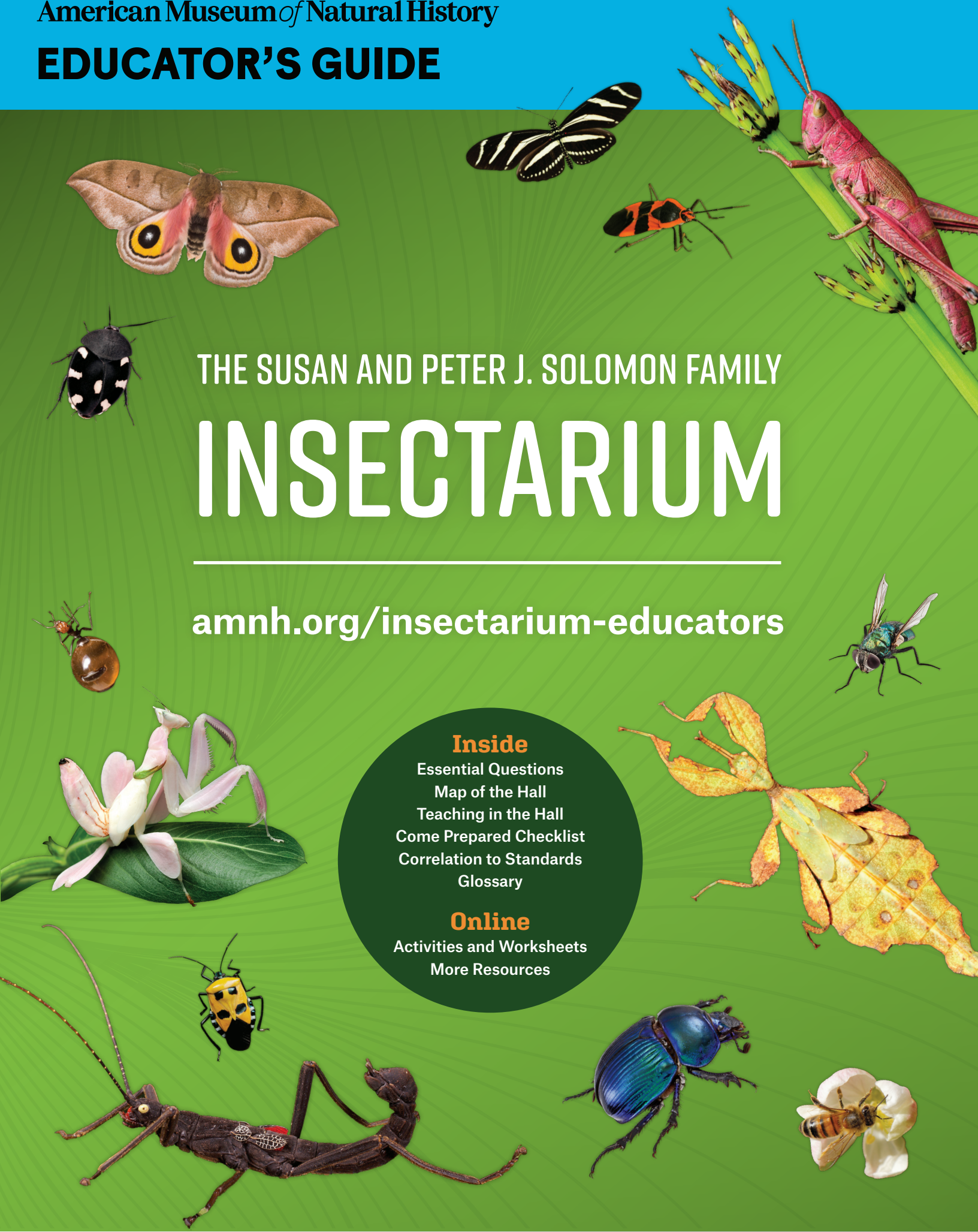
American Museum of Natural History

EDUCATOR'S GUIDE



THE SUSAN AND PETER J. SOLOMON FAMILY

INSECTARIUM

amnh.org/insectarium-educators

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ESSENTIAL QUESTIONS

What are insects?

Insects are a very large group of small, mostly land-dwelling animals. In fact, insects are the most abundant and diverse animals on the planet! Insects are **invertebrates**. They support their bodies from the outside with a shell, or exoskeleton, instead of with bones. The exoskeleton is segmented into three regions: the head, the thorax, and the abdomen. The thorax, or central region, has six segmented legs. Insects may use their legs to get around, and many **species** have also developed specialized uses for their legs and other appendages, such as trapping prey, distinguishing tastes, or making music to attract mates. Entomologists classify insects as belonging to the phylum Arthropoda, a group of animals with exoskeletons and jointed limbs, which also includes arachnids (e.g., spiders), myriapods (e.g., millipedes), and crustaceans (e.g., crabs).

Why are there so many insects?

Paleontologists have discovered fossil insects as old as 400 million years. That means insects have had a very long time to diversify—far longer than mammals like us, or even dinosaurs. With their small bodies and short reproductive cycles, insects produce many more generations during a given time than big animals that reproduce more slowly. More generations mean more opportunities for genes to mutate and recombine, generating tremendous genetic diversity. This diversity gives species better opportunities to **adapt** to new environments, where they occupy many **habitats** and **niches**, which in turn generates further diversity. Insects' diversity allowed them to evolve many adaptive strategies. For example, about 380 million years ago (mya) insects became the first animals to use wings to fly. Flight is important for finding food and mates, reaching new habitats, and escaping predators, giving insects a competitive edge. About 270 mya, some insect species evolved the ability to undergo complete **metamorphosis**, a strategy that reduces competition between adults and young, among other benefits. These and other adaptive strategies, including pollination, have helped insects diversify, multiply, and spread across Earth. So far, entomologists have named about 1.2 million insect species, but there may be as many as 3.5 million species, most waiting to be discovered.

What are the roles of insects in their ecosystems?

With millions of species, insects fill a vast variety of roles in **terrestrial** and freshwater food webs. As herbivores, they convert millions of tons of plant matter into food for other animals by eating plants and then becoming food themselves; birds alone eat 400 million tons of insects every year. As predators, they keep other insects and small invertebrates in check. As decomposers, they aerate soil and make waste materials useful again. (That's how dung beetles earned their name.) As transporters, they disperse seeds and host microbes, including those that can cause disease. More than any other group of organisms, they interact directly with plants—pollinating them (including 75 percent of our food-crop species), stripping them of foliage, depositing eggs and building cocoons on them, mimicking them, and preying on other insects that eat them. The healthiest and most resilient **ecosystems** are those with high **biodiversity**; the diversity of insect species helps protect Earth's ecosystems, and threats to insects threaten us all.

Why are insects in decline?

Ecologists have observed that insects are in decline around the world. Like organisms all over, they are under threat from habitat loss, pollution, pesticides, **anthropogenic** climate change, invasive species, and many other causes, some of which scientists don't yet understand. Some threats are global: climate is changing around the world; some pollutants have been found on every continent. Some threats are local: people are cutting down forests to plant crops or build cities, destroying insect habitats; invasive species are devouring and outcompeting local native populations. Around the world, the majority of insect species are in decline, in some places more than others. That means the biodiversity of insects is in serious trouble, and therefore so are their ecosystems. Scientists today are focusing urgently on questions of conservation—how to stop the decline of these fascinating, complex, and enormously important animals on which Earth's ecosystems depend.

Leafcutter ants, like many social insects, have evolved efficient behaviors that allow colonies to grow very large.

MAP OF THE HALL

The Insectarium invites visitors to explore the beauty and wonder of these amazing animals and find out why insects are essential to their ecosystems. It also shows the connection between insects and humans, encouraging visitors to listen and look for the remarkable variety of insects that are all around us, wherever we live.

Throughout this immersive space, students can:

Observe live insects in various habitats

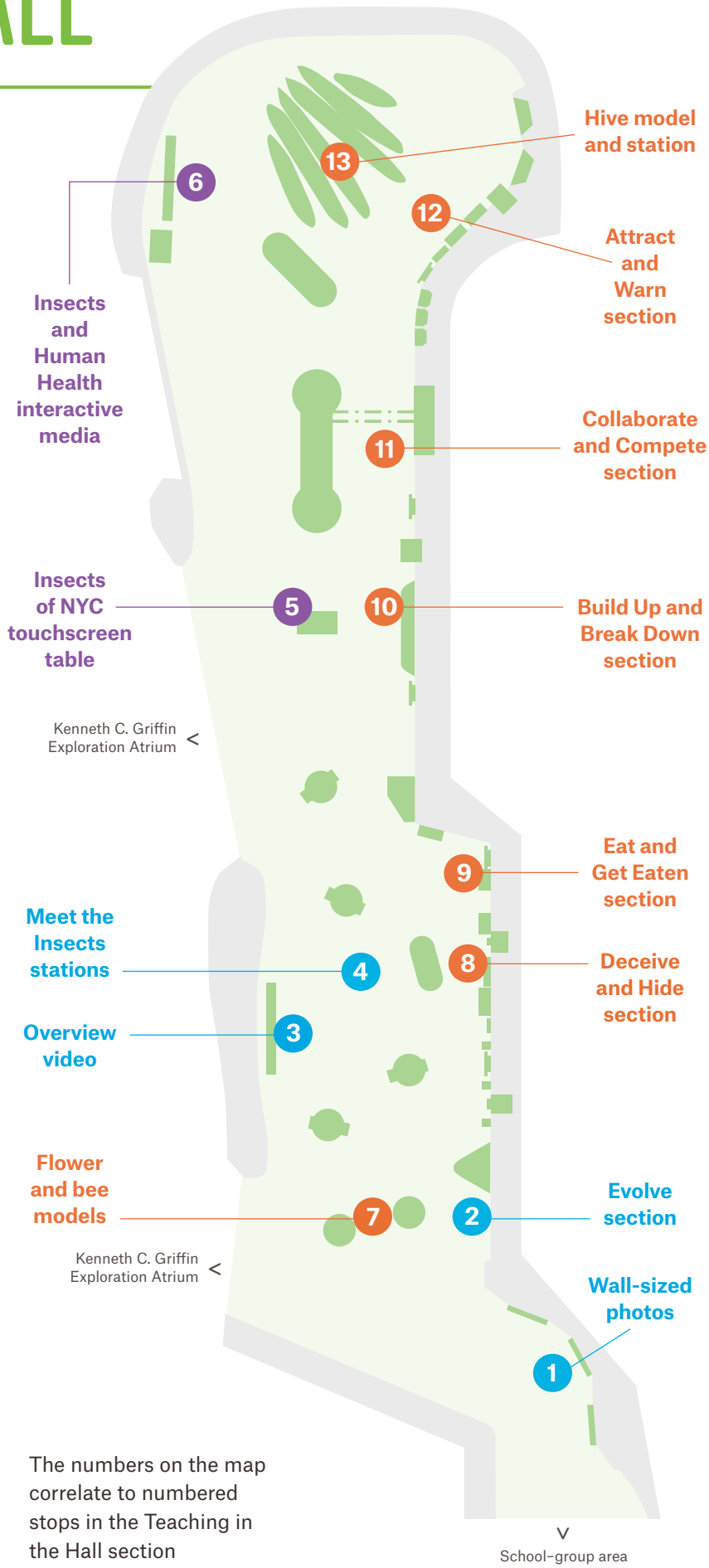
Examine pinned specimens

Interact with models and dioramas

Explore multi-sensory interactive media

Watch videos of insect behavior

Watch videos of scientists at work



The numbers on the map correlate to numbered stops in the Teaching in the Hall section

TEACHING IN THE HALL

This guide divides the Insectariun into three thematic areas: **Introducing Insects**, **Insects and Us**, and **Ecological Roles**.

= number of students that will fit in an area

Introducing Insects

Insects are everywhere, in vast numbers and astonishing diversity. Exhibits near the entrances present the major themes of the Insectarium. They explore the evolutionary relationships and showcase the beauty of these extraordinary animals.

1. Wall-size photos | 8-10 | Along with revealing three insects in microscopic detail, this area introduces the importance of insects, including why they are so dominant and in such decline, so ancient and so widespread, and so specialized and so essential.

2. Evolve section | 8-10 | Why are there so many insects, and where did they come from? This area explores when different insect groups emerged, how diversification helps insects persist, and how insect and plant species have coevolved mutually beneficial adaptations.

3. Overview video | 10-12 | This 4-minute video introduces the major themes of the Insectarium, focusing on the many roles insects play in Earth's ecosystems.

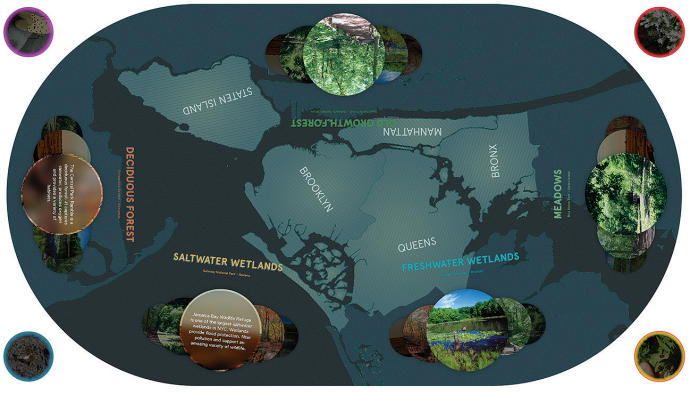
4. Meet the Insects stations | 6-8 per station | Four island stations, each featuring a pair of insect orders, explore the diversity of insects: Coleoptera (beetles), Dictyoptera (cockroaches, termites, mantises), Diptera (flies), Hemiptera (aphids, cicadas, true bugs, etc.), Hymenoptera (ants, bees, wasps, etc.), Lepidoptera (butterflies, moths), Orthoptera (crickets, grasshoppers, katydids), Phasmatodea (leaf insects, stick insects).

Insects and Us

Insects are connected to human life in many profound and intimate ways. These examples—just two of many in the hall—focus on our connections.

5. Insects of NYC touchscreen table | 8-10 | This interactive map highlights the biodiversity and ecological roles of insects that inhabit different ecosystems in the five boroughs of New York City: freshwater wetlands, deciduous forest, old growth forest, meadows, and saltwater wetlands. It also features photo galleries that show where people have spotted different species throughout the city.

6. Insects and Human Health interactive media | 5-6 | Three stations and a large video let visitors investigate some of the few insect species that spread diseases, where in the world they live, and how they affect human health.



Students can match insects with their roles in various ecosystems and see where species have been observed throughout New York City.

Ecological Roles

Without insects to pollinate plants, be food for animals, and decompose both, a great many species—including our own—would likely not survive. These areas in the hall explore what insects do in the world and how their behaviors help keep ecosystems healthy.

7. Flower and bee models | 2-4 | A button triggers a lighting sequence in the large-scale models to reveal how flowers attract bees, and how bees collect and distribute pollen.

8. Deceive and Hide section | 10-12 | Insects have many strategies to evade predators and capture prey: they use camouflage—colors, patterns, and body shapes—to blend into the environment. Some species mimic others—that is, look, behave, sound, or smell them. Traits like eyespots and false heads startle predators and scare them off. And some insects evade predators by playing dead.

Students can observe live insects and interact with media to explore the tricky strategies insects use to evade predators and capture prey.

9. Eat and Get Eaten section | 8-10 | Insects are an essential part of ecosystems as herbivores, predators, parasites, and decomposers. They participate in supply and demand from both sides of the equation: they eat an extraordinary variety of material, from nectar to animal dung, and they provide food for other animals in the form of their own bodies as well as the products of their industry.

10. Build Up and Break Down section | 8-10 | Insects can function as architects, creators, and decomposers. They build shelters that have inspired human architecture; they produce materials useful to humans, such as wax and honey; and they decompose waste materials such as rotting plants, animal carcasses, and poop, returning nutrients to the ecosystem.

honey wasp nest

11. Collaborate and Compete section | 12-18 | Insects have developed many adaptations for challenging others—to defend against enemies, battle rivals, and catch prey. And many social insects, such as the leafcutter ants in this large colony, work together like a superorganism.

Observe ant behavior in the largest live leafcutter ant colony on display in the United States.

12. Attract and Warn section | 8-10 | Insects communicate with one another through sound, sight, and scent. They use these cues to reveal important information, such as where to gather food; to warn away predators and rivals, for example with a puff of foul odor or a menacing movement; and to attract mates with alluring dances, songs, caresses, or even flashing lights.

13. Hive model and station | 10-12 | This glowing model of a honeybee hive is 20 times life-size. This area explores the variety of bee species, their importance as pollinators, and how a bee colony works together like a superorganism.

Experience life in the hive through videos and role-playing interactive media.

Food-Web Connection: Students can look for these icons at the live insect tanks. They show the insects' ecological roles in their ecosystems.

herbivores | **predators** | **seed dispersers** | **pollinators** | **disease vectors** | **decomposers** | **soil aerators** | **builders** | **parasites and parasitoids**

COME PREPARED CHECKLIST

- [ ] **Plan your visit.** For information about reservations, transportation, and lunchrooms, visit amnh.org/field-trips.
- [ ] **Read the Essential Questions** in this guide to see how themes in the Insectarium connect to your curriculum. Identify the key points that you'd like students to learn.
- [ ] **Review the Teaching in the Hall** section for an advance look at what your class will encounter.
- [ ] **Download activities and student worksheets** at amnh.org/insectarium-educators. Designed for use before, during, and after your visit, these activities focus on themes that correlate to the standards.
- [ ] **Decide how your class will explore the Insectarium:**
  - You and your chaperones can facilitate the visit using the Teaching in the Hall section.
  - Students can use the worksheets and/or maps to explore the hall on their own or in small groups.

CORRELATIONS TO STANDARDS

A Framework for K-12 Science Education

Disciplinary Core Ideas • LS1.A: Structure and function • LS1.B: Growth and development of organisms • LS1.C: Organization for matter and energy flow in organisms • LS1.D: Information processing • LS2.A: Interdependent relationships in ecosystems • LS2.D: Social interactions and group behavior • LS4.A: Evidence of common ancestry and diversity • LS4.C: Adaptation • LS4.D: Biodiversity and humans

Crosscutting Concepts • 1. Patterns • 2. Cause and effect: Mechanism and explanation • 3. Scale, proportion, and quantity • 6. Structure and function • 7. Stability and change

GLOSSARY

adaptation: a physical or behavioral characteristic that helps an organism survive in a particular habitat. Adaptations are evolutionary responses to changing environments.

anthropogenic: resulting from human activity

biodiversity: the variety of life at all levels, including the genetic differences within a species, the range of species in an ecosystem, and the array of ecosystems on Earth

ecosystem: all the living things in a given area (plants, animals, and other organisms), along with the components of their environment (things like air, water, and soil), interacting as a system

habitat: an area that provides the environmental factors necessary for members of a species to live and reproduce

invertebrate: an animal that lacks a vertebral column, or backbone

metamorphosis: a biological process by which a post-embryonic animal undergoes an abrupt, rapid physical change from one stage to another. In **incomplete metamorphosis**, insects undergo three phases: egg, larva, and adult; larvae may resemble small adults. In **complete metamorphosis**, insects undergo an additional phase—pupa—between larva and adult, and all phases are dramatically different in form.

niche: a term used to describe the living and nonliving factors necessary for the survival of a species, along with the ecological role a species fills in a community

species: a basic unit of biological classification. A species is typically defined as a group of organisms that share ancestry and characteristics and that can interbreed and produce fertile offspring.

terrestrial: living on land rather than in water

CREDITS

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IMAGE CREDITS

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