

# SCIENCE·3D

## TIGER QUEEN

In this packet, sample student answers are provided in **red** and notes to teachers are in **blue**.

In this **Mission Research**, students will explore how energy is used in ecosystems and how it flows through food webs (the rule of 10%). They will use this understanding to make calculations and construct explanations of why top predators are rare. Alternatively, they will model the phases of the moon and how they result from the positions of the Earth, sun, and moon.



We are about to go on a mission into an Indian forest to study tigers and their ecosystem. But first, we need to know what to expect. If we want to figure out how humans might be influencing the forest, the animals, and the whole ecosystem, then we need to know about how many individuals of each type to expect in a healthy ecosystem!

First, here are some terms we need to know:

**Individual** – a single organism

**Population** – group of organisms of the same type in the same place that can interbreed

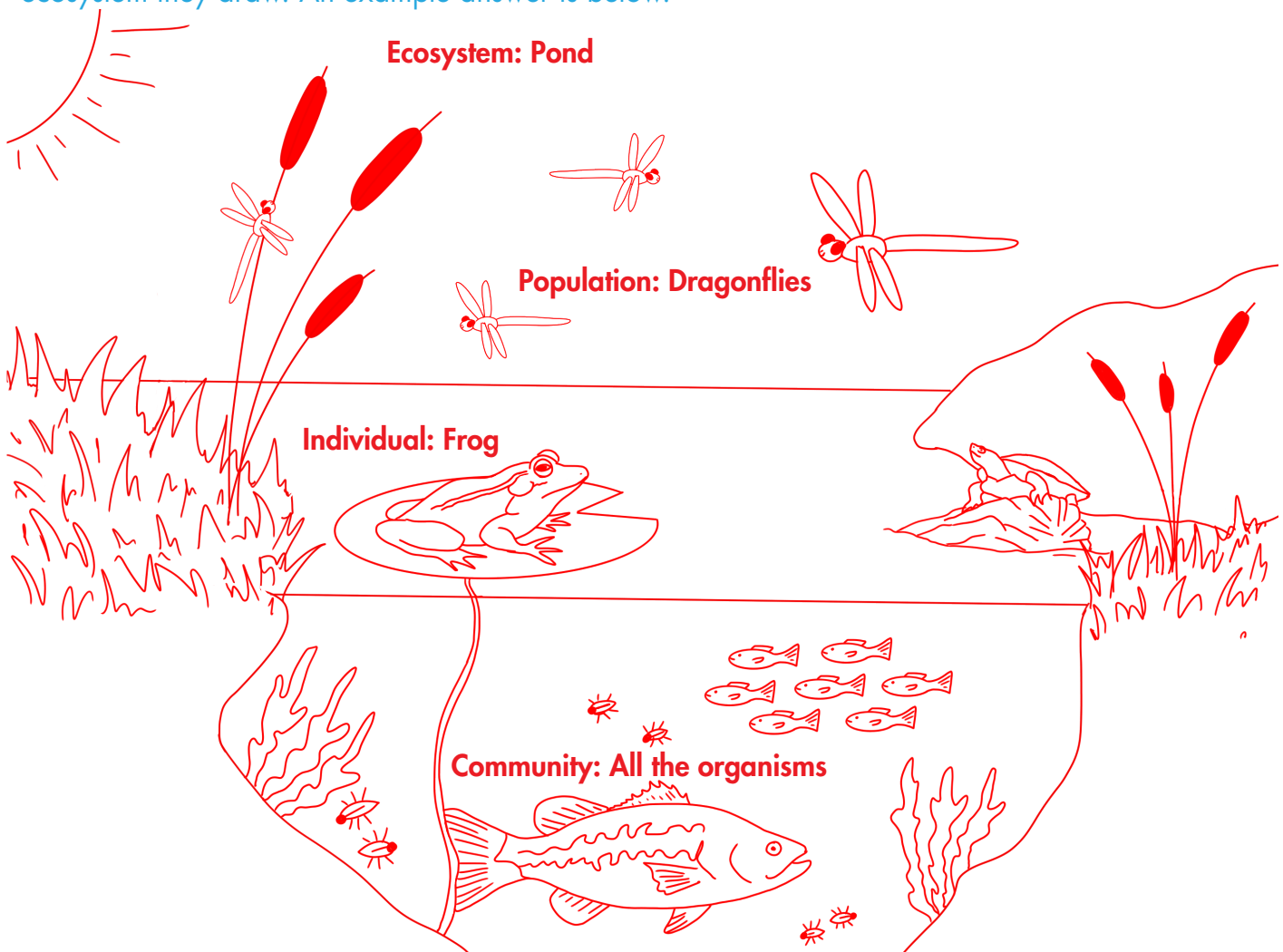
**Community** – populations of different types of organisms that live in the same area and may interact

**Ecosystem** – the living and non-living parts of the environment in an area

1. **Draw** a diagram of an ecosystem of your choice. Make sure you draw and label each of the terms mentioned above. For example, circle an individual and label it "individual."

**Differentiate Instruction:** Challenge students to include and label at least one type of producer, herbivore, and predator in their ecosystem. You can add complexity by asking them to label prey, scavengers, or decomposers. You could have students list what organisms get from the environment (such as shelter, air, and water).

Accept all reasonable answers. You can tell students that they have created a model of an ecosystem. If you want to add an extra step, have students trace the flow of energy and matter in the ecosystem they draw. An example answer is below.



2. **List** some ways that animals use energy in their daily lives.

Answers may vary. Identifying all possible correct answers is less important than students understanding that energy may be used to grow and reproduce but also for moving around. Not all energy ends up being stored to be able to pass to the next trophic level. Examples include: growth, reproduction, movement, other life processes (metabolism and body system function).

Much of the energy that a plant produces or an animal consumes is used for activities other than growth. It turns out that 90% of the energy is used for life processes or is lost to the environment. The rest (10% of the energy) is stored in the body. So, that means only 10% of the energy at one level of the food chain is transferred to animals at the next level.

3. Use the information in the paragraph above to **complete** the table below to determine how much energy will be available to each level of consumer. The first level is provided.

Type of Organism	Units of Energy
Phytoplankton (producer)	7,000,000
Zooplankton (eats phytoplankton/plants)	700,000
Small fish (eat zooplankton)	70,000
Seal (eats small fish)	7,000
White shark (eats seals)	700

4. Use the data in the table above to **construct** an argument about whether to expect more tigers compared to herbivores (plant eaters) or fewer tigers than herbivores in an ecosystem.

There should be fewer tigers than herbivores in an ecosystem. Only 10% of the energy passes to the next step in a food chain, so there is less energy available for tigers than there is for herbivores.

**Differentiate Instruction:** Have students create a table like the one in question 3 for Kismet and her forest. Have students figure out how much energy would be at Kismet's level if you start with 7,000,000 units of energy. Then, have students compare how much energy was available for Kismet compared to the white shark. Because tigers eat herbivores, students should see that tigers have more energy available to them than white sharks. Have them think about why that is (there are fewer steps in the food chain).

**Link to Daily Choices:** Have students think about how this information relates to what people eat. Ask them if this helps them understand why some people choose to eat more plants and less animals. Possible answer: By eating more plants, people need to use less of the energy that flows into ecosystems. For agriculture, there are also issues in the amount of energy and resources needed to produce different types of food (plants versus animals).

5. Based on the table you completed in question 3, **describe** why top predators are less common than their prey.

Only 10% of the energy passes from one step in a food chain to the next. So, predators will be less common than prey because there is less energy available to them.

**Extend the Lesson:** While students may have done this activity for the **Sea Turtle World** mission, consider having them draw the flow of energy in the Indian forest. Be sure that they show the fate of energy as it flows between organisms and from organisms into the physical environment (lost as heat). You could then have them compare this flow to the one in the **Sea Turtle World** mission or a local ecosystem. This activity will help reinforce their understanding of what happens to the 90% of energy that isn't available to the next step in the food chain. You can further expand the lesson to have students trace the cycle of matter among the spheres in Kismet's forest. This can be expanded on to compare to a local ecosystem as an alternative **Explore Your Backyard** activity. In this activity, focus on matter being incorporated into producers and flowing back to the atmosphere during cellular respiration and photosynthesis and into the geosphere during decomposition.

**Alternative Activity:** Have students draw the phases of the moon from new moon to full moon and back again. Have them draw a total of eight different phases in the cycle. Then, have them draw the position of the sun, moon, and Earth at the new moon, quarter moon, full moon, and the next quarter moon phases. They can use the Mission Reader as reference. Then, have students read: <https://www.sciencenews.org/article/moon-animals-light-behavior-lunar-phases>. Have them create a list of ways that the cycle of the moon affects animals. You could also link this to having students collect information on the phases of the moon in their location.