GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

# LESSON PLAN

## REPRODUCTION OF LIVING THINGS
## GRADES 6-8

## SUMMARY

Students analyze and interpret data to present an argument that explains why there is such dramatic color variation among male guppies in the same stream.

### NEXT GENERATION SCIENCE STANDARDS CORRELATION

**MS-LS1-4.** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

| Science & Engineering Practices | Connections to Classroom Activity |
|---|---|
| **Analyzing and Interpreting Data** | • Students analyze and interpret data of male guppy coloration from four pools in the same stream. |
| **Engaging in Argument From Evidence** | • Student groups present an argument supported by empirical evidence and scientific reasoning to support or refute an explanation for male guppy coloration. |

| Disciplinary Core Ideas | Connections to Classroom Activity |
|---|---|
| **LS1.B. Growth and Development of Organisms**<br>Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) | • Students use their understanding of animal behaviors that increase the odds of reproducing to construct an argument for variations in color of guppies. |

| Cross Cutting Concepts | Connections to Classroom Activity |
|---|---|
| **Patterns** | • Students use patterns they identify from charts, graphs, and images of male guppies to construct an argument to explain the range of color variations. |
| **Cause and Effect** | • Students use cause-and-effect relationships of predation and sexual selection to predict and explain male guppy color variation. |

## DURATION

Two 45-minute class periods

## MATERIALS

- Guppy and predator data
- Graph paper
- Colored pencils or markers

## ENGAGE

Show students Figure1, which provides data for wild guppies in a stream in Trinidad. Have students independently note any patterns and questions they notice in the data, then have them share with their groups. Ask the class, “What might have caused such dramatic color variation in guppies found in the same stream?”

Figure 1. Observations of Guppy and Predator Populations From Three Pools in Trinidad Stream

| | Illustration of Pool in Stream | Number of Fish in Pool |
|---|---|---|
| **Pool 1** |  | Number of guppies: 75<br>Average male coloration:<br>Brightly multi-colored with large spots<br><br>Predators<br>Number of cichlids: 0<br>Number of blue acara: 0<br>Number of rivulus: 12 |
| **Pool 2** |  | Number of guppies: 83<br>Average male coloration:<br>Medium coloration on body and tail with medium-sized spots<br><br>Predators<br>Number of cichlids: 0<br>Number of blue acara: 7<br>Number of rivulus: 15 |
| **Pool 3** |  | Number of guppies: 110<br>Average male coloration:<br>Drab coloration, very small spots concentrated near the tail<br><br>Predators<br>Number of cichlids: 17<br>Number of blue acara: 20<br>Number of rivulus: 5 |

Image and data source: www.pbs.org/wgbh/evolution/sex/guppy/low_bandwidth.html

Figure 2. Example of Color Variation Among Male Guppies

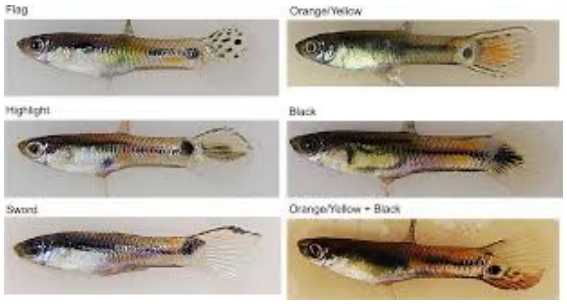


Image source: https://onlinelibrary.wiley.com/doi/pdf/10.1002/ece3.4418

## EXPLORE

Tell students that biologists have two hypotheses that might account for the color variations.

1. Predators are causing guppy populations to become more drab by preying on the most brightly colored individuals and eliminating them from the gene pool.
2. Female guppies are choosing to mate with the most brightly colored males, giving those males a higher probability of passing their genes on to the next generation.

Ask students if they have a different hypothesis they'd like to add. (Some students might add that guppy populations are evolving to more closely match—or stand out from—their environment, which would be insightful and acceptable. If so, add it to the list.)

Have students predict what the data might look like for each hypothesis. (Accept a range of answers. Students may predict that there will be more drab-colored males if there is an increase in predators and there may be more brightly colored males if there is less predation and more selection by female guppies.)

To maximize time, divide the class into groups of four. Give each group guppy data from one of the four pools to analyze.

| Pool 1 | Pool 2 | Pool 3 | Pool 4 |
|---|---|---|---|
| Initial population: 100 guppies; males mostly drab<br>Predators: 30 rivulus<br><br>Population data after 2 years<br>Number of guppies: 227<br>Number of generations: 5<br>Number of weeks: 112<br>Male color types:<br>• Brightest: 42%<br>• Bright: 6%<br>• Drab: 18%<br>• Drabbest: 34% | Initial population: 100 guppies; 25 of each type male (brightest, bright, drab, drabbest)<br>Predators: 30 rivulus, 30 acara, 30 cichlids<br><br>Population data after 1 year<br>Number of guppies: 171<br>Number of generations: 4<br>Number of weeks: 57<br>Male color types:<br>• Brightest: 15%<br>• Bright: 9%<br>• Drab: 26%<br>• Drabbest: 50% | Initial population: 100 guppies; 25 of each type male (brightest, bright, drab, drabbest)<br>Predators: 30 rivulus<br><br>Population data after 1 year<br>Number of guppies: 77<br>Number of generations: 4<br>Number of weeks: 56<br>Male color types:<br>• Brightest: 52%<br>• Bright: 36%<br>• Drab: 12%<br>• Drabbest: 0% | Initial population: 100 guppies; males mostly drab<br>Predators: 30 rivulus, 30 acara, 30 cichlids<br><br>Population data after 1 year<br>Number of guppies: 83<br>Number of generations: 4<br>Number of weeks: 57<br>Male color types:<br>• Brightest: 0%<br>• Bright: 0%<br>• Drab: 68%<br>• Drabbest: 32% |
| Population data after almost 8 years<br>Number of guppies: 232<br>Number of generations: 12<br>Number of weeks: 407<br>Male color types:<br>• Brightest: 95%<br>• Bright: <1%<br>• Drab: 3%<br>• Drabbest: 2% | Population data after almost 4 years<br>Number of guppies: 100<br>Number of generations: 7<br>Number of weeks: 203<br>Male color types:<br>• Brightest: 0%<br>• Bright: 0%<br>• Drab: 4%<br>• Drabbest: 96% | Population data after almost 6 years<br>Number of guppies: 91<br>Number of generations: 9<br>Number of weeks: 306<br>Male color types:<br>• Brightest: 68%<br>• Bright: 5%<br>• Drab: 12.5%<br>• Drabbest: 14.5% | Population data after almost 11 years<br>Number of guppies: 79<br>Number of generations: 17<br>Number of weeks: 578<br>Male color types:<br>• Brightest: 0%<br>• Bright: 0%<br>• Drab: 98%<br>• Drabbest: 2% |

(There are four datasets; some groups will be analyzing the same set.) Provide each group with graph paper and colored pencils or markers. Have students identify the type of data they have and what the most appropriate graph would be for it. (These data are counts of nominal data [colors], so a bar graph would be the most appropriate.)

Have each group develop a tentative argument from their data to wrap up day one of the lesson.

- Students should determine which, if any, of the hypotheses being tested is supported by their data. They should support their claims using patterns from the data and scientific reasoning. (Predators are more likely to see, so they eat brightly colored guppies. If there is less predation, then female guppies are more likely to see brightly colored males, mate with them, and produce more brightly colored offspring. Students may not have a scientific reason for why their evidence supports their claim until after they watch the Generation Genius video.)

*End of Day 1*

## EXPLAIN

Ask students what question they are trying to answer. Tell students that in order to consider some scientific ideas that might help them construct their initial argument, they are going to watch the Generation Genius video about reproduction of living things. Use some of the Before Discussion questions to uncover student understanding and to prime them for the video.

### WATCH THE GENERATION GENIUS REPRODUCTION OF LIVING THINGS VIDEO AS A GROUP

After watching the video, give groups time to revise their tentative argument before sharing with the whole class. Because each group has different data and will reach different conclusions, you will need to encourage critique and sharing of ideas. Use these questions to support sensemaking:

- Does any group have evidence to support Group A's claim?
- What data do we have that challenges Group B's claim?
- ___ and ___, you made similar claims. Did you have the same evidence?
- ____, what do you have to say to ___ about his/her idea? It sounds pretty different from yours.

## ELABORATE

1. African lions
2. Bighorn sheep
3. Birds-of-paradise
4. Black widow spider
5. Bower birds
6. Dung beetles
7. Elephant seals
8. Fireflies
9. Giraffes
10. Hooded seals
11. Irish elk
12. Mandarin ducks
13. Mandrills
14. Meerkats
15. Narwhals
16. Orangutans
17. Peacock spiders
18. Peacocks
19. Pheasants
20. Praying mantis
21. Pufferfish
22. Red-capped, long-tailed manikins
23. Sagebrush lizards
24. Sticklebacks
25. Triplewart seadevils
26. Widow birds
27. Wild turkeys

Have students select an organism of interest or choose from this list of organisms to research and communicate scientific information about the advantage(s) and trade-off(s) of the structural and/or behavioral adaptations that improve their chances of reproduction. Students could post their findings on your class webpage, on a bulletin board, or in a gallery of student work.

## EVALUATE

There are multiple ways to assess your students' understanding of this topic. The Exit Ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

## EXTENSION

Students collect additional data and/or investigate different questions about the variation in male guppy coloration by using simulations. These simulations allow students to manipulate and test different variables that they may have questions about after the argumentation session. More advanced students could conduct a statistical analysis of the data by importing it into Excel or a similar data analysis program.
Simulations are available at the following websites:

- www.pbs.org/wgbh/evolution/sex/guppy
- http://virtualbiologylab.org -> Evolution Models tab -> Selection -> Model 1–Endler's Guppies
- www.biologysimulations.com/sexual-selection