Invent an Insect

GRADE LEVELS	2nd - 6th; California Content Standards for 3rd and 4th grades; NGSS for 2nd – 5th Grade
SUBJECTS	Life Sciences
DURATION	**Preparation:** 20 minutes **Activity:** 60 – 120 minutes
SETTING	Classroom

Summary

Through the exploration of the physical structures and adaptations of insects students will gain an appreciation for the diverse world of insects. Students will then apply what they have discovered to create their own unique insect.

Objectives

Students will:

1) Recognize what makes an insect an insect by identifying the common structures and characteristics of insects.
2) Explore examples of insect adaptations and infer how they fit the insect's habitat or lifestyle.
3) Appreciate the diversity of insects.

Materials

- Invent an Insect sheet, one per student
- Insect Diagram, one per student
- Set of Insect Habitat cards
- Arthropods sheets (optional)
- Colored pencils/markers, modeling clay, one set per group of students (optional)

Preparation

- Print Insect Diagram and Invent an Insect sheets, one per student
- Print and cut out Insect Habitat cards, one card per group
- Print Arthropods pictures or set up as a slideshow (optional)

Scientific Terms for Students

abdomen: the last of an insect's three main body parts.

adaptation: any structure or behavior of an organism that improves its chances for survival

antenna (pl. antennae): the thin feelers on the head of an animal like a crayfish, isopod, or insect. Antennae are used to sense the environment.

arthropods: a group of animals with exoskeletons, jointed legs and segmented bodies, including insects, spiders, ticks, scorpions, centipedes, crabs and shrimp.

entomologist: a scientist who studies insects

exoskeleton: a hard, protective covering found in all arthropods, which provides structure like a skeleton, but is on the outside.

habitat: the place or type of place where a plant or animal naturally or normally lives and grows

head: the first of an insect's three main body parts

insects: a group of arthropods that is characterized by having a three-part segmented body, six legs, and two antennae, including beetles, ants, and bees.

larva (pl.: larvae)**:** the wormlike early stage in the life cycle of an insect.

metamorphosis: the change of an insect (or other animal) from one form into another as it develops into an adult. Butterflies are a well-known example.

thorax: the middle of an insects three body parts. An insect's legs and wings are always attached to the thorax.

Teacher Background

Arthropods:

Scientists classify animals according to how their bodies have evolved. Animals with similar characteristics are grouped together. **Insects** belong to a very large group of animals called **arthropods**. Spiders, crabs, centipedes, ticks, scorpions, shrimp, also belong to the arthropod group. The characteristic that defines an arthropod is an **exoskeleton**, or an external, jointed skeleton that provides structure and protection for the animal's softer insides. The plates of exoskeleton may overlap but have flexible joints in between, allowing' different body parts to move independently of the rest, much like animals with internal skeletons.

Defining Characteristics of Insects:

Three Body Segments

All insects have segmented bodies. Insect bodies are divided into three segments – the head, the thorax and the abdomen. With some insects, it's difficult to tell exactly where one segment stops and another begins. But there is a fool-proof way to tell which part is which. First, look for the eyes and antennae; they're always located on the head. Next, locate the legs; they're always connected to the thorax. All that remains on the body is the abdomen, located on the opposite end as the head!

Six Legs

All adult insects have six legs. Insects who undergo complete metamorphosis (meaning they change from an egg to a larva to a pupa to an adult) lack legs entirely during the first phases of their lives. By looking at an insect's legs, you can usually tell what type of environment it lives in. For example, many insects that live in the water, such as water boatmen, have flattened oar-like legs to help them paddle through the water. Other insects may have legs suited for running, or climbing, or jumping great distances.

Antennae

Adult insects also come equipped with a pair of sensitive antennae on their heads. These sensory organs are used to feel, smell, and sometimes hear. Antennae come in a wide range of shapes and sizes, depending upon how they are used. Scientists use antennae to help identify different types of insects because they are very particular to individual species of insects.

Wings

All but our most "primitive" orders of insects possess wings. Even in ants and termites the reproductive members of the colony possess wings. Typically, insects have two sets of wings that move together in unison. In beetles, the front pair of wings has been modified to form a protective casing for the hind wings called elytra. True flies appear to have only two wings. This is because the hind wings have been modified into halteres, which resemble small knobbed structures that act as a counterweight to the front wings, helping stabilize the insect's flight.

Insect Ecology

Insects occur in abundance everywhere on our planet, except in oceans and the polar regions. These places aside, wherever entomologists have looked, they have found a great diversity of insect species, each suited to the environment they live in. This includes extreme environments like mountain tops, deserts and frozen fresh water.

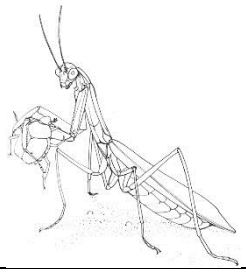
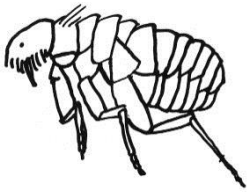
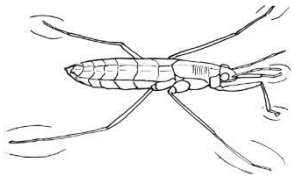
Not only have insects filled practically every habitat on Earth, but within each, they've filled nearly all ecological roles, from scavengers, to primary consumers, to predators, to parasites, and so on. Insects are not only well adjusted to the environments in which they live, but also their role within that environment, which is largely defined by what they eat. Plants, fungus, other insects, decaying matter, blood, and fecal matter have all been exploited by insects as sources for food. In order to eat, and sometimes catch, their food, insects have developed specialized body parts specific to each.

How we've come to have so many different types of insects filling so many roles is a matter of time and evolution. As far as we can tell, insect have been around for 325 million years, during which they have had plenty of opportunity to evolve and diversify. [Grimaldi, D., & Engel, M, 2005.]

Adaptation in Insects

Adaptation is the process whereby a group of organisms becomes better suited to its environment over the course of many generations. This fundamental concept of evolution shapes not only where an organism lives, but how it lives as well. Through a process of trial and error (error in this case meaning death without successful reproduction), combined with random genetic variations, populations of organisms and their descendants slowly become better adapted to the conditions around them.

Animals may adapt to their environment with changes in their behavior (e.g. a bumble bee flies further south to find plants in bloom during an atypically cold spring). They also adapt with changes in body structure. Every aspect of an insects' body may be explained as an adaptation to some environmental factor. Below are examples that may be helpful to review with students.
Images: Pyle, R.M. & Kest, K.

Insect	Environmental Factor	Adaptation
Praying Mantis 	Fast-moving prey	Trap-like front legs to quickly snatch prey
Flea 	Feeds on the blood of much larger animals	Biting and sucking mouthparts, plus powerful back legs for jumping around host animal
Water Strider 	Lives on the surface of still, fresh water	Long, water-resistant legs for "striding" on water's surface

Activity Procedure

Introduction

1. **What is an insect?** Discuss as a class what makes an insect. Be sure to specify what makes an insect different from other arthropods: they have three body segments, two antennae, and six legs. You can use the PDF Arthropods to show different arthropods, including insects, as examples or you can have students try to figure out if the arthropod is an insect or not. *Teacher tip: this PDF may either be printed out or shown as a slideshow for the whole class.*

2. **Insect Anatomy** Pass out one Insect Diagram handout for each student. Have students work in groups to try to fill out the sheets first, then have a class discussion about what each part is and what they think it does. *Teacher tip: Try to allow students to share definitions in their own words before giving the class the formal definitions.*

3. **Adaptation** Introduce the essential question: "How can there be so many similarities among living things, yet so many different species of plants and animals?" Discuss and define the term "adaptation." Use the arthropods in the PDF as examples and have students try to point out adaptations they see on their bodies or behaviors they know the animals have.

Activity

1. Divide class into small work groups of four to six students each and provide each group with an Insect Habitat Card and a set of art supplies. Each student will need an Invent an Insect worksheet. *Teacher tip: Provide modeling clay or other art supplies for a more dynamic and three-dimensional activity.*

2. Present the rules of the activities: Invented insects must be suited for the habitat described on your group's Insect Habitat Card and must eat at least one of the food sources listed. Invented insects should be grounded in reality (insects can't make jet packs to fly around) and have the same body parts as real insects. Have fun and be creative! Don't forget to give your insect a name.

Discussion and Conclusion

1. Have each group present their insect to the class and state what habitat they were given. Have students share at least one adaptation they gave their insect and why.

2. As a class discuss how each groups' insect was similar and different. Did any two have similar adaptations? Did any two have similar habitats, but different adaptations?

3. Reflect and try to answer the essential question: "How can there be so many similarities among living things, yet so many different species of plants and animals?"

Extensions & Variations

Additional Adaptations

To make the activity more challenging, assign an additional required adaptation. For example:

- looks like an animal other than an insect (mimicry)
- is active only at night (nocturnal)
- blends in with an environment (camouflage)
- must be able to eat specific things (crushing mouthparts for seeds)
- must be able to avoid certain predator characteristics (strong back legs for jumping)
- must be able to move or stay put (fleas move from host to host)

Research Project

Once students have invented their insects, have them research real insects that live in their assigned habitat with their assigned food source. See Resources for recommended books and websites. Provide students a blank Invent an Insect sheet on which they can draw and write about the insect they research.

Design a Habitat Challenge

Have students design habitats for others and see if they can build an insect adapted for that environment.

Go Outside!

Now that students have a perspective on insect habitats and adaptations, take them outside and see what insects students can discover in their school yard or neighborhood. Use clear plastic containers to catch and observe the insects with magnifying glasses. Then release them where they were found.

Use the Academy's Naturalist Center

Make an appointment with a reference librarian to check out insect books, field guides, videos and DVDs for your classroom. Or, contact them with pictures of insects that you find and they will help you identify them. Or get in touch with our Naturalist Center at: www.calacademy.org/academy/exhibits/naturalist_center/

Correlated California Content Standards

Grade Three: Life Sciences

3.b) Students know examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

3.d) Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations.

Grade Four: Life Sciences

2.) All organisms need energy and matter to live and grow. As a basis for understanding this concept:

a. Students know plants are the primary source of matter and energy entering most food chains.

b. Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.

c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

3.) Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:

a) Students know ecosystems can be characterized by their living and nonliving components.

b) Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

c) Students know many plants depend on animals for pollination and seed dispersal, and animals depend on plants for food and shelter.

d) Students know that most microorganisms do not cause disease and that many are beneficial.

Next Generation Science Standards

The items listed below indicate how the activity supports the three dimensions of the Next Generation Science Standards.

Science & Engineering Practices	Disciplinary Core Ideas	Cross Cutting Concepts
Developing and Using Models: Develop a simple model based on evidence to represent a proposed object or tool. (K-2) **Constructing Explanations and Designing Solutions:** Use evidence (e.g., observations, patterns) to support an explanation. (Grade 3) Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (Grade 4)	**LS1.A: Structure and Function:** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. **LS4.C: Adaptation:** For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. **LS4.D: Biodiversity and Humans:** There are many different kinds of living things in any area, and they exist in different places on land and in water.	**Structure and Function:** The shape and stability of structures of natural and designed objects are related to their function(s). (K-2) **Cause and Effect:** Cause and effect relationships are regularly used to explain change. (Grade 3)

Related Performance Expectations

These activities outlined here are just one step toward reaching the Performance Expectations listed below. Additional lessons will be required.

K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

3-5-ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Resources

Borror, D.J. & White, R.E. *A Field Guide to Insects: America North of Mexico.* New York, NY: Peterson Field Guide Series, Houghton Mifflin, 1970.

Doris, E. Entomology. New York, NY: Thames and Hudson Inc., 1993.

Grimaldi, D., & Engel, M. (2005). Diversity and Evolution. In Evolution of the insects (p. 3). New York, NY: Cambridge University Press.

McGavin, G.C. Insects, Spiders and Other Terrestrial Arthropods. New York, NY: Dorling Kindersley, 2000.

Powell, J.A. & Hogue, C.L. California Insects. Berkeley and Los Angeles, CA: University of California Press, 1980.

Pratt, H., & Bybee, R. (2012). Dimension 3 DISCIPLINARY CORE IDEAS—LIFE SCIENCES. In The NSTA reader's guide to a framework for K-12 science education (Expanded ed., p. 161). Arlington, Va.: NSTA Press.

Pyle, R.M. & Kest, K. Insects: A Peterson Field Guide Coloring Book. New York, NY: Houghton Mifflin Co., 1993.