THE ACADEMY OF NATURAL SCIENCES

of DREXEL UNIVERSITY

Teacher's Guide to **Amazing Arthropods**

Grades 3-6

Description: Eat or be eaten is the name of the game in this lesson about arthropods featuring museum specimens and real live invertebrates. Investigate the adaptations animals as diverse as millipedes and tarantulas use to obtain food or avoid becoming food in this hands-on class!

Outcomes: Students will be able to explain the characteristics of arthropods and differentiate between three major types of arthropods: insects, crustaceans, and arachnids. Students will be able to identify adaptations and predict the function of different arthropod features based on their forms. Students will be able to assess the role of arthropods within an ecosystem.

Connection to the Academy: The scientists at the Academy of Natural Sciences of Drexel University have been studying insects since the Academy was founded in 1812. The entomology department's collection now contains over 3,500,000 specimens belonging to over 11,000 species. The Academy is also home to the Titian Peale Collection, the oldest-surviving collection of insects in the Americas containing two Mediterranean butterflies that were collected in the 1740s. Current entomology research at the Academy focuses on taxonomy, systematics, biogeography, and behavior of Orthoptera and Tipuloidea species, as well as the surveying of aquatic insects in Mongolia.

Vocabulary

Adaptation
Arthropod
Invertebrate
Exoskeleton
Insect
Decomposer
Habitat
Biomimicry

Suggested Activities Before Your Visit

Investigating Arthropods - Introduction: Scientists research the complexity of life organizing species diversity into a number of nested groups based on shared or modified characteristics. For example, vertebrates (fish, reptiles, birds, amphibians, and mammals) have a backbone. Invertebrates are animals without a backbone. Although "invertebrate" is a catch-all term and not a true scientific grouping like "vertebrate," it is useful when discussing animals without backbones. There are many more types of invertebrates than vertebrates on the planet. In fact, 98% of all known species are invertebrates and lack a backbone. The skeleton of a vertebrate provides the animal with structure, mobility, and protections. Invertebrates have different adaptations that allow them to be the most successful animals on the planet.

Arthropods are a unique group of invertebrates having an exoskeleton to cover their body and protect them, unlike invertebrates such as worms, jellyfish, and squid. The word Arthropod means "jointed foot." Arthropods have a jointed exoskeleton made largely of chitin. (A material similar to cellulose found in plants.) Sometimes the chitin is stiffened further with calcium carbonate. The stiffness of the exoskeleton varies; for example, a caterpillar's exoskeleton is soft and a beetle's is very hard. In order for the arthropod to move, as their skeleton is external, the exoskeleton has joints at strategic locations on the animal's body.

Arthropods are very diverse and extremely successful. For example, there are over 400,000 known

types of just beetles! There are many modifications to the jointed exoskeleton body plan that help different types of arthropods survive in their environment. These adaptations can help distinguish between different groups. For example, insects (butterflies, beetles, cockroaches, mosquitoes, ants, and more!) have three body sections and six legs. They often have wings, antenna, and a large variety of mouthparts. Arachnids, such as spiders, scorpions, mites, and ticks, have two main body sections and eight legs. Arachnids lack wings and antenna. Crustaceans, such as lobsters, crabs, and shrimp are based on a 10 leg body plan and many (but not all) are aquatic.

- **Craft- Arthropod Anatomy**- Show students pictures of a variety of arthropods (e.g.: cricket, butterfly, spider, scorpion, crab, lobster, shrimp, beetle, cockroach, and ant). What do they all have in common? What might be different? Discuss arthropod, exoskeleton, jointed legs, and number of body parts. Give the students an opportunity to build their own arthropod. Provide them with exoskeleton material (clear plastic food containers such as Gladware work well) as well as materials for other body parts such as model magic (clay), pipe cleaners, feathers, beads, and any other desired craft supplies and ask them to make their own arthropod. Encourage students to add custom traits like wings or mouthparts or to make interesting body forms. Have them write a paragraph on the characteristics and adaptations of the arthropod they have made.

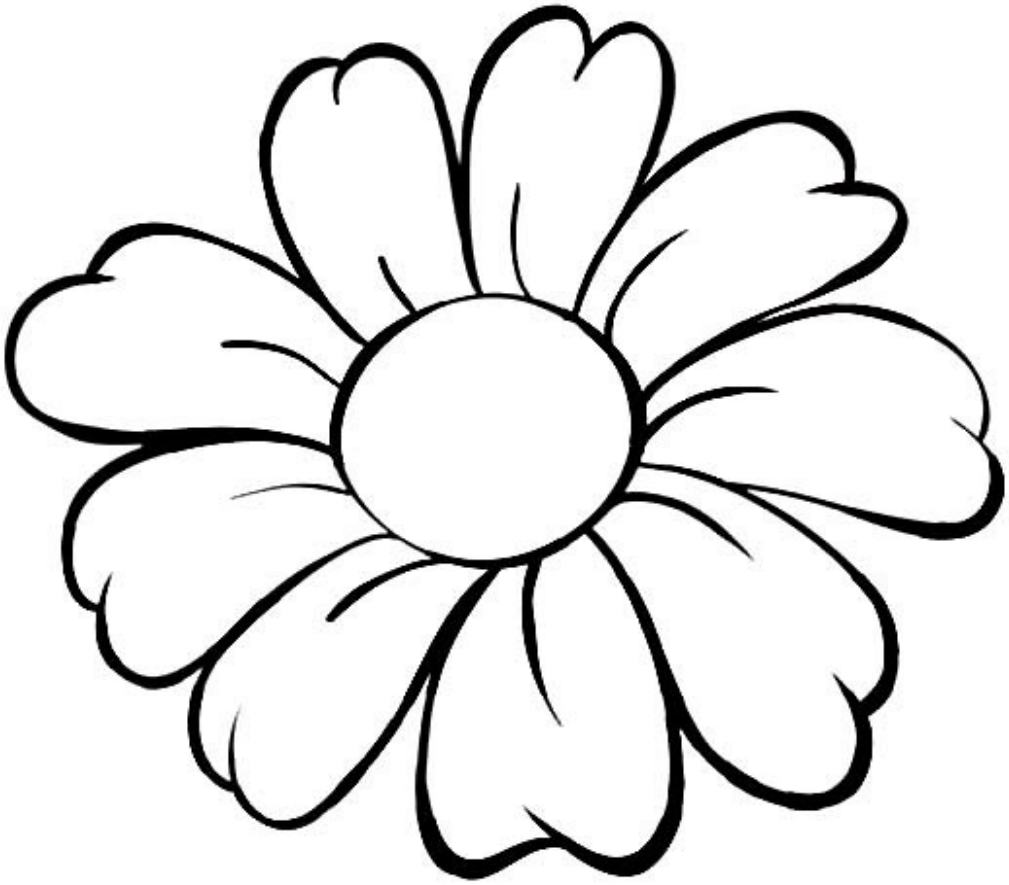
Suggested Activities After Your Visit

Classroom Activities

- **From a Bug's Eye View-** Discuss models with the students. What is a model? Does anyone build models such as model cars, airplanes, etc.? Scientists use models to help them understand how the world functions on a more human scale. Explain to students that they will be using models of an insect eye in order to study insect vision. Provide students with kaleidoscopes that mimic a compound eye. Allow students to explore the room using the model compound eyes. Compare and contrast how vision through the compound eye is similar and different than their vision. Ask students to develop testable questions about how the compound eye is different than their eye (e.g. Is it harder to see from a distance? Is the image fuzzier or clearer? Is it harder or easier to see movement? How many images can they see?). Allow students to explore their questions and gather data. Share the results in a class discussion. Have students research compound eyes. Compare and contrast the model compound eyes with a real compound eye. What is similar to a real compound eye? What is different? What did the model get wrong? What advantages and disadvantages does the compound eye have? How do these advantages help the insect? Brainstorm a list of the advantages and disadvantages of human eyes. How is this list different than the insect list?
    - **Extension: Pollinators-**
        - **Background information**: Like humans, bees have the ability to detect three main wavelengths of light. Unlike humans, honey bees can sense into the UV spectrum (green, blue and UV). Certain flowers have evolved what are called honey guides. These are areas of the flowers that reflect UV light. These honey guides are invisible to us, but are visible to bees. They seem to serve as sort of a landing guide for bees—informing them that there is a large nectar award in the center of the flower. What does the flower get? A greater chance of getting pollinated. This type

of relationship is selected for in the wild. Bees visiting the flowers with the honey guides would potentially receive more nectar and more energy to provide the hive with in order to survive. At the same time, flowers with honey guides would attract more pollinators and would reproduce more successfully. Some butterflies, which can sense UV, may also respond to cues from flowers.

- **Bee Vision Experiment: Imagining what bees see.** In this activity, students will have an opportunity to demonstrate to their classmates the advantages of being able to sense the honey guides on certain flowers.
  - Activity Prep: For this activity you will need 10 pairs of lab goggles, cellophane, markers, and drawings of flowers. Optional items include antenna headbands and black and yellow striped shirts for the honey bees! 5 of the goggles will be covered with cellophane and represent insects that cannot see UV light. The other 5 goggles will not have the cellophane and will represent honeybees. To make the goggles, you will need one color of cellophane (for example yellow) to cover the goggle lenses. The challenge is to find the same exact color of marker as the cellophane. You may need to test a few shades of the matching color markers to find the correct match. When looking at a streak of the marker color through the cellophane, if you CANNOT see the streak on the paper, you have found a perfect shade match between the cellophane and the marker! The idea is that when wearing the cellophane covered googles, students would NOT be able to see the honey guides on flowers (made with the matching color marker). Next make 30 copies of the flower images provided. Using the colored marker that matches the cellophane color, shade in the inner half of the petals on 15 of the flowers. The marked flowers will be the nectar-rich flowers with honey guides; the unmarked flowers will be the nectar-poor flowers. Number all of the flowers in a colored marker that can be seen.
  - Show students pictures of flowers photographed under "normal light". Then, show students pictures of the same flowers photographed with UV light (easily found in an internet search). Have students discuss how the flowers look different. Why might the flowers have these markings? Explain the concept of honey guides to the students (see information above).
  - To begin the activity, choose 10 students. Have 5 of them wear the special lab goggles (insects that cannot see UV) and 5 of them wear normal goggles (honeybees, which can see UV). THEN (and not before) distribute the 30 flowers around the room. The students' goal is to obtain nectar from the flowers. Some flowers have more nectar than others (indicated by honey guides). The more nectar they have, the greater chance they have of surviving. The students must get enough nectar to survive. Participating students will be given 30 seconds to "visit" flowers. As they move around the room to the flowers with their goggles on, have them collect at least 5 flowers. When the time is up, gather the students back together and have them take off their goggles. How much nectar were the students able to get? Was there a difference between honeybee success and other insect success (i.e. were bees more successful in finding flowers with honey guides than the non-bees?)



- **Insect Innovations-** Many of the inventions used by humans have been inspired by nature. This type of design is called biomimicry. Why might people look to nature when trying to find solutions to problems? Arthropods in particular have been a major source of inspiration. What traits of arthropods might make them such good examples for efficient design? Ask students to research an invention or innovation that was inspired by an arthropod. What traits of that arthropod inspired the design? What problem is this design solving? After students research their invention, have them present their findings on a poster at a mini-conference.
    - **Alternative-** Explain to students the idea of biomimicry and ask why designers and engineers might use biomimicry. Using what they have learned about arthropods, students should create an invention that solves a problem using principles gained from the study of arthropods. Students can either work independently or be broken into "design teams". Ask students to choose an arthropod to learn about. What problems does the arthropod need to solve in its daily life? Could the same adaptation be used to solve a similar human problem? After students research their arthropod, challenge them to come up with an invention based on one of the characteristics or adaptations of their arthropod. Students should either draw their invention or create a model of it to present to the class.
- **Experiment- Sensing capability of live arthropods-** Students will be provided with live crickets (which can be purchased at pet supply stores). Students will be asked to explore the sensory preferences of their insects in a controlled experiment. Some avenues for exploration could include texture of material, temperature, light vs dark, color, smell, or food preference. Have students formulate a plan for their experiment and collect their data in an organized fashion. After the experimentation is complete, have students share their findings, supported by data, with the class in the form of a poster or a graph.

- **Current Events-** Have students research a current event involving arthropods. Some examples could include the impacts of honeybee loss, mosquito-borne illnesses, using horseshoe crab blood to make sure medical equipment is sterile, eating insects, or using insects as inspiration for engineering. Options for projects could include writing and sharing a summary with classmates or developing an informational poster on the topic.

Homework Assignments

- **Arthropod Identification**- See attached sheet.

Interdisciplinary Activities

- Split students into groups and have them write songs about what they have learned about arthropods. Students will then perform their songs for their classmates.
- Many cultures have stories that explain the behavior or physical attributes of things in nature. Have students read some stories about arthropods from other cultures. How is the animal portrayed in this story? Read a different story about the same arthropod from a different culture. What is similar about the portrayal? What is different? What might be based on the animal's actual characteristics? Challenge students to write their own story about an arthropod explaining why a certain arthropod behaves or looks the way that it does. Students can illustrate their story and share it with the class.

Writing/Drawing Prompts

- Pretend that you are an insect. Write a formal letter to humans persuading them to stop squishing your fellow insects, and support your persuasion with facts about your animal.
- Insects have many capabilities that humans do not. Design an invention that either utilizes and insect or is inspired by an insect. Explain what it does and why it would be useful.
- What if arthropods developed a civilization like humans did? Explain what you think this civilization would be like using information you have learned about insects.

Class Project Ideas

- Ask students to go home and spend 15 minutes looking for invertebrates in their backyards or in a local park. Students should keep track of what types of invertebrates they see, as well as how many they see of each type and where they see them (grass, soil, tree, etc). Students should also be encouraged to take pictures of the invertebrates when possible. Once all students have collected their data, have them compile the data for the whole class in order to create a survey of the invertebrates living in your area. Which of the animals are arthropods and which are not? Which were the most common? Which were the least common? In what type of habitat were the most invertebrates found? What type of habitat contained the least invertebrates? Students should create posters to present in order to share their class findings. Poster content can range from written descriptions to graphs to basic statistics depending on the needs of your class.
    - **Extension-** If this activity is done annually, show students results from previous years. If there are major changes, have students discuss why the changes might be occurring. Have students draft a letter to local government explaining to them why they are concerned about any population changes.

Resources for Students

- http://andygiger.com/science/beye/beyehome.html -Bee Eye Simulator
- Biomimicry: Inventions Inspired by Nature by Dora Lee and Margot Thompson
- Nature Got There First by Phil Gates

Resources for Teachers

- Biomimicry: Innovation Inspired by Nature by Janine M. Benyus
- Ladybugology by Michael Elsohn Ross. Backyard Buddies Series. Other titles include Criketology, Spiderology, and Cricketology.
- The Arthropod Story http://tolweb.org/treehouses/?treehouse_id=3923
- http://biomimicry.net/
- http://biomimicry.org/
- http://www.montessorimaterials.org/science.htm - Pictures of animals in different groups
- http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/CompoundEye.html -Information on Compound Eyes
- http://ae.oxfordjournals.org/content/ae/48/3/134.full.pdf - Summary of some insect stories
- http://www.native-languages.org/legends-insect.htm - Database of insect stories complete with stories
- DK Insects Spiders and Other Terrestrial Arthropods- George C. McGavin

Arthropod Identification

All of the creatures on this worksheet are arthropods. Once you identify them, do some research on them and fill out the rest of the chart with what you have learned.

Picture	Name	Type of Arthropod	Food Source	Habitat	Adaptation