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Creators: Beth Krauss and Maureen Collier
NYSSLS 5-E Lesson Plan

Grade/Grade Band: AP Biology	**Topic**: Evolution/Natural Selection	**Timeline:** 120 minutes Lesson # __1___ in a series of __1__ lessons

Lesson Title: Evolutionary Advantage of the Eastern Grey Squirrel

Brief Lesson Description:

Students will use the Eastern Gray Squirrel Case Study to create a claim about the evolutionary advantage of coat color in a particular environment. They will use data from SquirrelMapper and other resources for their evidence. Working in small groups, students will create a poster to display their findings. Students will submit a CER for a summative assessment.

Performance Expectation(s): AP Biology CED EVO-1.E (see CED Below for specific standards)

Specific Learning Outcomes: (What will the students *know and be able to do* as a result of this lesson?)

Natural selection acts on phenotypic variations. Environments change and apply selective pressures to populations. Some phenotypic variations significantly increase or decrease the fitness of the organism in particular environments. (CED)

- The students will be able to design, execute, analyze and present a research project on the potential evolutionary benefits of the different color morphs of the eastern gray squirrel in different habitats.
- The students will be able to generate a claim as to the evolutionary adaptive advantage of coat color in the Eastern Gray Squirrel in a particular environment.
- The students will be able to evaluate a scientific claim using evidence from data

Narrative/Background Information

Prior Student Knowledge:

- Students identify evolution is a change in genetic makeup in a population over time and is supported by multiple lines of evidence. (CED)

AP Biology Science Practices:	**AP Biology Big Ideas:**	**CED:**
SCIENCE PRACTICE 1: The student can use representations and models to communicate scientific phenomena and solve scientific problems. **SCIENCE PRACTICE 2:** The student can use mathematics appropriately. **SCIENCE PRACTICE 3:** The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course **SCIENCE PRACTICE 5:** The student can perform data analysis and evaluation of evidence. **SCIENCE PRACTICE 7:** The student is able to connect and relate knowledge	**Big Idea 1** - What conditions in a population make it more or less likely to evolve?	**EVO-1.E.1 -** Natural selection acts on phenotypic variations. **EVO-1.E.2 -** Environments change and apply selective pressures to populations. **EVO-1.E.3 -** Some phenotypic variations significantly increase or decrease the fitness of the organism in particular environments.

across various scales, concepts and representations in and across domains.		

Possible Preconceptions/Misconceptions:

- Misconceptions - Different phenotypes are due to the *need* of the organism to adapt to its environment. The dominant phenotype is the most frequent.

Teaching Materials: (A list of materials required, including any AV materials, to run your lesson.)

- iNaturalist app (if students have cell phones)
- Computers with internet access
- poster board/paper
- markers
- Claim, Evidence, Reasoning (CER) Template and Rubric

Safety: (Address any safety issues for demos, activities, lab, etc.)

If going outside for iNaturalist - make sure the walking area is appropriate for all students/handicap accessible, be aware of students with medical needs (bee allergies, asthma, etc.)

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:
40 Minutes. (See supplemental materials for lesson resources)

1. Open with a picture of Eastern Gray Squirrels with the 2 different color morphs.
2. Hand out post-it notes and have students write down 3 questions based on the picture.
3. Have students share their questions. They can hang their post-it notes on wall or poster paper. (At the end of day 2, revisit the questions to see if they were answered.)
4. Then pose the question, "How would scientists collect data to determine abundance of the different colored morphs?" Have students "turn and talk" to share ideas.
5. Discuss the techniques of mark and recapture, sampling, point count, trail cams.
6. Introduce the iNaturalist app.
7. Go outside with the students so they can explore the schoolyard using the iNaturalist and set up a trail cam.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
80 minutes

1. **Guiding Question:** Is there an evolutionary selective/adaptive advantage for one squirrel color morph in a particular environment?
2. Students will come up with an environment to investigate such as differences in urban vs rural, differences between cities, different sized cities, differences in cold vs warm climates, etc.
3. Students are then tasked with generating a claim as to the evolutionary adaptive advantage of coat color in the Eastern Gray Squirrel in a particular environment.
4. Using SquirrelMapper they are able to explore the data and apply Chi-Square analysis.
   (If students have not been introduced to Chi-Square a separate lesson on using the formula and table may be needed.)

EXPLAIN: Concepts Explained and Vocabulary Defined:

- The groups will prepare a white board/poster where they will share their initial argument with other groups, get constructive feedback and revise the initial argument
- In the Introduction of the Student Copy of the case study, key vocabulary is explained.

Key vocabulary that you will use: natural selection, morph, melanic, range, crypsis, thermogenesis, homozygous, heterozygous, phenotypic variation, selective pressure, fitness

ELABORATE: Applications and Extensions:

The following activities give further examples of how through natural selection populations of organisms have evolved color morphs to be better suited to their environment. These activities can be utilized to strengthen students' understanding of the role of natural selection in an organism's survival.

- Colored Variation Over Time in Rock Pocket Mice Populations https://www.biointeractive.org/classroom-resources/color-variation-over-time-rock-pocket-mouse-populations
- Peppered moths of Industrial Revolution
- **https://askabiologist.asu.edu/activities/peppered-moth**

EVALUATE:
Summative Assessment: Students will develop a final CER and be graded using a rubric

Differentiation/Modifications:
This lesson can be modified to different student abilities and grade levels. Suggestions include a qualitative analysis of the collected squirrel morph data instead of a quantitative (statistical) analysis. Using the preset geographical areas in Squirrel Mapper will give the teacher a known outcome that can be used to aid students with the data interpretation. Younger students can use iNaturalist to map squirrel populations on school grounds or in their neighborhoods and play the Squirrel Spotter game.

Applicable NYS HS learning standards – HS-LS4-1; HS-LS4-2; HS-LS4-3, HS-LS4-4, HS-LS4-5, HS-LS3-1

References:
Adapted from Argument-Driven Inquiry in Biology: lab investigations for Grades 9-12, Copyright 2014 NSTA

Teacher Appendix: Articles

Benson, E. (2013). The Urbanization of the Eastern Gray Squirrel in the United States. *The Journal of American History*, *100*(3), 691–710. http://www.jstor.org/stable/44308759

Buff, B.F., Cosentino, B.J., & Gibbs, J.P. (2019). The Biological System—Urban Wildlife, Adaptation, and Evolution: Urbanization as a Driver of Contemporary Evolution in Gray Squirrels (Sciurus carolinensis). In M.H.P. Hall & S.B. Balogh (Eds.), *Understanding Urban Ecology: An Interdisciplinary Systems Approach* (pp. 269-286). Springer International.

Cosentino, B. J., & Gibbs, J. P. (2022). Parallel evolution of urban-rural clines in melanism in a widespread mammal. *Scientific reports*, *12*(1), 1752. https://doi.org/10.1038/s41598-022-05746-2

Gustafson, E. J., & VanDruff, L. W. (1990). Behavior of Black and Gray Morphs of Sciurus carolinensis in an Urban Environment. *The American Midland Naturalist*, *123*(1), 186–192. https://doi.org/10.2307/2425772