

The Matter with Matter



Imagine you are floating down a stream in the Florida Everglades. As your boat moves through the algae-covered water, you pass tall saw grass along the shoreline. Mosquitoes, bees and seagulls swoop through the air above you. Frogs and largemouth bass circle the boat. Finally, your guide turns off the engine. He points to a small island in the stream. There, sunning himself on a rock, sits a large alligator.

This is a common sight through the marshes of South Florida. But most people pass through without thinking of how the plants and organisms—the grass, algae, insects, the alligator—depend on one another for survival. In this environment like in any other, energy and matter are constantly being recycled. The grass absorbs carbon dioxide from the air. Some insects eat the grass. The birds eat the insects. Occasionally, the alligator eats the birds.

Floating through the Everglades ecosystem for a day, one could witness the entire cycle of life. And yet the amount of matter in that ecosystem will never change. After an insect eats a piece of grass, the nutrients may pass through three or four different organisms before they return to the soil. But at no point does the amount of matter in the ecosystem change. Matter does not disappear. It simply cycles through the environment, taking on different shapes and properties.

Where do you find matter in the Everglades? Everywhere. In the air above the grasses, for instance, matter is found in the form of carbon dioxide. Furthermore, in the swampy soil, matter is found in the form of water, nitrogen and other nutrients. When saw grass sprouts out of the soil, it relies on this raw matter found in the soil and the air.

Like the saw grass, the patches of algae on the surface of the water also rely on carbon dioxide in the air. Insects nibble on the algae on the water. In doing so, of course, they risk being eaten by fish or frogs hiding below the surface. Now and then, a largemouth bass or a bullfrog gets lucky and slurps up an idle insect eating algae on the water. If a Florida fisherman catches and eats that same largemouth bass, he is consuming the same matter contained in the algae, which the insect ate days before. This matter is finally returned to the environment through human waste. And so the whole process repeats itself.

In this cycle, everything begins with what are called producers. Consumers consume the matter produced by the producers. Consumers may also consume the producers themselves, other consumers and decomposers, who are the ones bringing everything back to where it began. Some decomposers, for example, are bacteria, which break down the matter and return it to the soil and the atmosphere.

It is helpful to imagine the cycle of life in the Everglades as a pyramid. At the bottom of the pyramid lie the producers. Producers here include the algae and the saw grass, both of which absorb carbon dioxide to make sugars. Insects occupy the second step of the pyramid. Eventually, they come around and eat algae and the grass to derive energy from the sugar they contain. On the next level are the frogs, whose tongues capture insects out of the air. Humans reside at the top of the pyramid. Some fishermen might catch a dozen frogs in their net and sell them to a local restaurant. There, the chef decides to deep fry the frogs to make fried frog legs, which customers eat. The bacteria that line the customers' large intestines then decompose the frog legs over the next 24 to 48 hours, at which time they excrete the waste, which can be used as a fertilizer to enrich the soil where plants grow. And like that, the process returns to the bottom of the pyramid.

But how does the matter in the atmosphere become a blade of grass? Simply put, the grass seedling takes water from the soil and carbon dioxide from the air. It then uses the power of the sun to make sugars which enable the seedling to grow and become a blade of grass.

One thing to remember is the higher you go on the pyramid, the more matter and energy are required to sustain life. For example, an insect needs only a little bit of energy and matter to survive. The alligator, however, requires a lot of energy and matter to get through the day.

Just to survive, the alligator must consume fish, frogs, snakes and small mammals like rats, on a regular basis.

In every ecosystem, there will always be fewer consumers than producers. Out of necessity, the bottom level of the pyramid will contain far more energy than the top level. For an ecosystem to survive, the organisms in it need a plentiful supply of food and energy. Let's say on a small plot of land in the Everglades, there might be 5 million blades of saw grass. Around 50,000 insects might feast on those millions of blades of grass. In turn, 500 larger insects will eat the smaller insects for dinner. After that, 100 lucky fish will devour the larger insects. At the end, the lone alligator will eat perhaps five or six fish in a week, in addition to whatever else it manages to find.

Scientists use a simple rule to understand how energy is transferred from one level of the food pyramid to the next. They call it the "10 percent rule." According to the rule, only 10 percent of the energy on one level moves to the next level on the ecological pyramid. The saw grass, for example, takes energy from the sun and the air and converts it into usable matter. But it loses much of that energy through the process of cellular respiration. That is, the grass must convert energy from the sun into nutrients that are then absorbed by the insects. In doing so, the grass releases energy, similarly to how humans release salt and water in the form of sweat when exercising. So by the time we reach the insect level of the pyramid, insects can access only ten percent of the energy contained by the grass.

Nevertheless, matter and energy do not simply disappear. They return to the atmosphere to be used again, and again, and again. Insects don't eat every blade of grass in their ecosystem. The majority of grass grows and then wilts without having been touched. In decomposing, the individual blades return to the environment, without ever passing through the upper levels of the pyramid.

The same goes for frogs and fish and other, larger consumers in the Everglades. Alligators don't eat every fish in their ecosystem. Humans don't fry every frog in South Florida. Sometimes, fish and frogs live out their lives in peace, eating flies and floating through ponds and streams. Frogs and fish, in other words, can die of old age, just as humans can. When they die, they stop consuming matter and energy from small organisms. As a result, bacteria and other decomposers begin to break them down, and return their matter to the soil and air.

In this way, dead animals resemble old, run-down factories. When the factory is no longer safe to work in, construction workers knock it down. They bring the materials—the bricks, the concrete foundations, the iron pipes that sent water to different floors—to the scrap yard. The workers at the scrap yard sell off some of the usable materials. The rest they break down to use for cement mixing which is used to build new buildings.

Nature works in a similar way, but without the help of human beings. And yet, we, too, are part of nature. Without the cycle of matter and energy, we would never have built those old factories in the first place.

Name: _____ Date: _____

1. What happens to the amount of matter in an ecosystem?

- A It decreases then increases.
- B It gradually increases.
- C It never changes.
- D It decreases at a rate of 10%.

2. What does the author mainly describe in the passage?

- A the lifecycle of the bullfrog
- B changes to the ecosystem of the Florida Everglades
- C why the ecological pyramid has more energy at the top than the bottom
- D how matter and energy are constantly being recycled

3. Matter is recycled throughout an ecosystem, so the total amount of matter remains constant. What evidence from the text supports this statement?

- A Matter from plants is passed from one organism to the next as animals eat the plants and each other, and is eventually returned to the environment through waste and decomposition.
- B The amount of energy transferred between levels on the pyramid of life is only 10% of the energy at the previous level.
- C Plants receive their energy from the sun, which they use during photosynthesis to create nutrients.
- D The higher you go on the pyramid of life, the more energy and matter are required to sustain life.

4. Why will there always be fewer consumers than producers in an ecosystem?

- A because consumers take longer than producers to reproduce
- B because consumers eat each other but do not eat producers
- C because consumers get their energy and food from producers, so without a large supply of producers the ecosystem would die
- D because the number of consumers in an ecosystem is regulated by the government

5. What is this passage mostly about?

- A alligators in the Florida Everglades
- B recycling matter and the ecological pyramid
- C fried frog legs and other Floridian cuisine
- D how the amount of matter in an ecosystem slowly decreases

6. Read the following sentences: "Imagine you are floating down a stream in the Florida Everglades. As your boat moves through the algae-covered water, you pass tall saw grass along the shoreline. Mosquitoes, bees and seagulls swoop through the air above you."

Why does the author begin the passage in this way?

- A to confuse the reader with unnecessary information
- B to make the reader hear the sounds of the Everglades
- C to introduce the topic of the passage with an interesting image
- D to remember their own trip to the Everglades

7. Choose the answer that best completes the sentence below.

When an organism dies, its matter and energy do not simply disappear; _____, they are returned to the atmosphere to be used again.

- A in conclusion
- B in particular
- C as an illustration
- D on the contrary

8. Where are producers on the pyramid of life?

9. What would happen to the consumers if the number of producers in an ecosystem was drastically reduced?

10. Explain why every organism in an ecosystem depends on each other to survive, using the relationships between producers, consumers, and decomposers.
