PHOTOSYNTHETIC ANIMALS

(1) By now you know that plants can create their own food using a process called photosynthesis. You also know that animals, like us, cannot photosynthesize. However, recent research has discovered that there are a few animals that can photosynthesize, and there might be more yet to be discovered. Let's examine two photosynthetic animals in closer detail.

(2) Meet *Elysia chlorotica*, otherwise known as the green marine sea slug. This 3 centimeter sea slug looks a lot like the animal version of a leaf. It acquires its characteristic green coloring through consuming a type of green algae called *Vaucheria litorea*. *V. litorea* is a photosynthetic organism because of the chloroplasts in its cells. Chloroplasts are the organelles that help plants, algae, kelp and certain protists photosynthesize.

(3) Juvenile sea slugs are brown with reddish spots because they have yet to begin feeding on the algae. When they do, they will ingest the algal cells but their digestive tracts will not entirely break down the cells. Instead, the slug's digestive tract cells will engulf intact chloroplasts from the algae. These chloroplasts function within the sea slug the way they would within the algae, by photosynthesizing and producing food for the sea slug. Over time, enough chloroplasts will be consumed that the sea slug can live for nine months without eating. It can sustaining itself solely on the food made by the chloroplasts. The term for the addition of chloroplasts into the cells of a different host species is called kleptoplasty.

(4) If stealing chloroplasts isn't amazing enough, the sea slug is also suspected of being able to perform horizontal gene transfer (HGT) which is something previously only observed in bacteria. During HGT, a host organism steals genes from another organism and adds the genes to their own collection of DNA. The sea slug has used HGT to steal algal genes. These genes function to help support the healthy maintenance and function of the chloroplasts. Without these genes, the chloroplasts would require frequent replacement.

(5) Are sea slugs so lazy that they would avoid feeding themselves by stealing chloroplasts?

Elysia chlorotica, credit Patrick J. Krug

feeding themselves by stealing chloroplasts? Kleptoplasty is actually a really useful strategy for survival. When sea slugs no longer need to feed, this frees up precious energy for mating and avoiding predation.

(6) Meet the yellow spotted salamander, scientifically known as *Ambystoma maculatum*. They live in the eastern parts of Canada and the United States and can grow 15 – 25 cm in length. Like the sea slug, this salamander also photosynthesizes but unlike the sea slug, the salamander does not use this ability to generate food.

(7) Within yellow spotted salamander eggs and embryos are living algal cells from a type of algae called *Oophilia amblystomatis*. Not surprisingly, *Oophilia* means egg-loving. Why is the algae there? Salamander eggs are covered in a jelly that prevents them from drying out, but this protective coating also prevents oxygen from diffusing from the air into the eggs. Without oxygen, the mitochondria within the eggs cannot produce the energy needed to keep the salamander eggs alive. This is where the algae do their part. They are located close to the mitochondria in the eggs and during the process of photosynthesis, algal chloroplasts produce oxygen as one of their products. Observe the equation for the reaction of photosynthesis:

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carbon dioxide + water → glucose + (oxygen)

Since the mitochondria are nearby, it's very easy for them to soak up the oxygen as soon as it's produced by the algal chloroplasts. What does the algae get from its relationship with the salamander? Look at the equation again and notice that photosynthesis requires carbon dioxide as a starting ingredient. The jelly that prevents oxygen from entering the eggs also prevents carbon dioxide from entering as well. Without the carbon dioxide, the chloroplasts can't function to make food and the algae will begin to starve. Luckily, when the mitochondria produce energy, they use a process called cellular respiration which produces carbon dioxide as one of its products. Observe the equation for the reaction of cellular respiration:

glucose + oxygen → (carbon dioxide) + water

Thus the salamander mitochondria produce the carbon dioxide that is needed by the algal chloroplasts for photosynthesis. Since the relationship between the algae and salamander is beneficial to both partners, this type of symbiotic relationship is called mutualism.

Article Questions

1) _____ is the process whereby cells take in and use the chloroplasts of another type of organism. _____ means egg-loving. A symbiotic relationship where both members in the relationship benefit is called _____.

2) How do the chloroplasts help the sea slug?

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3) What does the sea slug do with the energy that it saves by not needing to find food?

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4) How does the algae help the salamander?

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5) How does the salamander help the algae?

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6) Record the equations for photosynthesis and cellular respiration.

Photosynthesis: ● _____

Cellular respiration: ● _____

What do you notice about these two equations and how is this important to the algae and the salamander?

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