Aquarium Simulator

Name: _____ **Period:** _____ **Date:** _____

> Open **peebedu.com** and navigate to **Aquarium Simulator**. Read the introduction popup, which describes the nitrogen cycle in an aquarium ecosystem: ammonia production by fish, conversion to nitrite and then nitrate by beneficial bacteria, and absorption of nitrate by aquatic plants. Click through the introduction, then explore the simulator controls.

Part 1 — Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Aquarium Simulator as a scientific model.

M — Mode

What type of model is the Aquarium Simulator? Describe how this computational simulation represents an aquatic ecosystem. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about ecological interactions in an aquarium.

A — Accuracy

(a) Identify two things this simulation represents **accurately** about aquatic ecosystem dynamics. For each, name the specific simulation feature and explain what ecological concept it demonstrates.

(b) Identify two things this simulation **oversimplifies or leaves out** about real aquatic ecosystems. Consider what you cannot observe in the simulation that would be important for a complete understanding of community ecology.

P — Purpose

What is the learning goal of this simulation? Explain how the Aquarium Simulator is designed to help you understand how populations of different species interact within a community and how those interactions affect the flow of matter through an ecosystem. In your answer, connect at least one specific simulation feature to a biological concept about population or community ecology.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries about aquatic ecology or nitrogen cycling might change or improve a simulation like the Aquarium Simulator. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- What are the strengths of this simulation as a model for aquatic community ecology?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect organism-level processes to community-level outcomes?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Population Dynamics and the Nitrogen Cycle

> *Simulation Task: Start with an empty tank. Add two guppies and one Anubias plant, then add nitrifying bacteria. Click "Feed Fish" three times and observe the Nitrogen Cycle Monitor. Record the ammonia, nitrite, and nitrate levels. Then add four more goldfish without adding additional plants or bacteria. Feed the fish again three times and observe how the nitrogen levels change.*

(A) (1 pt) **Describe** how population size affects the interactions between organisms and their environment in the aquarium.

(B) (1 pt) **Explain** how the relationship between fish population size and nitrogen compound levels demonstrates that population growth dynamics depend on death rate and the carrying capacity of the environment.

(C) (1 pt) **Predict** what would happen to the ammonia and nitrate levels in the tank if you continued to add fish without adding any plants or bacteria.

(D) (1 pt) **Justify** your prediction by explaining how resource limitations and waste accumulation in the aquarium impose density-dependent constraints on the fish population.

EK 8.3.A.1, 8.3.A.2

Analyze Model / Visual Representation

Question 2 — Community Interactions and the Nitrogen Cycle

> *Simulation Task: Reset the aquarium using "Clear Aquarium." Build a balanced community: add two guppies, one goldfish, two Hornwort plants, and one Anubias plant. Add all three bacteria types (nitrifying, ammonifying, and denitrifying). Feed the fish twice and observe the Nitrogen Cycle Monitor stabilize. Then remove all plants and observe the changes in nitrogen compound levels over the next several feedings.*

(A) (1 pt) **Describe** how the different species populations in the aquarium (fish, plants, and bacteria) form an interacting community.

(B) (1 pt) **Explain** how the relationships among the interacting populations in the aquarium can be characterized by positive and negative effects.

(C) (1 pt) **Represent** the flow of nitrogen through the aquarium community.

Draw your nitrogen-flow diagram here.

(D) (1 pt) **Connect** the community interactions observed in the aquarium to how environmental changes, such as rising ammonia levels after plant removal, could act as a selective pressure on a fish population over many generations.

EK 8.5.B.1, 8.5.B.3