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?

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.

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
Genes, Traits & Change over Time
NGSS Connections

1. DISCIPLINARY CORE IDEAS
   - LS1.B: Growth & Development of Organisms
   - LS3.A+B: Inheritance & Variation of Traits
   - LS4.B: Natural Selection
   - LS4.C: Adaptation

2. SCIENCE & ENGINEERING PRACTICES
   - Constructing Explanations
   - Using & Building Models
   - (Analyzing & Interpreting Data)

3. CROSSCUTTING CONCEPTS
   - Cause & Effect
   - Structure & Function

PERFORMANCE EXPECTATIONS
MS-LS1 — From Molecules to Organisms: Structures & Processes
MS-LS3 — Heredity: Inheritance & Variation of Traits
MS-LS4 — Biological Evolution: Unity & Diversity
Genes, Traits & Change over Time
Example Implicit Association Test

INSTRUCTIONS
In this task you will press the ‘E’ key (left response key) or the ‘I’ key (right response key) to categorize words and pictures into groups as fast as you can. Here are the groups and the words and pictures that belong to them:

**Category** | **Item**
---|---
Helpful | Nice, Kind, Useful, Good
Harmful | Dangerous, Hurt, Pain, Bad
Mutations

Helpful or Mutation

Harmful

Dangerous

Compare accuracy & time for different groupings

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.