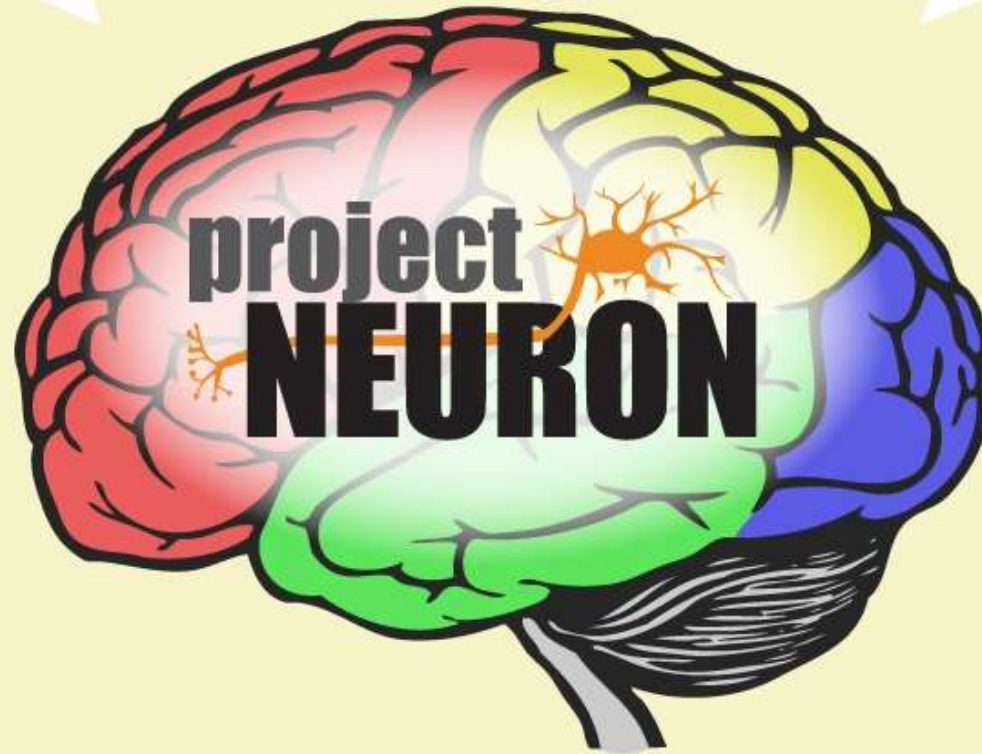


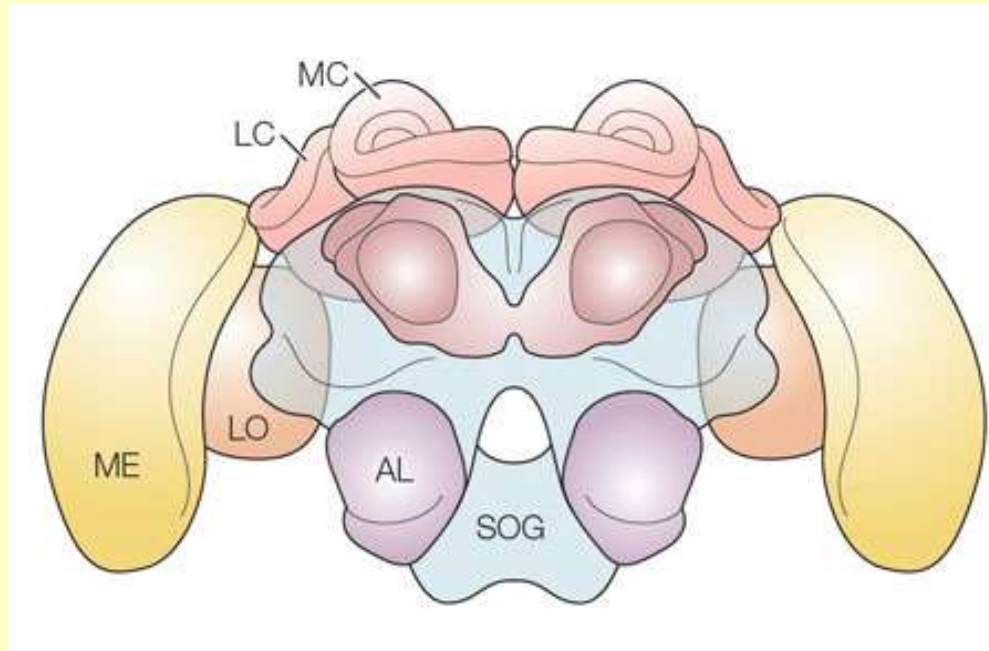
What makes honey bees work together? *How genes and environment affect behavior*



*Claudia Lutz, Rob Wallon, Claire Scavuzzo,  
Sara Patterson Adamek, Barbara Hug  
University of Illinois*



# What makes honey bees work together? *How genes and environment affect behavior*



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# Session Overview

- What is Project NEURON?
- Introduce the curriculum unit
- Experience two hands-on activities from the unit
- Discussion and feedback



# What is Project NEURON?

- Curriculum development
  - Inquiry-based
  - Connect to standards
- Professional development
  - Summer institutes
  - Conferences
- Educators, scientists, and graduate students



# Project NEURON Curriculum Units

- **Do you see what I see?**
  - *Light, sight, and natural selection*
- **What can I learn from worms?**
  - *Regeneration, stem cells, and models*
- **What makes me tick...tock?**
  - *Circadian rhythms, genetics, and health*
- **What changes our minds?**
  - *Toxicants, exposure, and the environment*
  - *Foods, drugs, and the brain*
- **Why dread a bump on the head?**
  - *The neuroscience of traumatic brain injury (TBI)*
- **Food for thought: What fuels us?**
  - *Glucose, the endocrine system, and health*
- **What makes honey bees work together?**
  - *How genes and environment affect behavior*
- **How do small microbes make a big difference?**
  - *Microbes, ecology, and the tree of life*

Available at:  
[neuron.illinois.edu](http://neuron.illinois.edu)

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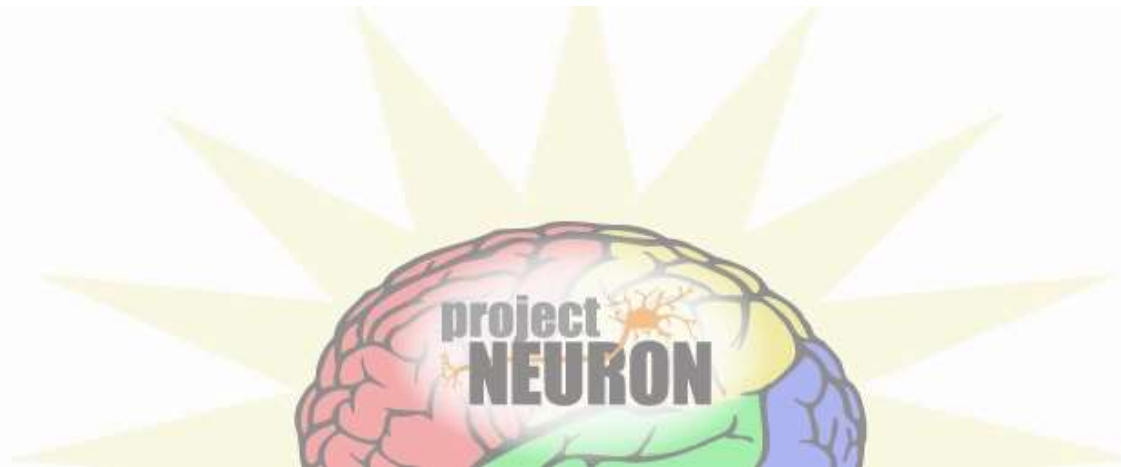
# Collaborative curriculum development

- Science Educators (Project NEURON)
  - Initial unit planning
  - Developing lessons
  - Modify/revise materials based on feedback
- Scientists (Robinson lab)
  - Initial unit planning
  - Provide feedback on lesson content
- Teachers (High School Science)
  - Initial unit planning
  - Enact lessons in the classroom
  - Provide feedback



# The Curriculum Unit

**What makes honey bees work together?**

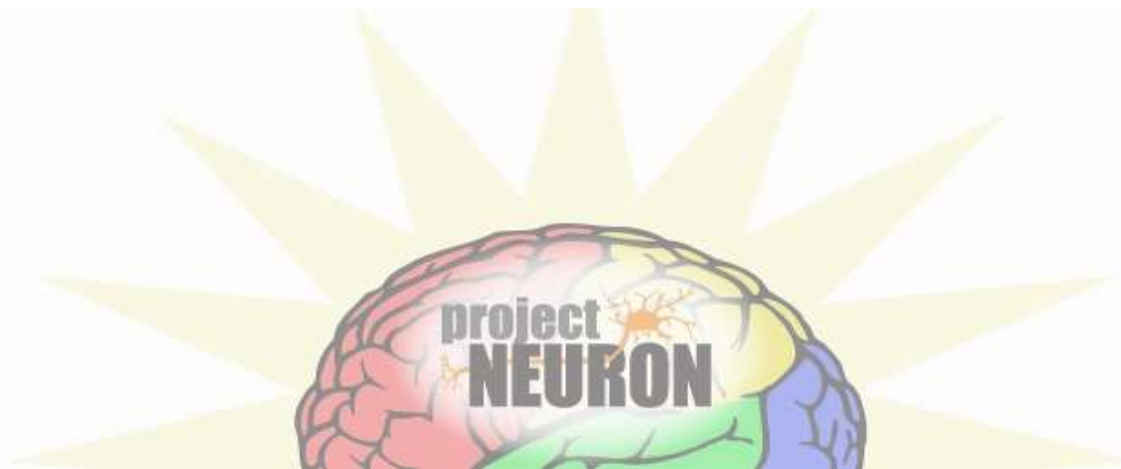




# The Curriculum Unit

## **What makes honey bees work together?**

Brainstorm factors that influence animal behaviors  
(humans are animals too!)

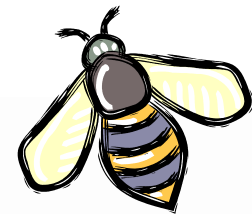


# The Curriculum Unit

## **What makes honey bees work together?**

Brainstorm factors that influence animal behaviors  
(humans are animals too!)

- Genetics (nature)
- Environment (nurture)



# The Curriculum Unit

## **What makes honey bees work together?**

- Lesson 1: What do honey bees do?
- Lesson 2: Why do honey bees have different jobs?
- Lesson 3: How do honey bees heat the hive?
- Lesson 4: What is the genetic basis for the evolution of eusocial behaviors?



# The Curriculum Unit

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# Lesson 1: What do honey bees do?

## Learning Objectives

- Generate questions about honey bees
- Identify honey bee behaviors
- Describe influences on behavior

So . . . what do honey bees do?

# Lesson 1: What do honey bees do?

## Learning Objectives

- Generate questions about honey bees
- Identify honey bee behaviors
- Describe influences on behavior



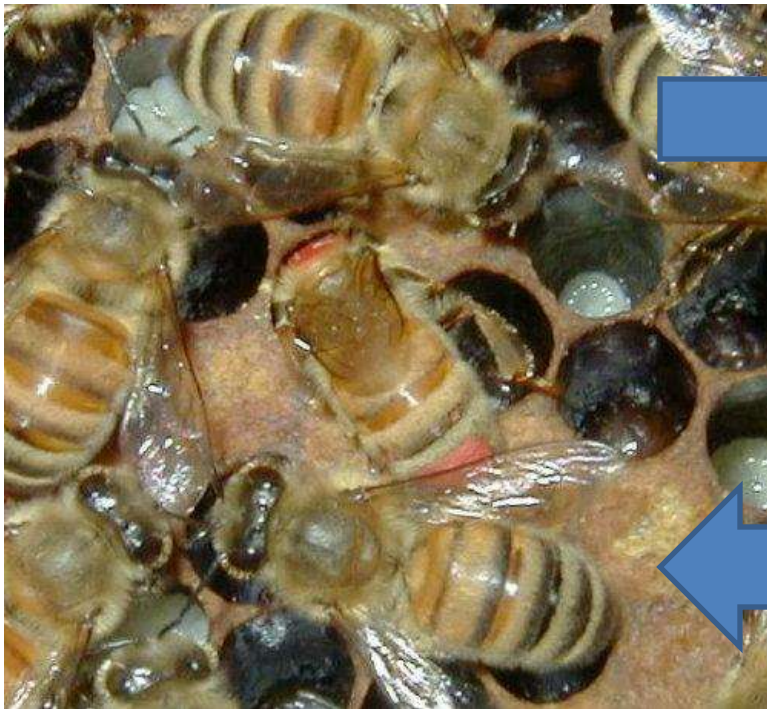
# Lesson 1: What do honey bees do?

- Nurse bees (days 3-11)
- Forager bees (days 14-42+)



# Lesson 1: What do honey bees do?

- Nurse bees (days 3-11)
- Forager bees (days 14-42+)





# The Curriculum Unit

## **What makes honey bees work together?**

- Lesson 1: What do honey bees do?
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# Lesson 2: Why do honey bees have different jobs?

## Learning Objectives

- Describe the **concept of gene expression**
- Explain how **gene expression influences the behavioral** roles of honey bees
- Model how the **environment influences the behavioral** roles of honey bees

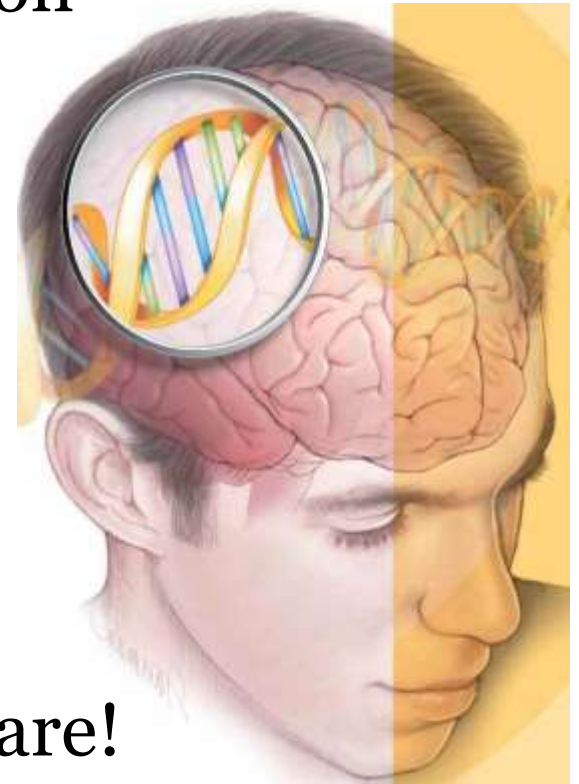
## AP Biology Big Idea 3:

“Living systems store, retrieve, transmit and respond to information essential to life processes.”

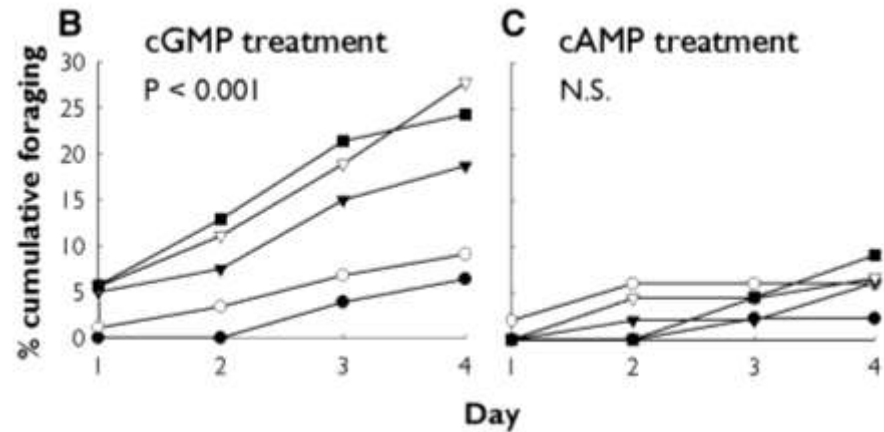
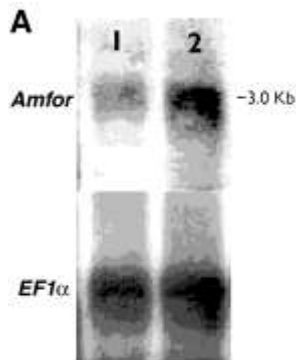
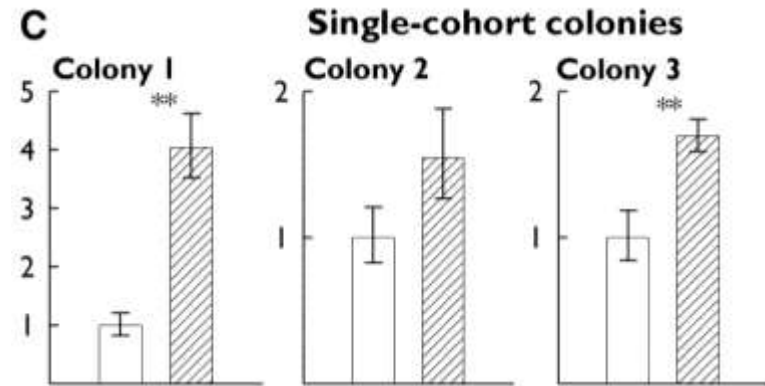
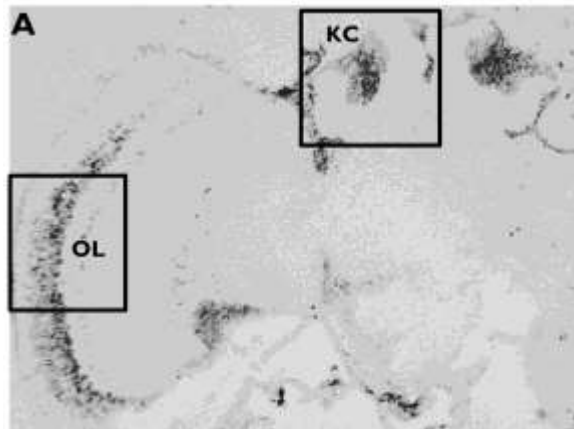
# Activity: Analyzing gene expression data

## Reading and data interpretation activity

- Everyone: background information
- Groups:
  - Experiment 1
  - Experiment 2A
  - Experiments 2B and 3
  - Experiments 4A and 4B
- Discuss in groups, be ready to share!

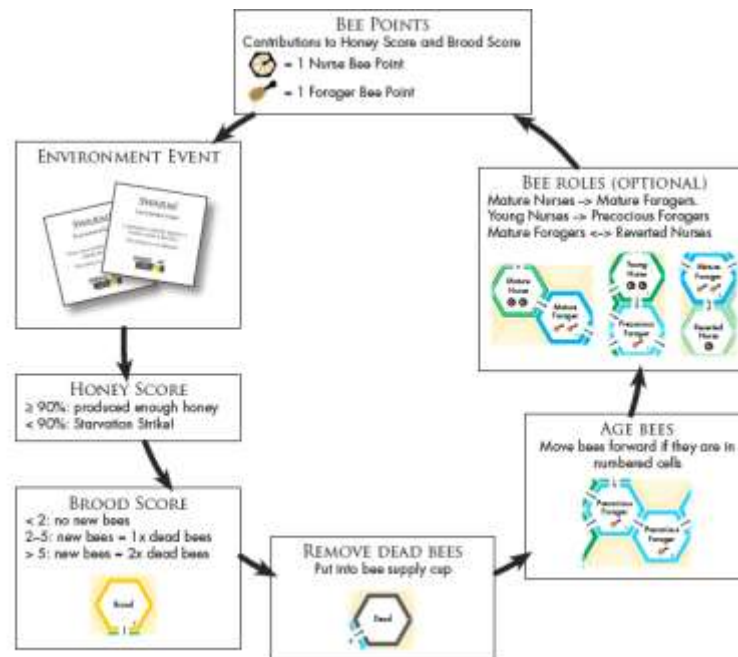


# Analyzing gene expression data: Discussion



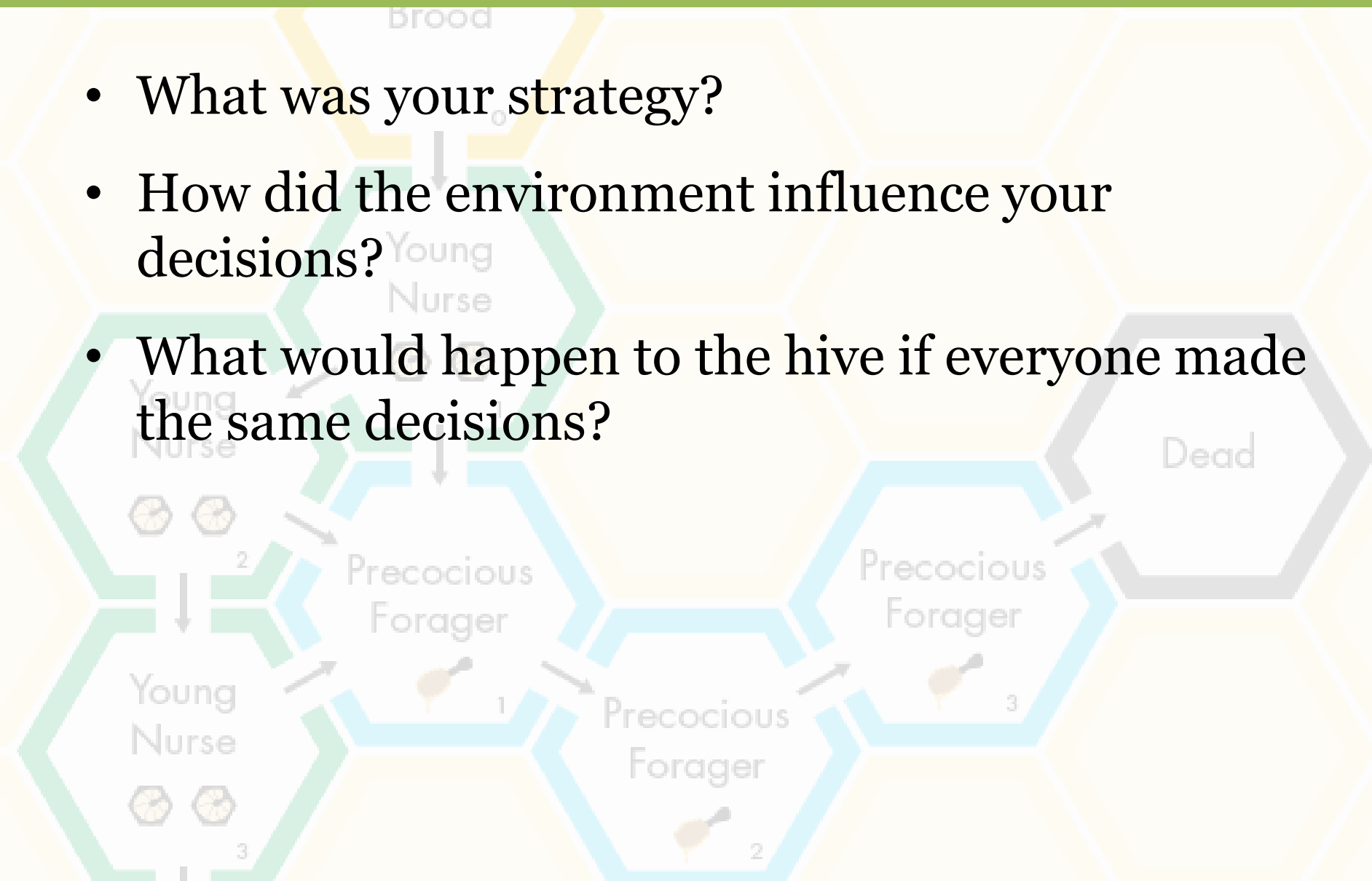
# Activity: Swarm!

- Look over game rules
- Boards will already be set up for play
- Keep the hive alive!



# Swarm!: Discussion

- What was your strategy?
- How did the environment influence your decisions?
- What would happen to the hive if everyone made the same decisions?



# The Curriculum Unit

## **What makes honey bees work together?**

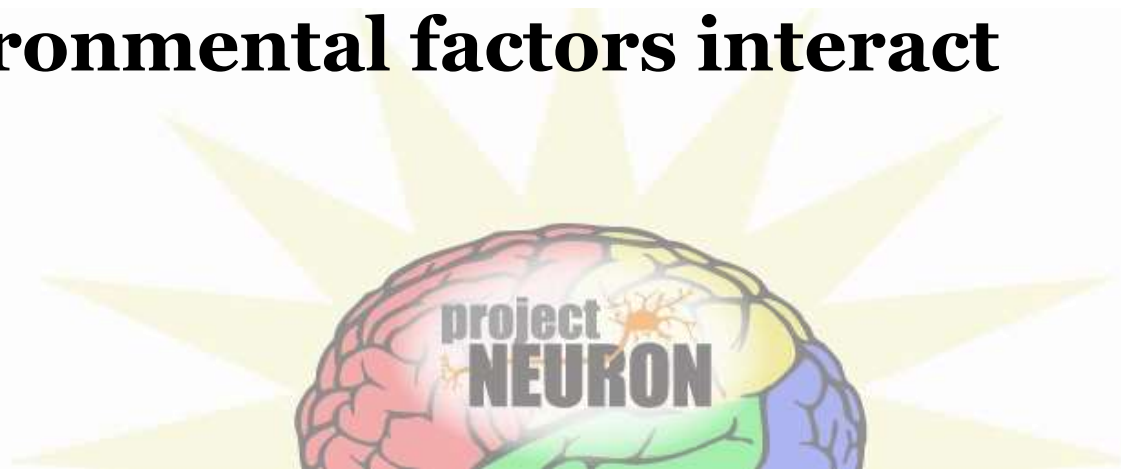
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# Lesson 3: How do honey bees heat the hive?

## Learning Objectives

- Apply the concept of **homeostasis** to a social group
- Investigate the **effect of temperature on bee behavior**
- Develop a model for **how genetic and environmental factors interact**





# The Curriculum Unit

## **What makes honey bees work together?**

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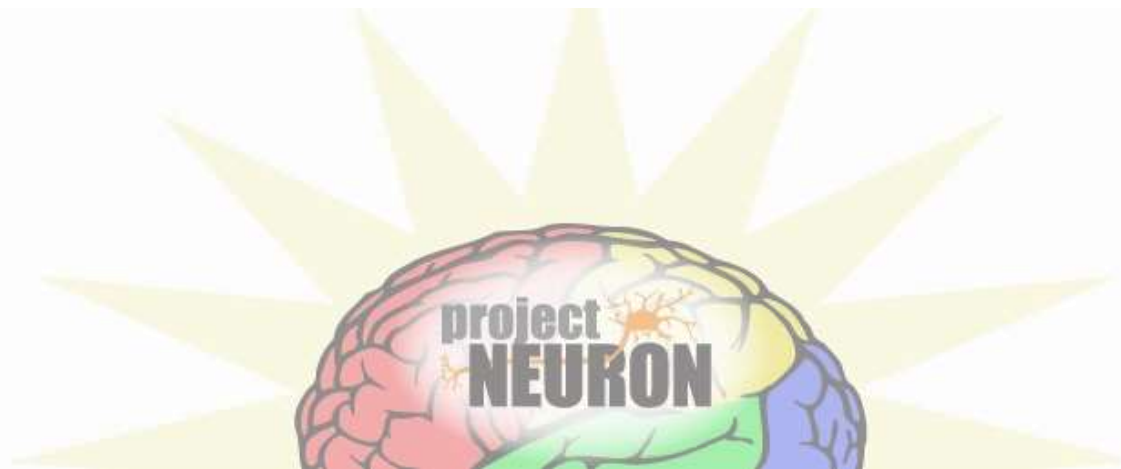
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“Branch Out With Software to Create Phylogenetic Trees”

- Time: Friday, November 22<sup>nd</sup> 2:30 PM - 3:45 PM
- Location: Dunwoody Room

# Discussion

- How could you use these lessons in your classroom?
- How might you modify these materials to fit with your curriculum?



# Acknowledgements

- NIH, SEPA
- University of Illinois
  - Project NEURON
  - Robinson Lab
  - Institute for Genomic Biology

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# Thanks!

For additional information visit:  
**<http://neuron.illinois.edu>**

E-mail:  
**[neuron@illinois.edu](mailto:neuron@illinois.edu)**



The screenshot shows the Project NEURON website homepage. At the top, there is a navigation bar with the Illinois logo on the left, a search box, and a "log in/Create account" link. Below the navigation bar is a main header with the text "Project NEURON" and "Novel Education for Understanding Research on Neuroscience". The main content area features several paragraphs of text, including a section titled "Find out more about our 2013 Summer Professional Development!" and a "News and Events" section. The "News and Events" section lists several events, including "Color Sorting Activity in The Science Teacher" (March 25, 2013), "Color Sorting Game is Back Online" (February 20, 2013), and "Project NEURON at 2013 Public Engagement Symposium" (February 6, 2013). There is also a "Neuroscience Day" banner for S. SIOUX CITY, NE and MISSION, SD, featuring a brain graphic.