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# K-12 Partnership Lesson Plan

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# *From Molecules to Populations*

# *Describing diversity using molecular tools*

## Overview

Ever wonder how biologists reconstruct ancient human migrations? Or, how a paternity test works? It’s all in the genes, folks! Our session will focus on the many practical applications of molecular biology. Building on the Lady Beetle Blitz session, we’ll describe variation in field collected beetles, categorizing them based on phenotype, and then use molecular tools to reconstruct their North American Invasion in the late 1980s.

Participants will describe and categorize the diversity of the sample population based on their phenotype. Students will then use sample DNA sequences to explore how migratory patterns are reflected in genetic sequences. Students will then apply these skills to an optional activity looking at genetic signatures of ancient human migrations.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Describe the diversity of a population in terms of phenotype and genotype
* Use genotypic information to answer questions about the migration of a species
* Use genotypic information to answer evolutionary questions about organisms

**Length of Lesson**

1-2 class periods, depending on activities chosen

**Grade Levels**

Middle school, high school

**Standards covered (NGSS)**

Disciplinary Core Ideas:

*Middle School*

* **MS-LS4-2**: apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships

*High School*

* **HS-LS3-1:** ask questions to clarify relationship about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring

Cross Cutting Concepts:

* Patterns
* Stability and change of systems

Science and Engineering Practices

* Analyzing and interpreting data
* Engaging in argument from evidence

**Materials**

* Asian Lady Beetles collected in the field (see “Lady Beetle Blitz” lesson on the KBS GK-12 site for methods)
* Handouts for beetle activity
  + Phenotypic and genotypic comparison
  + Organism genetic sequences
  + Lady beetle intro sequences from different locations
* Handouts for human migration extension
  + Mitochondrial DNA data and questions

**Background**

### In this lesson, students will explore the relationship between genotype and phenotype using a commonly found insect: the Asian Lady Beetle. This exercise works as a follow-up to field collection methods in the “Lady Beetle Blitz” lesson. Asian Lady Beetles show a variety of phenotypic differences in spot number and shell color.

### Asian lady beetles are native to Asia but were introduced to the United States for pest control. The first lady beetles were introduced to California in 1916 and again in 1964 to control aphids on crops. Although these beetles were never recovered, scientists do not think they established. Other programs were used in additional states in the early 1980s with similar results (CT, DE, GA, LA, ME, MD, MS, OH, PA, WA). In 1988, however, a population of multicolored Asian lady beetles was found in Louisiana. This population quickly spread to neighboring states and eventually throughout the eastern United States.

### In this activity students will learn how to use differences to genetic sequences to determine how closely related two individuals are. They will then use genetic sequences from Asian lady beetles from different states to determine if genes can be used to reconstruct historic patterns of migration.

### Vocabulary:

### *Phenotype*: observable characteristics of an organism (e.g. color, spot number, metabolic rate, behavior, etc.)

### *Genotype*: DNA sequence that determines an organism’s phenotype

### *Nucleotide*: organic molecules that serve as the building blocks for DNA (and RNA). For DNA these come in 4 forms: adenine (A), guanine (G), thymine (T), and cytosine (C)

### *Allele*: a single variant of a gene (e.g. blue eye allele vs. brown eye allele)

### Activities of the session

**Part 1**: Phenotypic differences of beetles from the field

1. Collect Asian Lady Beetles from the field using methods from the Lady Beetle Blitz lesson
2. Back in the classroom, sort the Asian Lady Beetles according to phenotypic characteristics
3. Record phenotypic differences on page one of the “Phenotypic and genotypic comparison” worksheet
4. Discuss the relationship between phenotype and genotype

**Part 2**: Genotypic comparison of Asian Lady Beetles

(can start here if you aren’t able to collect in the field)

1. Use the “Organism genetic sequences” handout to answer questions in part B on the “Phenotypic and genotypic comparison” worksheet
2. Use the “Lady beetle intro sequences” handout to answer questions in part C on the “Phenotypic and genotypic comparison” worksheet

**Part 3** (optional): Human migration extension

1. Use the “Mitochondrial DNA data” worksheet to apply the lesson from the beetle exercises to understanding ancient human migrations.

**Resources**

* Dolan DNA learning Center Genetic Origins Site (contains database for mitochondrial DNA and a comparison tool): <http://www.geneticorigins.org/mito/mitoframeset.htm>
* Lady Beetle ID sheet available on the “From Molecules to Populations” lesson page on the GK-12 KBS site
* <http://www.extension.umn.edu/garden/insects/find/multicolored-asian-lady-beetles/>