Making Neuroscience Fun

A Brain Awareness Program for All Ages

Brain Health: It's SPECtacular

It's a SPECtacular Jungle Out There (A Brain Health Story)
(4th Grade – 9 - 10 yrs.)
Think, Pair, Share: You Scratch My Back...

STORY CONNECTION – SLIDE 3 (Approx Time: 25-30 mins)

Keeping our brain healthy is important for making sure that we can survive in the world that we live in. We need a healthy brain because our brain is what allows us to do all the behaviors that we must do to survive – eating, drinking, sleeping, thinking, learning, remembering, etc. We need our brain to do all the behaviors that we do. The behaviors get the things that our brain needs to survive. Because the world we live in is always changing, the brain and behaviors need to change. The brain changes the behaviors, and the behaviors change the brain. We need our brain to do the behaviors we need to do to keep our brain and our body alive. This is what is known as a **reciprocal** relationship.

Materials needed:

- Animal Partnerships sheets (included below) or paper
- Pencils
- Animal Information Sheets (included below) or this website:
    - https://www.nhm.ac.uk/discover/mutualism-examples-of-species-that-work-together.html

Preparation needed:

- Determine student partners/small groups
- Determine if student(s) will use Animal Partnership Sheets
    - If so, print enough copies for each group to have one animal partnership (some groups may duplicate depending on number of student(s) in the whole group).
    - If not, prepare for student(s) to use the website.
- Print Animal Partnership Note Sheet (1 per student)
- NOTE: The directions are written for student groups to become experts on one relationship and share out. Feel free to use this activity in different ways: carousel, rotate information between groups, etc.

Instructions:

1. In this activity, student(s) will explore reciprocal relationships as they relate to other animals.
2. Review with student(s):
    - The reciprocal relationship between the body and the brain.
    - Explain that within the animal kingdom, there are animals that have a relationship like that of our body and brain.
    - Explain that these relationships are called mutualistic relationships and that both animals benefit from the relationship.

3. Ask if any student(s) are aware of any animals that have this type of relationship. Take answer and discuss, as necessary.
4. Next, give the student(s) the list of animal partnerships
5. Ask student(s) to think about the animals and how they might help one another.
6. Give student(s) a few minutes and have each student write down anything they know or think they know in the “notes” column.
7. Explain to student(s) they will be working in groups to become an expert on one animal relationship by reading information, taking notes, and will be responsible for sharing that knowledge with the other student(s).
8. Ask student(s) if they have any questions or need any clarification. Clear up any misunderstandings.
9. Put student(s) into partners or small groups.
10. Give each partner group or small group the information sheet about one of the animal relationships.
11. Give them an allotted amount of time to:
    - Read the information
    - Take notes about the reciprocal relationship on their animal partnership sheet.
12. When time is over or all partners/groups are finished, have the group come back together and allow them to share their learning with each other. By the end of the activity, they should have a better understanding of the relationship between the animals and how each animal benefits from the relationship.
13. In closing, review that just like the animals they learned about today depend on each other for survival in a mutualistic relationship, their bodies and brains must also work together and depend on each other to be healthy. This is called a reciprocal relationship and it is vital for good Brain Health.

Activity Images and Information Credit: https://www.nhm.ac.uk/discover/mutualism-examples-of-species-that-work-together.html

Animal Partnerships	Notes
Pistol Shrimps and Gobies	
Aphids and Ants	
Woolley Bats and Pitcher Plants	
Coral and Algae	

Ox Peckers and Large Mammals	
Clownfish and Anemones	
Honeyguides and Humans	
Senita Cactus and Senita Moth	

Pistol Shrimps and Gobies

True gobies (Gobiidae) are a family of about 2,000 species of fish. Most of them are quite small and live on the seafloor. In some cases, gobies will form mutualistic relationships with pistol shrimps of the family Alpheidae.

Pistol shrimp are burrowers, digging holes in the sandy seafloor that they will maintain and sometimes share with a goby. Outside the burrow, the pair stay close together, often with the shrimp maintaining physical contact by resting its sensitive antennae on the fish.

When the goby spots a potential predator, it uses chemical cues and bolts for cover in the shared burrow. The shrimp relies on these tactile and chemical cues to know when it needs to hide, too. When the goby is active, it signals to the shrimp that it is relatively safe to be outside the burrow.

A 2019 study showed that, as predicted by their role as lookouts, the goby - in this case the fierce shrimp goby (*Ctenogobiops feroculus*) - was always first to venture outside. It seems that the shrimp's decision to leave the safety of its home only begins once its partner has exited the burrow.

The shrimps are also thought to benefit from their relationship with the fish through an increase in food, such as the fish's feces or any parasites on its body.

Aphids and Ants

Aphids are little sap-sucking insects that secrete honeydew, a sugary liquid that is the waste product of their diet. Many aphid species are known to engage in a mutualistic relationship with ants that feed on the honeydew by 'milking' the aphids with their antennae.

In return, some species of ants will protect the aphids from predators and parasites. Some will move aphid eggs and nymphs underground to their nest, which ultimately makes harvesting their honeydew more efficient - like an ant equivalent of a dairy farm.

However, some aphids have evolved to take advantage of the honeydew-seeking ants. *Paracletus cimiciformis* aphids come in two morphs: the round morph, which is milked, and a flat, ant-mimicking morph. When the ants carry the flat individuals to their brood chamber, the aphids will drink the body fluid of the ants' larvae.

Honeydew is produced by a variety of insects, including scale insects and some caterpillars, and is appealing to species other than ants. In Madagascar, some geckos have been observed lapping up the honeydew produced by plant hoppers. This may be mutualism, with the gecko's presence keeping predators of planthoppers away, but scientists are not sure yet.

Woolley Bats and Pitcher Plants

Pitcher plants are carnivores that use nectar at the rim of their tube-like structure to attract prey such as insects and small vertebrates. A slippery substance at the rim causes these animals to fall into the digestive juices contained in the plant's equivalent of a stomach.

While you might think it would be prudent for animals to avoid these plants where possible, some bats voluntarily clamber inside them.
Woolly bats are known to roost in *Nepenthes hemsleyana*, a tropical pitcher plant found in Borneo.

While the bat gets a hidey-hole to rest in, the plant benefits by catching the guano (feces) that the little mammal produces. This provides the plant with the nutrients it needs to survive.

A similar relationship occurs between tree shrews and another Bornean pitcher plant, *Nepenthes lowii*. The shrews climb onto the pitcher's rim to feed on the nectar. In return, with the plant's hollow body acting a bit like a toilet bowl, the shrews drop their nutritional feces into the plant's stomach.

Coral and Algae

Corals may look like rocks or plants, but they are actually marine animals. The bright colors of reef-building corals come from the zooxanthellae algae they have a mutualistic relationship with.

Coral starts life as a tiny, free-swimming larva which eventually fixes itself to a hard surface and metamorphoses into a polyp. The polyp replicates and expands to form a colony by producing many identical polyps, growing one on top of each other and secreting a hardened skeleton around themselves.

As corals grow, they acquire zooxanthellae from their surrounding environment. Coral provides shelter and essential nutrients for the zooxanthellae to use during photosynthesis, while the zooxanthellae produce synthetized sugars, which the coral feeds on, and oxygen as a by-product.

Pollution and heat stress can cause corals to expel their algae which turns the coral ghostly white - this is known as coral bleaching. Going too long without algae can be fatal to the coral, as it usually cannot grab enough food particles from its surroundings to fulfil its energy demand.

Ox Peckers and Large Mammals

There are two species of oxpecker: the red-billed oxpecker (*Buphagus erythrorhynchus*) and yellow-billed oxpecker (*Buphagus africanus*). Both regularly spend time clinging to large grazing mammals such as wildebeest, rhinos, and zebras.

The birds pick at parasites on the mammal's body, including ticks and blood-sucking flies. This may help keep the mammal's parasite load under control, and the birds get an easy meal.

Like a number of other species, oxpeckers will raise the alarm and warn their hosts of impending danger. People have observed that the birds will help hosts such as rhinos (which are short-sighted) evade humans.

However, mammals and oxpeckers may not be a perfect example of mutualism, as the birds can harm their hosts. The birds remove parasites and seem to prefer hosts with large numbers of them, but they will also dig into wounds. While the mammals appear relatively tolerant of this behavior, it is not beneficial to them.

Clownfish and Anemones

Anemones are flowerlike marine animals with neurotoxin filled stinging tentacles. They use these to help them subdue their prey, which are mostly plankton, crabs, and fish, though larger species take larger prey such as starfish and jellyfish.

Anemones associate with many fish species, but they are particularly close with one group. Clownfish, also known as anemonefish, are immune to anemone stings, though scientists are not exactly sure how. It is thought that the layer of mucus on the fish's body is involved in protecting them. This means clownfish can safely nestle into the anemone's tentacles to hide from predators.

In return, clownfish help the anemone in multiple ways. They keep the anemones free of parasites and provide them with nutrients through their feces, which may also stimulate the growth-beneficial symbiotic algae within the anemone. Clownfish may also drop food onto the anemone and also drive off anemone-eating intruders that stray too close. It is also thought that the movement of clownfish helps to circulate the water, and in turn helps to oxygenate the anemone. It is possible that the bright colors of clownfish also help to lure meals of small animals to within reach of the anemone.

Honeyguides and Humans

The eggs, larvae and beeswax contained in bee nests are a key food source for greater honeyguides (*Indicator indicator*). One of the ways these birds gain easy access to a nutritious meal is by leading other honey-coveting species to the nest and allowing them to do the hard work of breaking into it.
The human-honeyguide relationship is the best-documented of these partnerships. The wild honeyguides recruit people with a demanding call, indicating that they have found a bee nest. The honey-hunting humans reply with calls passed down through generations and follow the bird.

When they reach the nest, the humans subdue the bees, such as with smoke, break into the nest and help themselves to the sugar-rich honey contained within. The Hadza people of Tanzania are one group known to work with honeyguides. It has been estimated that up to 10% of their diet is acquired with the help of the birds.

With the bees dispatched and the humans satisfied, the honeyguides are left to dine on the beeswax, eggs and larvae left behind.

Senita Cactus and Senita Moth

When the sun sets on North America's Sonoran Desert, the night-blooming flowers of Senita cacti (*Lophocereus schottii*) are visited by tiny Senita moths (*Upiga virescens*).

The female moths collect pollen on specialized abdominal scales and transfer it from flower to flower, pollinating cacti as she goes. The Senita moth is the only nocturnal pollinator of this cactus and is responsible for 75-95% of its pollination. The rest is attributed to other insects that are active during the day.

During her visits, the female moth will lay one egg on a flower petal. When the flower closes and the larva hatches, it will bore into the top of the developing fruit, spending about six days feeding on the seeds and fruit tissue.

The moth larvae do not eat all the seeds or fruit - it has been found that they only destroy about 21% of the developing fruit, which means the cactus can continue to prosper. There are several similar mutualistic relationships, such as yuccas and yucca moths, figs, and fig wasps, and Phyllanthaceae and *Epicephala* moths. Senita moths differ from these in that although the relationship is highly specialized, they are not the sole pollinator of their host plant, yet their relationship with the cactus clearly plays an important role in the cactus's survival.