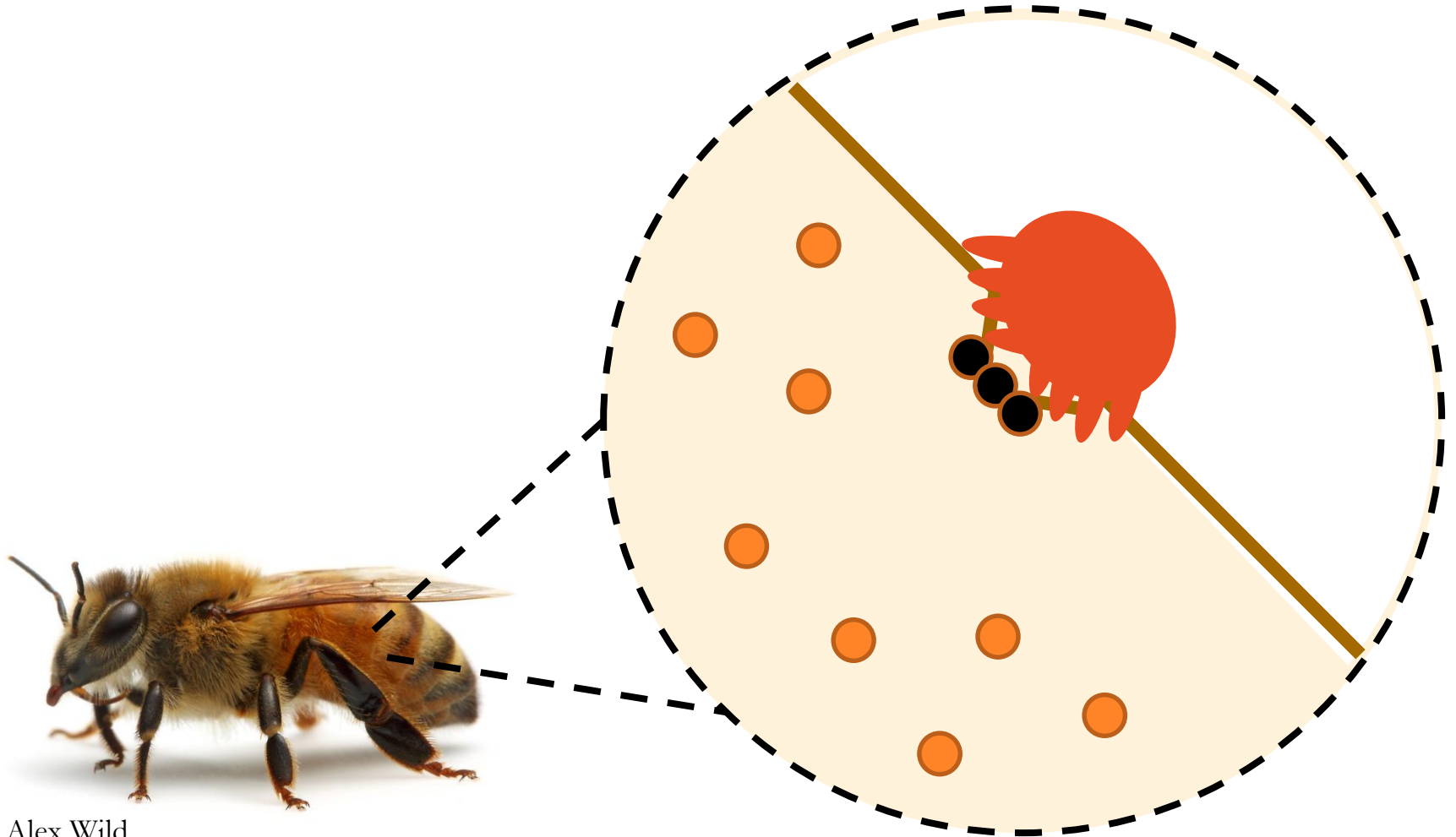
Hemocytes from a nodule around invader, invader marked for excretion.

### 2. Encapsulation

Invader surrounded by hemocytes, invader deactivated with toxins.



# Cellular immunity & *Varroa destructor*



Alex Wild

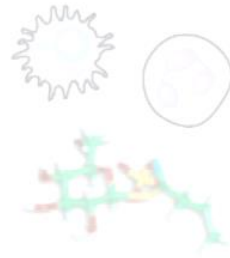


# Disease resistance in honey bees

Genetic



Physiological



Individual Behavior

Group

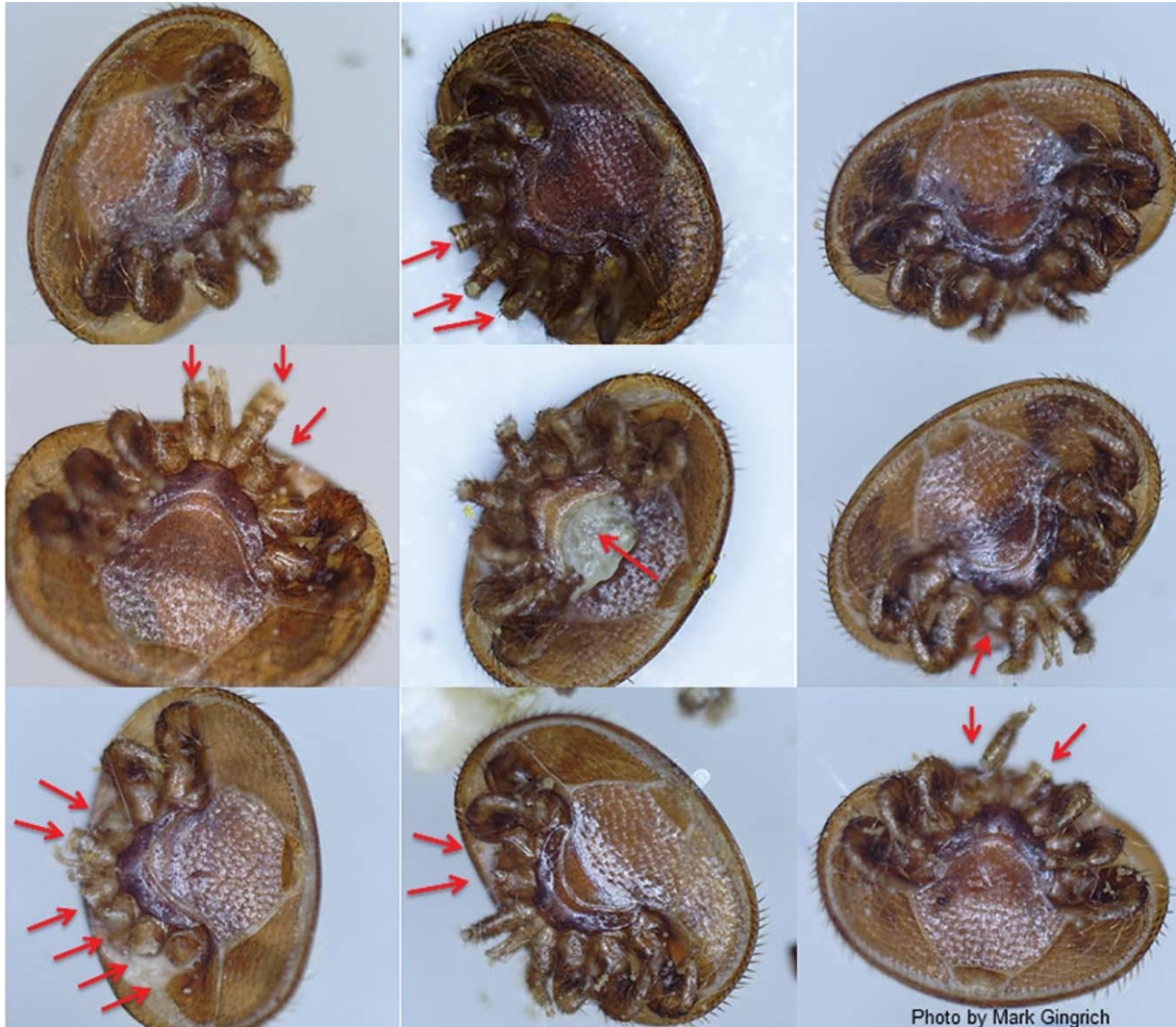


# Grooming



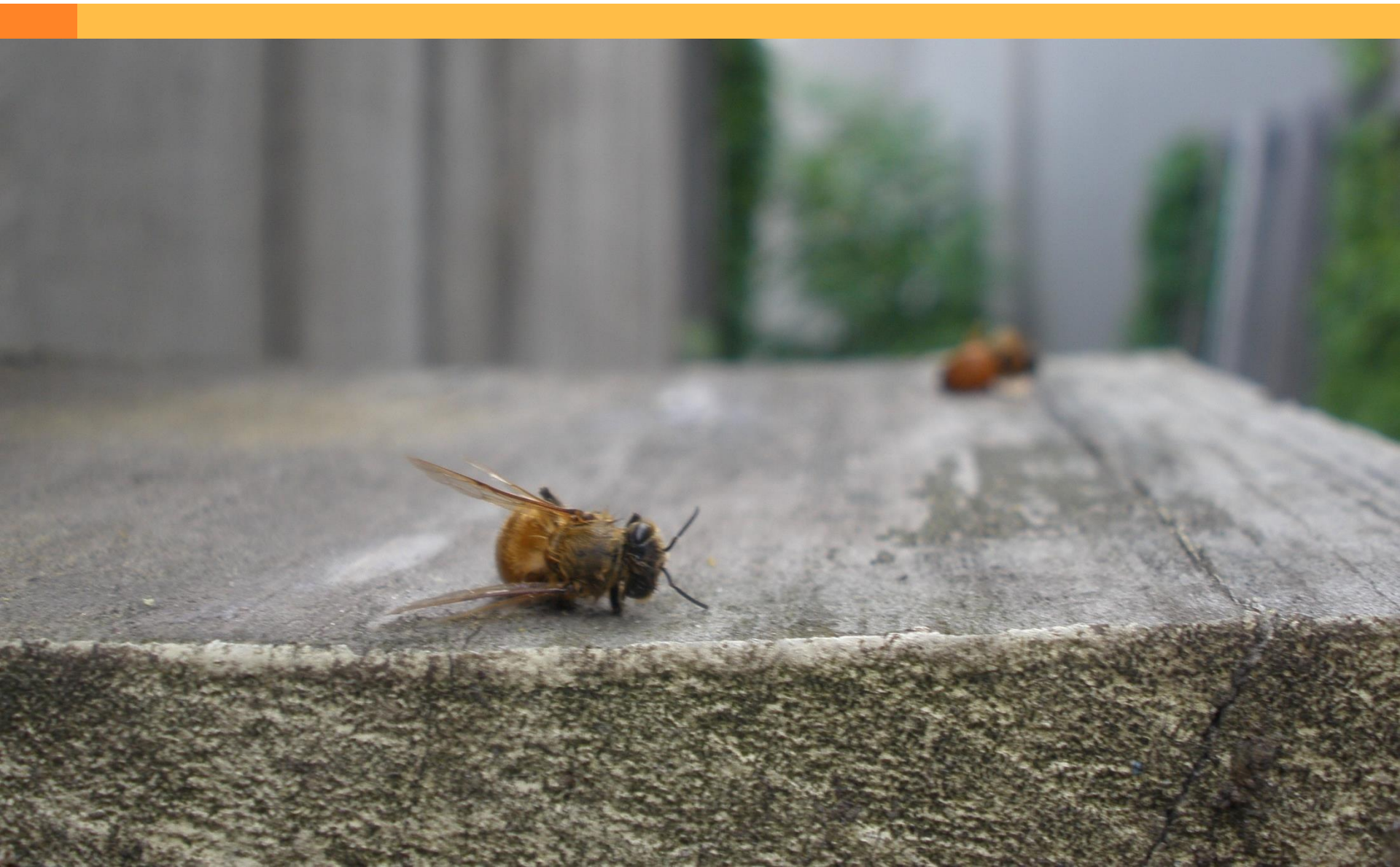


# Mite biters





# Undertaking

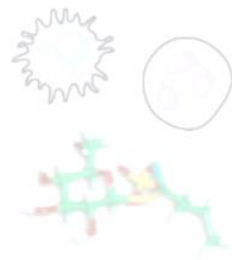


# Disease resistance in honey bees

Genetic

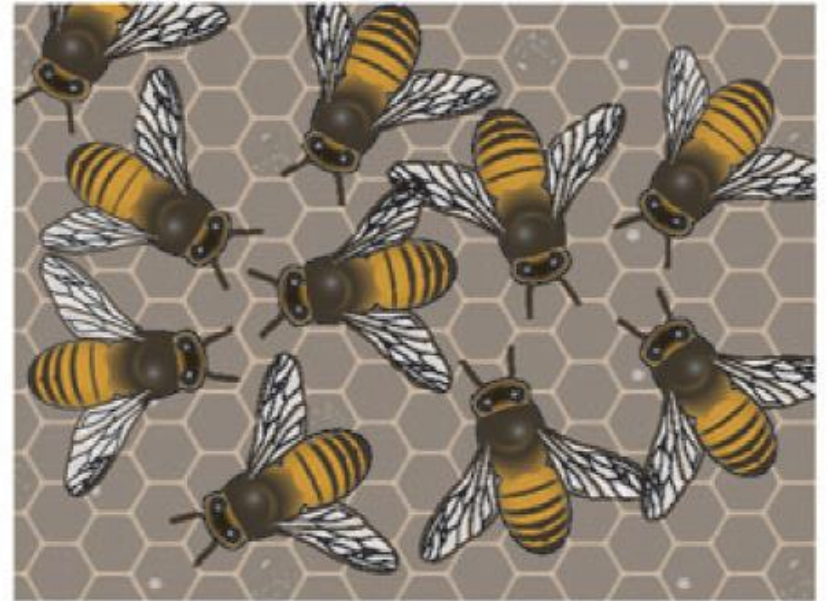


Physiological



Individual Behavior

Group Behavior



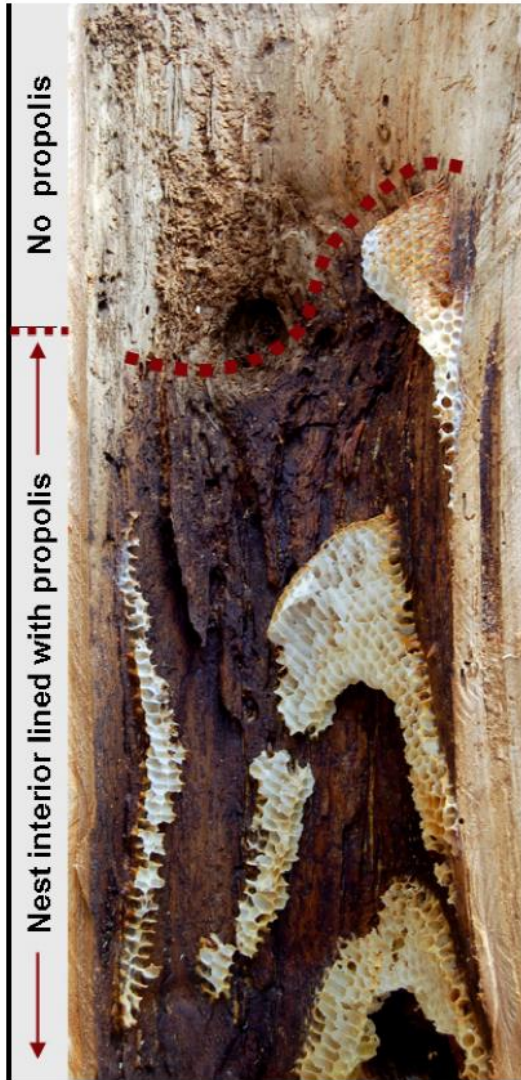


# Glucose oxidase

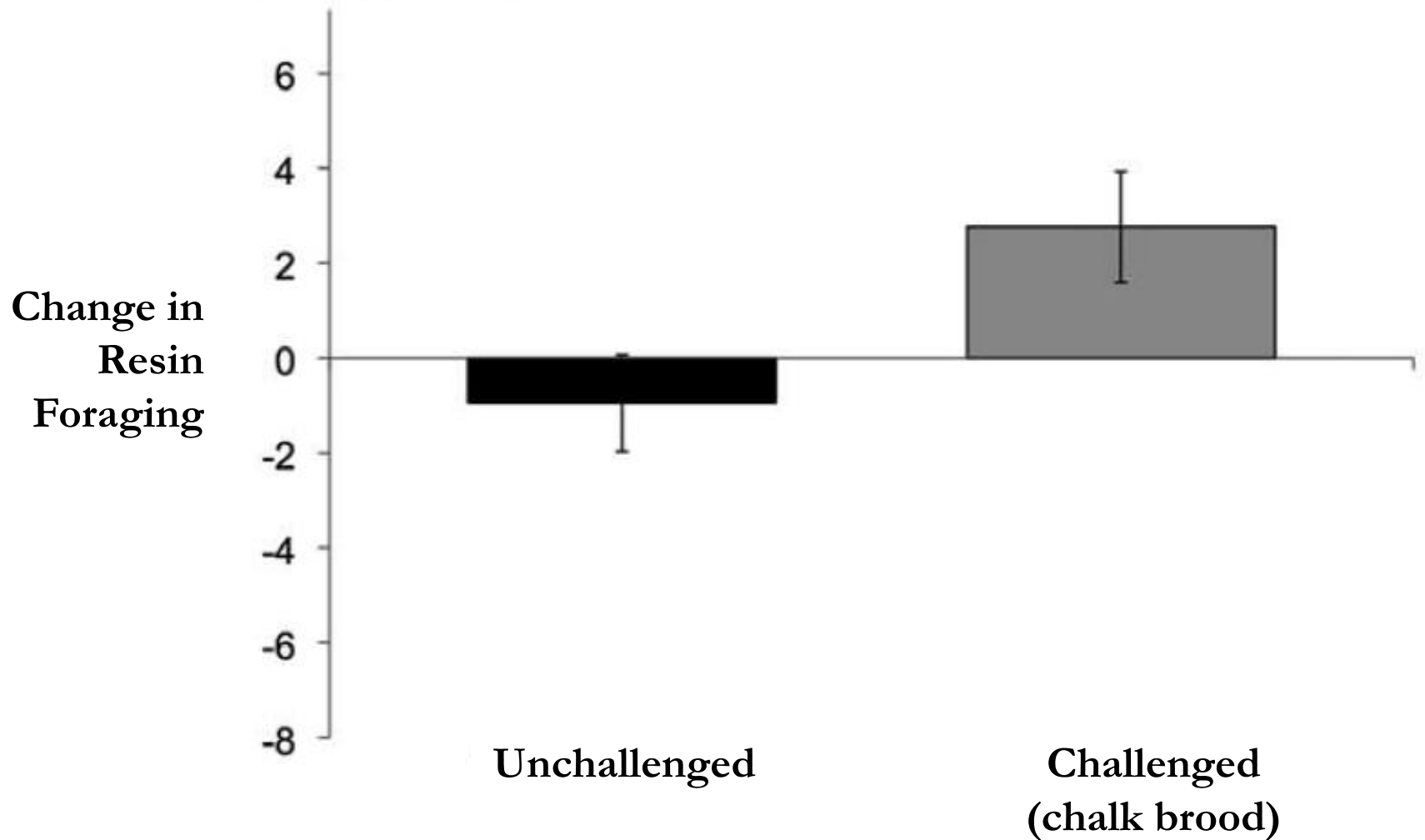




# Hygienic behavior



# Hygienic behavior



# Thermoregulation

Japanese  
GIANT  
Hornet

DEPLOY!!!



Japanese Honey Bees



HUG!  
HUG LIKE  
YOU'VE NEVER  
HUGGED BEFORE

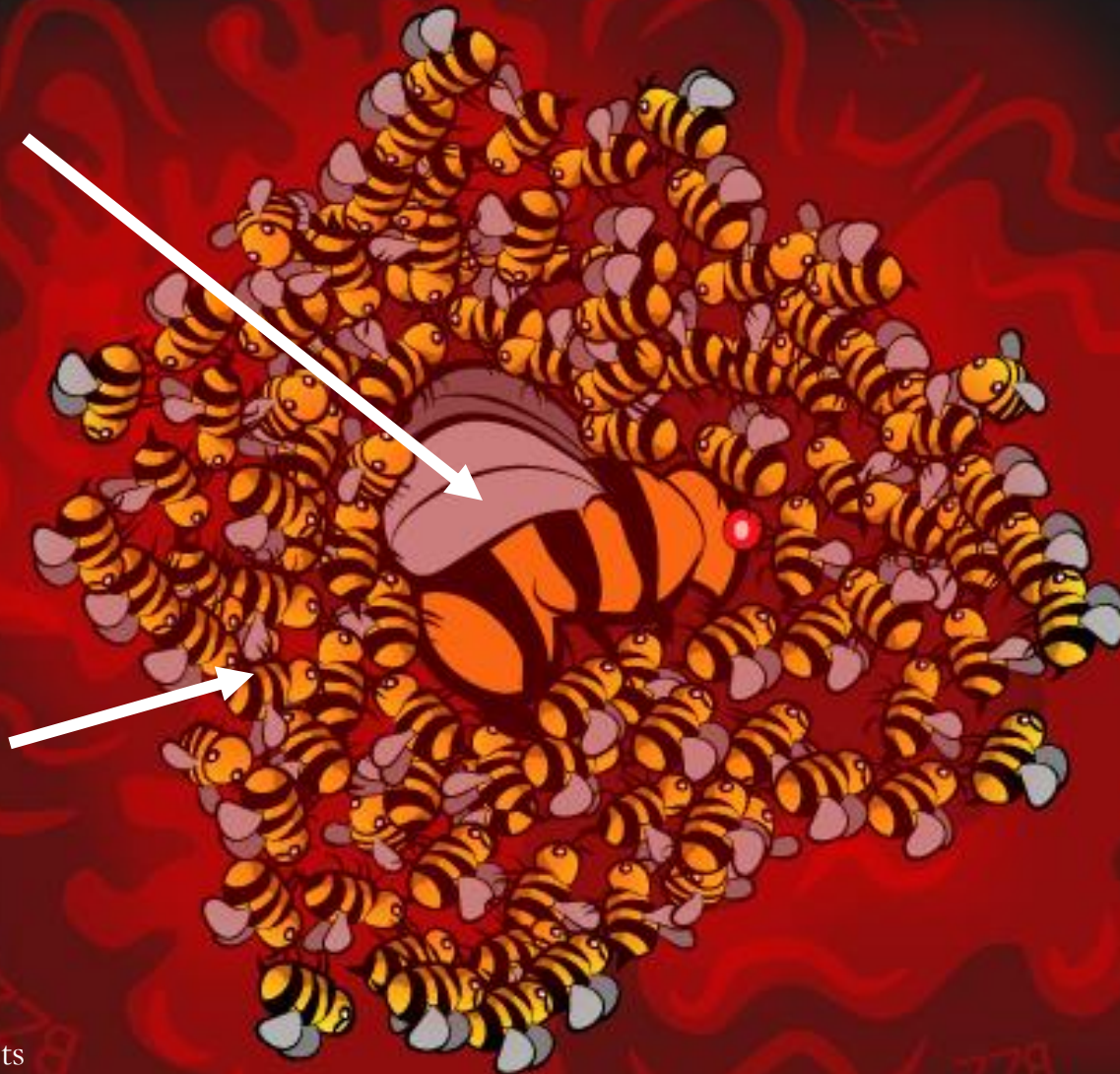




# Thermoregulation

46 °C  
114.8 °F

50 °C  
122 °F

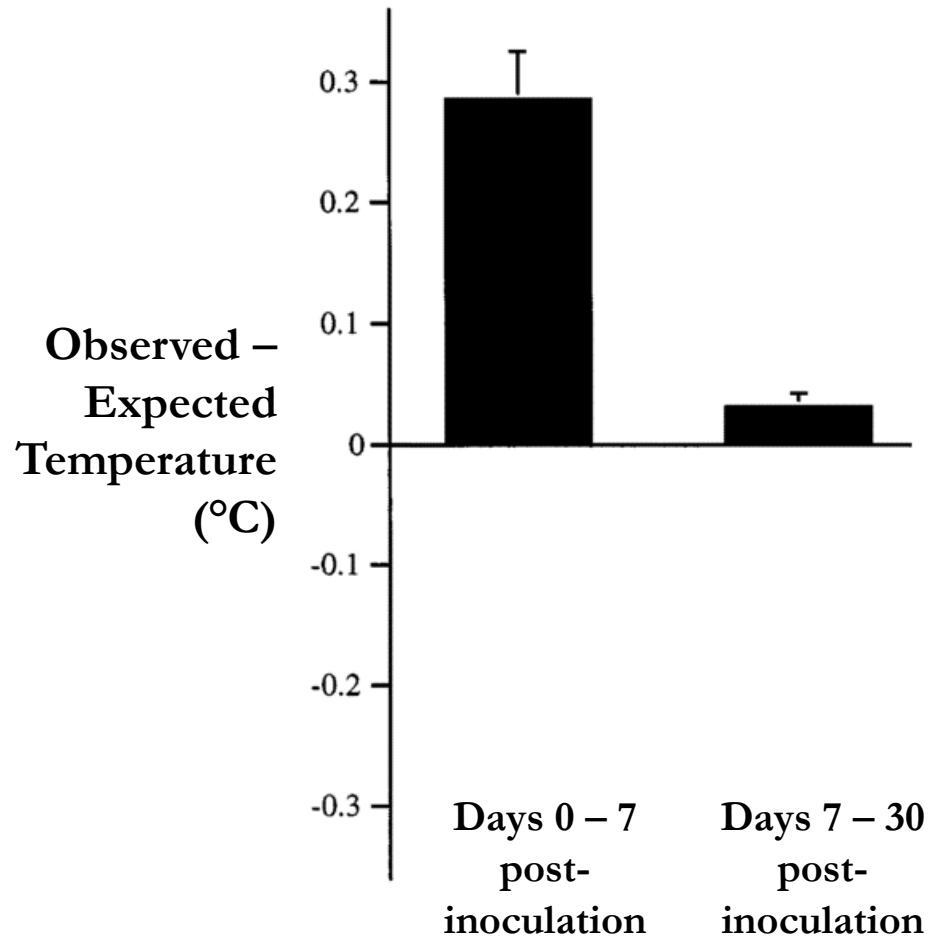


# Thermoregulation & disease

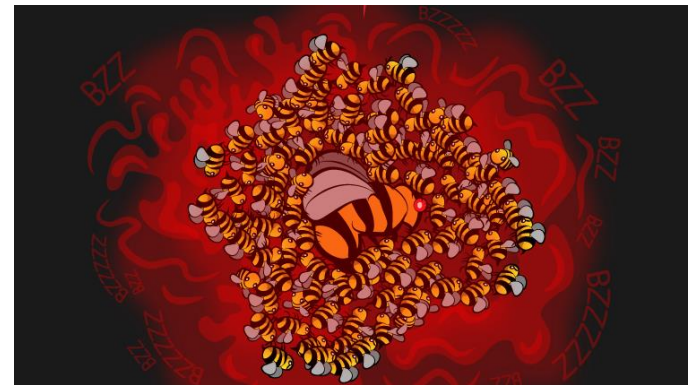
- **Chalkbrood:** fungal disease caused by *Ascosphaera apis*
  - Infects the larval gut, penetrates surrounding tissue (Jensen et al. 2013)
  - Larvae must be chilled to **30 °C (86 °F)** or less for infection to take hold (Bailey 1981)



# Thermoregulation & disease

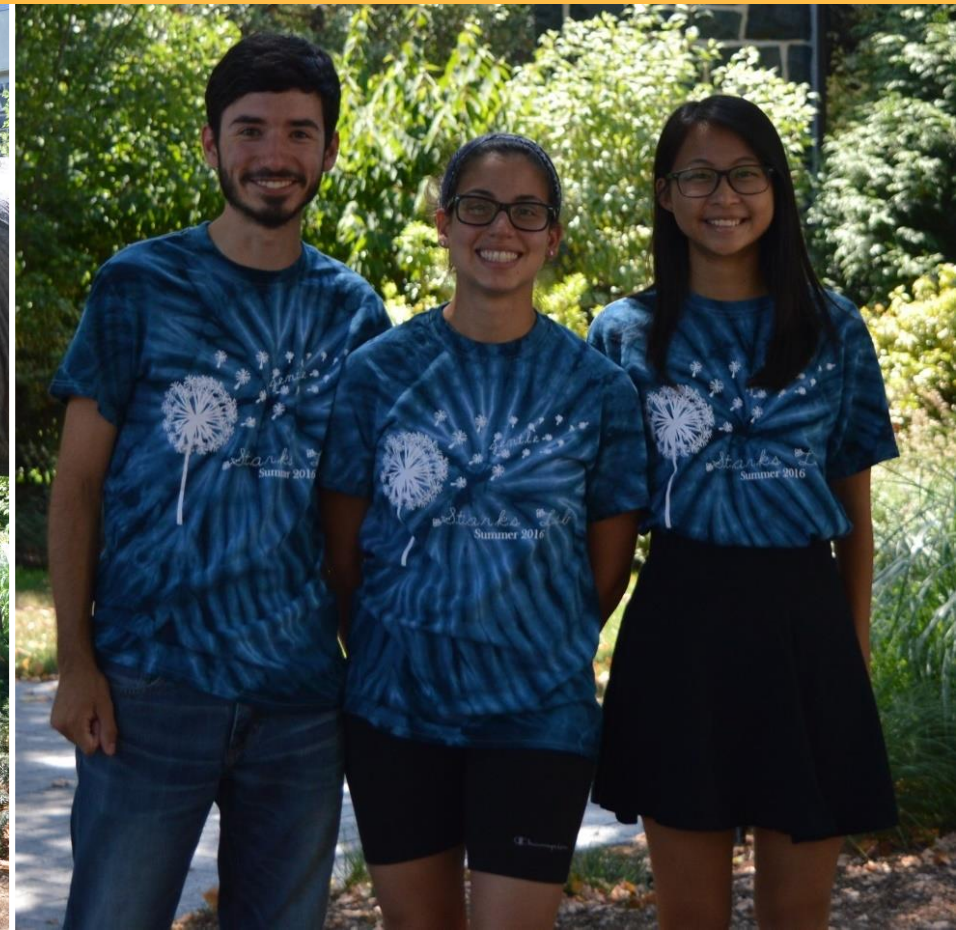


Thermoregulation as  
a social immune  
response =  
honey bee fever





# Thank you!



**Starks Lab Summer 2016**  
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Topsfield, MA. USA







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# Questions?

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