



## Spider Web Design Challenge

## **Summary**

This activity explores a predatory relationship within an ecosystem, emphasizing specialized mechanisms spiders use to carry out a major life function: capturing and subduing their prey. As youth likely already know, many spiders use webs to catch or hold on to prey. In this activity, they will be engineering a web inspired by an ogre-faced spider – a type of spider casts a web to entangle their prey! To simulate this action, youth will design their own webs composed of straws and tape and compete capture the "prey" needed to obtain nutrients and energy!

GRADE 6 LIFE SCIENCES



#### ■ MATERIALS | HERE'S WHAT YOU NEED FOR THIS ACTIVITY!

- Paper and pencils for sketching
- Straws
- Pipe-cleaners
- A variety of tapes (doublesided scotch tape, masking tape, duct tape)
- Yarn
- Pennies

- Materials to make fake "prey": styrofoam block, golf tee, pingpong ball (with optional googley eyes)
- Measuring tape
- Optional: Computer, projector, and screen
- Optional: additional plastic insects

<b>1</b> VOCABULARY WORDS	
ECOSYSTEM	A biological community of interacting organisms and their physical environment
ADAPTATION	A change that alters the ability of a species to adapt to its environment
ENERGY	An abstract property defined as the capacity to do work. The basic forms of energy include chemical, electrical, mechanical, nuclear, and radiant (light).
SPECIES	A group of organisms that have similar physical and genetic characteristics and are able to produce viable offspring (offspring that can also reproduce)

<b>1</b> VOCABULARY WORDS	
PREDATOR	An organism that kills other organisms for food
PREY	An organism that gets eaten by other organisms
POPULATION	A particular number of organisms belonging to the same species that live in the same geographical area
OVERPOPULATION	When the number of organisms belonging to a species exceeds the resources available in an ecosystem to sustain them

## **Preparation Before the Lesson**

- 1. If you have access to a computer and projector, pull up the following videos about ogre-faced spider predation:
  - a. <u>https://www.youtube.com/watch?v=cAMxmyOoSYc</u>
  - b. <u>https://www.sciencemag.org/news/2020/10/these-frightening-</u> ogre-faced-spiders-use-their-legs-hear
- 2. Think about materials management. How do you want to arrange your materials for this activity? What set up will help you run the activity as smoothly as possible, and let youth access materials as needed during the designing portion of the activity?

3. Set up the testing area in advance. Place a piece of masking tape on the floor as a "starting point." From the tape, measure five feet. Place the Styrofoam block at this point and tape it down so that it doesn't move. Insert the golf tee in the block and place the ping-pong ball on the tee. You can add googly eyes to the ping pong "prey" for fun.



4. Sprinkle plastic insects around the golf tee to add additional prey and to see whether or not the spider webs can capture those insects as well!

#### **Delivering the Lesson**

#### **1. HOOK THE YOUTH:**

Think about how you're going to "hook" the youth, or get them excited about this activity. Can you think of a creative way to motivate youth, relate the activity to their lives, or pique their interest? If you're stuck, we've included some suggestions below:

- Start out by asking youth to imagine that they're a spider, having to compete against others in their ecosystem for food – or energy. What adaptation can they think up that would help them better capture their prey?
- Ask youth what they know about arachnids already. After some answers, let the youth know that arachnids are animals that have two body parts, a head and thorax, that are fused together and an abdomen. Arachnids also have an exoskeleton and eight jointed legs. Examples of arachnids are spiders, scorpions and ticks.

 (This one's a little gory, so use your judgement!) Did you know, in Ancient Rome, a certain type of gladiator called *Retiarus* (or, "net-man") used a net as a weapon to toss over his opponent and entangle him?! You can show a <u>recreated image</u> on the screen and ask youth what they think the benefits and draw-backs of this method would be.

#### 2. INTRODUCE THE CONTENT:

Let youth know that they are going to explore a strategy that one kind of spider has developed to get the food, or energy, it needs to survive. They'll be observing a species called the ogre-faced spider (*Deinopus subrufa*) that throws its web on top of prey, instead of spinning it between structures like most spiders do.

If you didn't already in the "hook" section, show youth the following two videos. They will introduce the youth to the ogre-faced spider and demonstrate how an ogre-faced spider defends itself and captures prey by ensnaring an assassin bug.

- <u>https://www.youtube.com/watch?v=Bp6oGmaLHGY</u>
- <u>https://www.youtube.com/watch?v=tS8FwAouK8A</u>

#### **②** POSSIBLE QUESTIONS TO ASK WHILE INTRODUCING THE CONTENT:

- What do you notice about the ogre-faced spider?
- What specialized features does the ogre-faced spider have for catching its prey?
- Do you think the ogre-faced spider's adaptation is useful in capturing prey? Why or why not?

#### **3. ISSUE THE DESIGN CHALLENGE:**

# Once youth understand the unique adaptation of the ogre-faced spider, deliver the design challenge!

Many ogre-faced spider webs have sadly not been as effective as they once were. As a result, there has been a decline in ogre-faced spiders and an overpopulation of insect prey. Can you help restore the balance of this ecosystem? Design a sticky web that can represent what a more successful spider would use in nature to better capture delicious prey from 5 feet away. Only the best adaptations will survive long enough to reproduce and restore the population size. May the best adaptations feast!

Have the group decide on fair testing rules. Deciding on constraints and criteria is an opportunity to incorporate youth voice as they decide what counts as "success" in this design challenges.

#### **POSSIBLE QUESTIONS TO ASK:**

- Can you step over the tape line when tossing your web?
- Can you run before throwing your web?
- Can you throw your web up or just straight?
- Are all the fake insects/prey "worth" the same amount?
- How many tosses of the web does each group get?

#### 4. PROVIDE TIME FOR PLANNING, BUILDING, AND TESTING:

Provide youth with paper and a pencil to sketch their plans. Once groups have an idea and a sketch, distribute materials according to the materials management plan you decided on in the "preparation before the lesson" section. Provide time for youth to build their webs. Use building time to circulate and ask questions as groups create their webs.

**O** POSSIBLE QUESTIONS TO ASK WHILE BUILDING:

- Can you tell me about your design?
- What made you decide to add this particular feature?
- How is your web similar to or different from the ogre-faced spider's web?

After youth have constructed their webs, invite them to throw their webs at the "prey." Remind youth that they need to consider the distance they must throw the web (five feet) in order to catch their prey, and the different throwing techniques they might use for the best aim and landing.

Allow the youth to take turns in attempting to ensnare the ping-pong ball as well as any surrounding plastic insects, using the agreed-upon rules that the group came up with together. If the youth are able to capture their pingpong ball, congratulate them. If the youths are unsuccessful, encourage them to think about why their webs may have been unsuccessful.

Provide time for youth to make modifications to their webs or to simply try again at capturing the ping-pong ball and plastic insects.

#### **O** POSSIBLE QUESTIONS TO ASK WHILE TESTING:

- How does your web work? Is it behaving how you expected?
- What were some challenges you had in constructing your web?

#### **OPOSSIBLE QUESTIONS TO ASK WHILE TESTING:**

- If you were unsuccessful in capturing your prey, what were some modifications you had to make to your web?
- If you were successful in capturing your prey, what features do you think contributed to your success?

#### 5. LEAD THE GROUP IN A REFLECTION ACTIVITY:

Once all of the youth have made their attempts, facilitate a reflection discussion. You can ask the questions below, or incorporate your own.

#### **POSSIBLE QUESTIONS TO ASK:**

- What do you think the benefits and draw-backs of this hunting method are?
- How does this adaptation help the ogre-faced spider get the energy and nutrients it needs?
- How did the changes in the population size affect the relationship between the predator (ogre-faced spider) and prey (insects) and the balance of the ecosystem?
- How was a better spider web design beneficial to ogre-faced spiders in this model?
- How does having a more well-suited adaptation affect the ogre-faced spider population? How does this affect the prey population?

### **Additional Background Information**

Spiders are not insects, they are arachnids. Arachnids belong to a higher classification of animal called chelicerates, which refers to the mouthparts found near the mouths of arachnids. Chelicerates are thought to have shared an aquatic, segmented, worm-like common ancestor with insects sometime around 500 to 600 million years ago, although some scientists think that their common ancestor may have existed much earlier. After this time, arachnids and insects developed over different evolutionary pathways. Arachnids retained fewer fused segments (two) than insects (three). Both arachnids and insects are thought to have made the transition from water onto land sometime about 400 million years ago. Features unique to insects and arachnids are the fusion of segments, jointed-legs, and the development of an exoskeleton. Like insects, spiders and other arachnids have an exoskeleton, which allows them some protection and movement. Arachnids only developed fusion between the head and thorax, forming the cephalothorax and left the remaining abdominal segment to be separate. This is important because the abdomen of spiders has become modified by the development of two glands that enable spiders to spin silk.

We have identified over 45,000 species of spiders that have evolved over millions of years, making them one of the most diverse animals on the planet. All species of spiders spin silk but not all of them spin webs. Spiders have developed a variety of ways to utilize silk, most often used as a means of capturing prey. The ogre-faced spider, *Deinopus subrufa*, is known for throwing its silk-spun web much like a gladiator would throw a net at his or her opponent. Once ensnared in the web, the spider will inject venom into its prey, immobilizing it and readying it for consumption. Understanding the different types of interdependent relationships that exist within ecosystems allows us to model the transfer of energy needed to sustain populations over time. A predator-prey relationship in nature is necessary for keeping populations of both species in balance. In the scenario from this lesson, the ineffectiveness of the ogre-faced spider webs allowed more prey to remain in the ecosystem, thus sparking overpopulation. The design challenge prompt simulates a natural selection event where ogre-faced spiders with more effective webs for capturing prey are able to reproduce and restore the declining predator population.

In the predator-prey relationship, one limits the growth of the other. For example, there is more food for predators when the prey population increases. After a short delay, the predator population increases as well, as a result of more food availability. When this happens, more prey are captured. As a result, the prey population goes down. Predator populations start to decrease as well. And so it continues as you can see in the graphic below. The limiting factor is the prey population.





#### **Resources**

<u>https://www.ck12.org/ngss/middle-school-life-sciences/ecosystems:-</u> <u>interactions,-energy,-and-dynamics</u>

## **Scope and Sequence Major Understandings**

#### **DISCIPLINARY CORE IDEAS:**

**MS-LS2-2:** Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms... Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.