

Louisa A. Stark, Ann Lambert, Sheila Homburger,
Molly Malone, Jen Taylor, Kristin Fenker, Dina
Drits-Esser, Kristin Bass, Kevin Pompei

Genetic Science Learning Center
University of Utah



CONTEXT

Evolution is central to biology but challenging to learn. Research shows that students have an easier time learning evolution concepts when they understand related ideas from genetics. We are developing a new NGSS-friendly heredity and evolution unit, plus related assessment measures. We will use them to understand the mechanisms of 3D student learning and misconception change in heredity and evolution

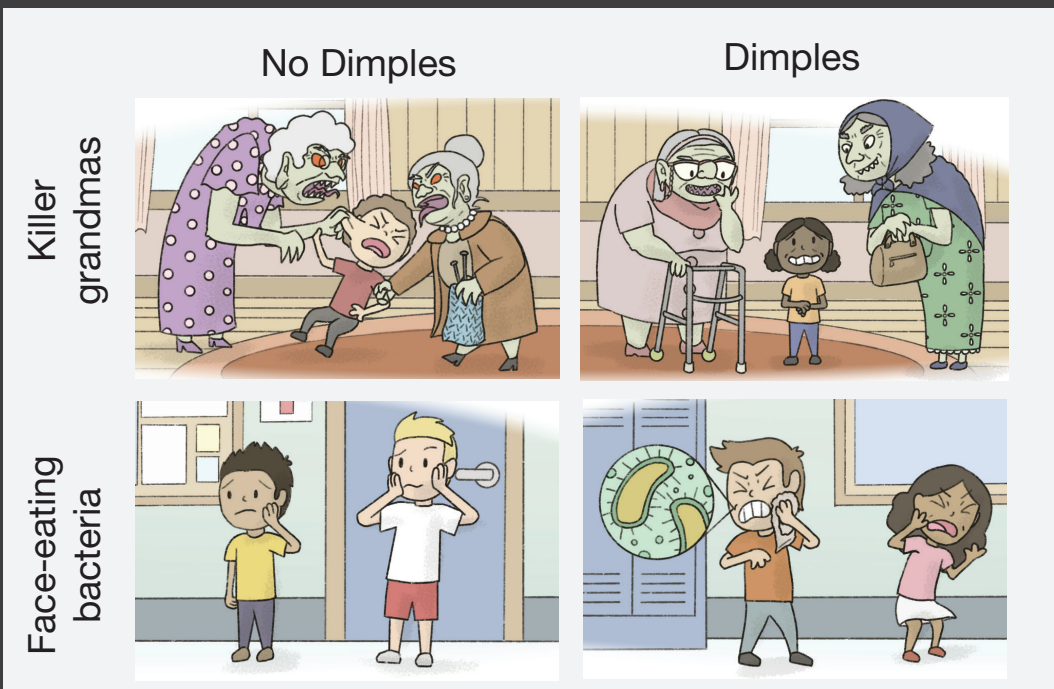
HYPOTHESES

- An evolution unit that integrates heredity ideas will **increase students’ understanding** of the mechanisms of evolutionary change.
- Novel assessment measures will **quantify 3D learning & implicit misconceptions**.
- Qualitative measures will help **assess student thinking**, including whether they incorporate heredity concepts in their explanations of evolution.

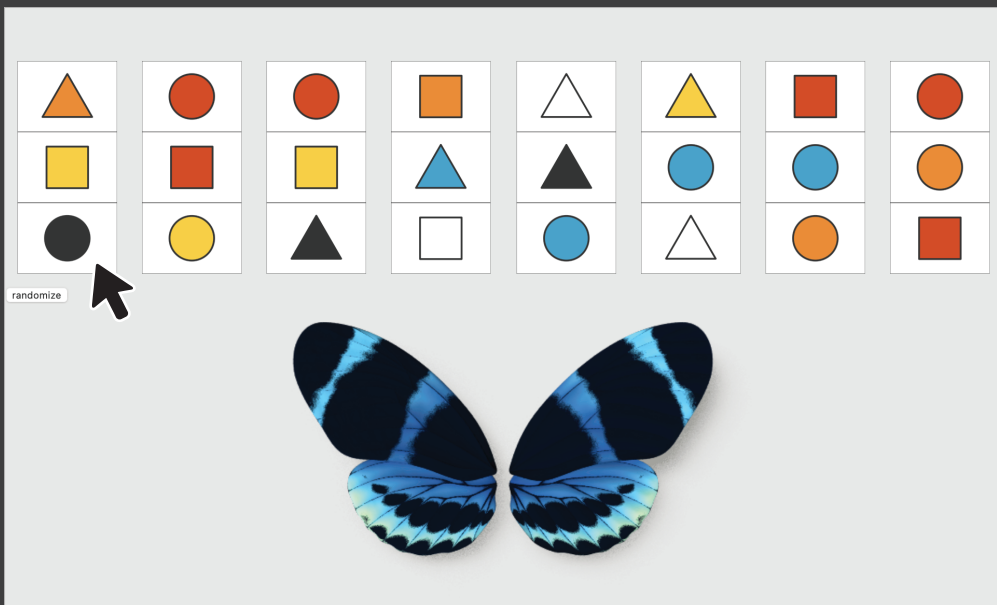
Genes, Traits & Change over Time:
Developing and Testing a **3D Middle School Unit** that Integrates **Heredity & Evolution**

Unit Modules & Essential Questions

- **Traits:** *How are traits made?*
- **Inheritance:** *How are traits passed down?*
- **Reproductive Success:** *How do traits affect who reproduces?*
- **Natural Selection & Adaptation:** *How do species’ traits change over time?*
- **Evidence for Evolution:** *How do changes in traits provide evidence for evolution?*



EXAMPLE LESSONS



UNIT FEATURES

- Focus on the **mechanisms** that drive **genetic variation** and **natural selection**
- Scaffolded practice working with **models**, crafting **explanations**, and identifying **cause and effect** relationships
- Embedded **formative assessments**
- Easy-to-implement **multimedia & paper-based** activities
- **Teacher supports**
- ~4–6 weeks of classroom time

POTENTIAL IMPACTS

- Improve STEM education** for students by:
- Providing an example of a cohesive pair of curriculum units for middle and high school
 - Integrating all three dimensions of NGSS
- Advance knowledge** of:
- How teachers & students use embedded formative assessments
 - How 3D curricula lead to 3D learning gains
 - Potential differential change in explicit vs. implicit misconceptions of heredity and evolution



This project is funded by the National Science Foundation, grant #1814194. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Genes, Traits & Change over Time

NGSS Connections

Trait Shuffle

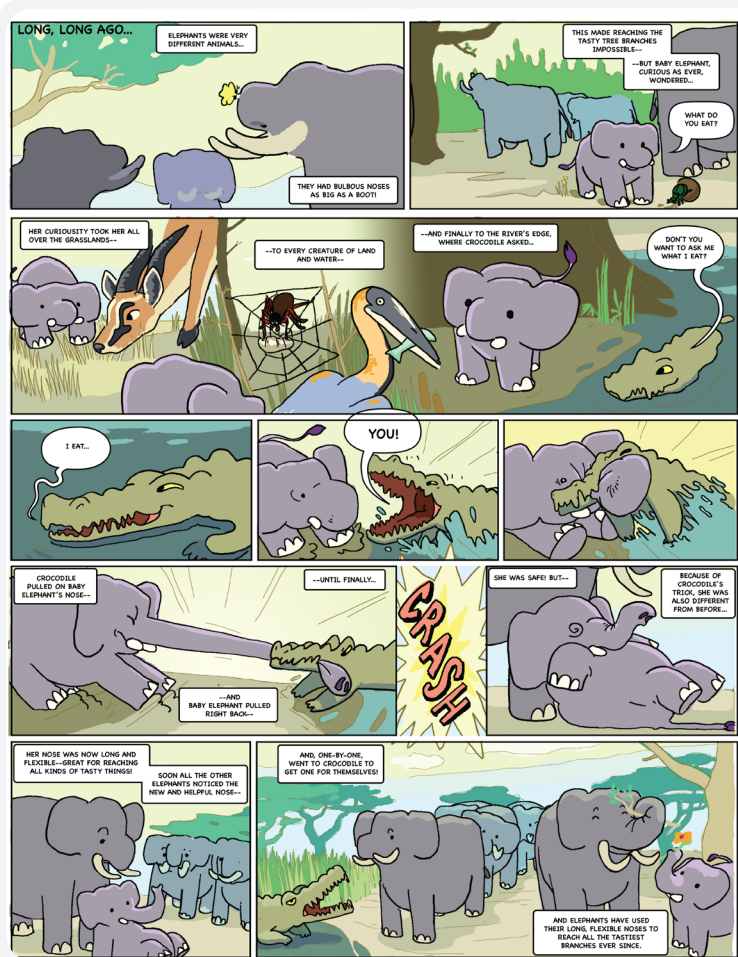


EXAMPLE LESSON

Mutt Mixer



EXAMPLE LESSON



EXAMPLE LESSON

1 DISCIPLINARY CORE IDEAS

LS1.B: Growth & Development of Organisms

LS3.A+B: Inheritance & Variation of Traits

LS4.B: Natural Selection

LS4.C: Adaptation

LS4.A Evidence of Common Ancestry

2 SCIENCE & ENGINEERING PRACTICES

Constructing Explanations

Using & Building Models

(Analyzing & Interpreting Data)

3 CROSSCUTTING CONCEPTS

Cause & Effect

Structure & Function

NAME _____ DATE _____

Learn.Genetics.Utah.edu
GENETIC SCIENCE LEARNING CENTER

Traits: Model Diagram

Directions: Draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

KEY:

- The evidence **supports** the model
- The evidence **strongly supports** the model
- The evidence **contradicts** the model (shows it's wrong)
- The evidence **has nothing to do with** the model

Evidence #1 – People have genes that code for proteins called actin and myosin. These proteins help build muscles and make them work.

Evidence #2 – When people work out, their muscles get stronger.

Evidence #3 – People who do not have enough to eat tend to have less muscle than people who eat well.

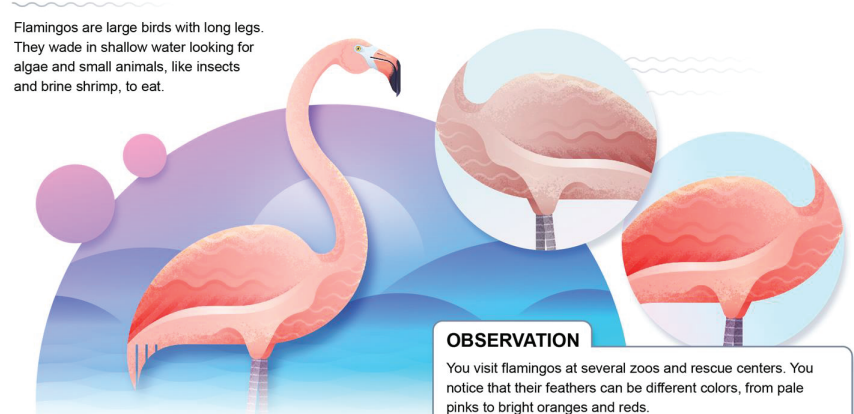
Evidence #4 – Muscle strength is a trait that can be different from one person to the next.

Model A
Traits are made by genes.

Model B
Traits are made by genes and the environment.

© 2021 University of Utah Updated May 20, 2021 4

Heritable or Acquired? Flamingos



OBSERVATION
You visit flamingos at several zoos and rescue centers. You notice that their feathers can be different colors, from pale pink to bright oranges and reds.

EXPERIMENT
You collect 6 male female pairs of flamingos: three pairs that are pale pink, and three pairs that are brightly colored. You raise them all in the same environment and give them the same types of food to eat. Each pair has a chick, which you also raise in the same conditions. Once the chicks grow up you observe their colors.

RESULTS			Color in flamingos is: ☐ heritable ☐ acquired
Pair #	Parent color	Offspring color	
1	pale	medium pink	Evidence: _____
2	pale	medium pink	
3	pale	medium pink	
4	bright	medium pink	
5	bright	medium pink	
6	bright	medium pink	

PERFORMANCE EXPECTATIONS

MS-LS1 — From Molecules to Organisms: Structures & Processes

MS-LS3 — Heredity: Inheritance & Variation of Traits

MS-LS4 — Biological Evolution: Unity & Diversity

MIXED METHODS RESEARCH PLAN

Quantitative approaches: measure student learning gains & implicit misconception change

- 1D multiple choice items
- 3D item cluster
- Implicit misconception tests

Qualitative approaches: probe student thinking

- Formative assessments
- Classroom observations
- Student & teacher interviews

TESTING PROCEDURE

- **Pretest:** 1D multiple choice items & implicit misconceptions tests
- Students experience the unit, including embedded formative assessments
- **Posttest:** 1D multiple choice items, implicit misconceptions tests & 3D item cluster

EXAMPLE EXPLICIT MEASURE OF MISCONCEPTIONS

Which of the following statements best describes new genetic variations?

- A. They are usually helpful to the organism.
- B. They do not make a difference to the organism.
- C. They are usually harmful to the organism.
- D. They can be helpful, harmful, or not make a difference.

Genes, Traits & Change over Time

Example Implicit Association Test

