Name: _____

MATTHAEI BOTANICAL GARDENS AND NICHOLS ARBORETUM
UNIVERSITY OF MICHIGAN

Adaptations

Adaptations are special traits that allow plants to meet their needs. They are inherited, and evolve over time in response to particular conditions. Adaptations make it easier for plants to survive in their specific habitat, and reproduce, passing those traits on to their offspring. All plants, no matter where they grow, are adapted to certain conditions, which can include temperature, available water, soil type, and interactions with animals and other organisms. An adaptation that increases a plant's chances of surviving in one habitat may not be beneficial in another habitat.

The conservatory is divided into three biomes: tropical, warm temperate, and arid. Biomes are defined by their climate. As you walk between the different houses, note the changes in temperature and moisture in the air. Only the plants that are adapted to those conditions can survive in that biome. While you explore the three houses, use the chart below to record some notes about plant adaptations in each biome. Write down the names of a few plants that have the adaptations listed, draw the adaptation, or record your other observations.

Tropical House	
Waxy and smooth leaf surfaces and **drip tips** help leaves shed excess water.	**Smooth bark** makes it more difficult for plants to grow on the surface of trees.
Vining plants climb on other plants in order to reach the sunlight.	**Epiphytes** are plants that grow on other plants in order to reach the sunlight.

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Temperate House	
Thick bark retains moisture and protects trees from wildfires (hint: look for the cork oak).	**Small leaves** help the plant retain water by reducing the moisture lost to evaporation.
Light colors on leaf surfaces reflect sunlight and decrease water loss.	The bog exhibit contains **insectivorous** plants. They get nutrients by digesting insects!
Arid House	
Plants **store water** in thick stems and leaves.	**Spines** discourage animals from eating plants for food or water.
Some plants have **green stems** that perform photosynthesis.	**Hairs** on leaves or stems help shade the plant and reflect light.

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Tropical House

Waxy and smooth leaf surfaces and **drip tips** help leaves shed excess water. Tropical rainforests receive between 80 and 400 inches of rain per year (MI has an annual average of 31.75 in). In rainforests that receive this much water, plants need to shed excess water in order to prevent the growth of fungi and bacteria on leaf surfaces. Smooth leaf surfaces and drip tips (pointed tips of leaves) help water run off quickly. Students can feel the waxy leaves of the fiddleleaf fig and note the dramatic drip tips on the Peepul tree.	**Smooth bark** makes it more difficult for plants to grow on the surface of trees. Thick bark is an adaptation that reduces water loss via evaporation. Since moisture is so abundant in the rainforest, tropical plants don't typically have thick bark. Smooth bark also makes it more difficult for vines and epiphytes to grow on the tree's surface. Some trees can even exfoliate, or shed, patches of bark, which forces climbing vines to lose their grip on the tree. Thus, this adaptation reduces competition for sunlight and other resources.
Vining plants climb on other plants in order to reach the sunlight. Because the canopy layer is so thick in the rainforest, very little light reaches the forest floor. Vines and lianas (woody vining plants) have their roots in the ground, but access sunlight by climbing on other plants. Students can observe the vanilla vine near the chocolate tree, as well as the long roots of the monstera plant on the balcony. Students can also touch the aerial roots of the banyan tree, which starts life as a seed in the branches of another tree in the canopy, and then sends roots down to the ground.	**Epiphytes** are plants that grow on other plants in order to reach the sunlight. Like vines, epiphytes use other plants to access sunlight. They grow on the trunks and branches of other plants. The conservatory has many epiphytes on the log near the chocolate tree. Matthaei also has an extensive collection of bromeliads, many of which are epiphytes that collect water in a central reservoir or tank. This allows the plant to access water even though it does not have a well-developed root system. The tank also supports an ecosystem of bacteria, insect larvae, and even bird and frogs.

Temperate House

Thick bark retains moisture and protects trees from wildfires (hint: look for the cork oak).

Fire is an important part of many ecosystems, including the Mediterranean where the cork oak originates. This tree's thick, blocky bark protects it from fire by providing a barrier between the fire and the living tissue of the tree. Humans use the bark too. Sections of cork can be harvested without damaging the plant, and the tree is able to regenerate the bark. It can be used to make bulletin boards, stoppers for bottles, and even shoes!

Small leaves help the plant retain water by reducing the moisture lost to evaporation.

Have students compare the size of leaves the temperate house to those they observed in the tropical house. Smaller leaves lose less water because they absorb less sunlight and heat. Needle-shaped leaves are particularly effective at preventing water loss because they have a very small surface area and are covered with a waxy coating. Students can observe this on the coastal redwood and Wollemi pine.

Light colors on leaf surfaces reflect sunlight and decrease water loss.

When sunlight hits a surface, some of the light energy is absorbed and some is reflected. Lighter colors reflect more light; darker colors absorb more. This means that the lighter the color of the leaf, the more light it reflects and the less it absorbs. This helps the plant stay cool and reduces the amount of water lost to evaporation. This is especially important for plants in the dry season, during which they might not be able to access much water.

The bog exhibit contains **insectivorous** plants. They get nutrients by digesting insects!

Carnivory is an adaptation that enables plants to acquire the nutrients they need in a nutrient-poor bog environment. The plants in this exhibit have a few different kinds of traps. Venus flytraps have snap traps that close when trigger hairs are touched by an insect. Pitcher plants have pitfall traps--their leaves are folded into "pitchers" filled with water that attracts insects. Sundews have leaves that release a sticky substance that traps insects, like flypaper.

Arid House

Plants **store water** in thick stems and leaves.

Cacti have thick stems that store water. Students can look for a pleated shape, which allows the stem to expand and store more water when there is more rainfall. During dry times, the plant uses the water and the stem shrinks. Succulent plants have thick spongy leaves that also store moisture. A waxy coating on the outside of leaves reduces water loss. One common succulent is the aloe plant, which Native Americans used as medicine. Today, it is often used in lotions to ease painful burns.

Spines discourage animals from eating plants for food or water.

Animals that live in the desert need water too, and they might eat plants like cactuses, which store moisture in their stems, in order to get adequate water. Spines are a type of modified leaf, and they help keep the plants safe from herbivory. This adaptation also helps the plant retain water, since spines do not lose water to evaporation the way leaves do. Please note that students should not touch any of the plants with spines in the arid house.

Some plants have **green stems** that perform photosynthesis.

Usually, green leaves are the plant part that performs photosynthesis. However, cacti have modified leaves (spines) that do not do photosynthesis. But if the leaves aren't photosynthetic, how does the plant grow? Students may notice that the surface of the stem is green, indicating that chlorophyll is present and photosynthesis is happening there instead. This also helps the plant retain moisture: stems lose less water than leaves do during photosynthesis.

Hairs on leaves or stems help shade the plant and reflect light.

Have students look for plants with white hairy surfaces in the arid house. These hairs are an important adaptation. They protect the plant from both sunlight and frost, and prevent bleaching of the stem, which would interrupt the process of photosynthesis. Students can compare this adaptation to a person wearing a white or light colored shirt on a hot day. Hairs also hold water when it rains, which keeps the plant cool.

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What adaptations help plants survive in Michigan?

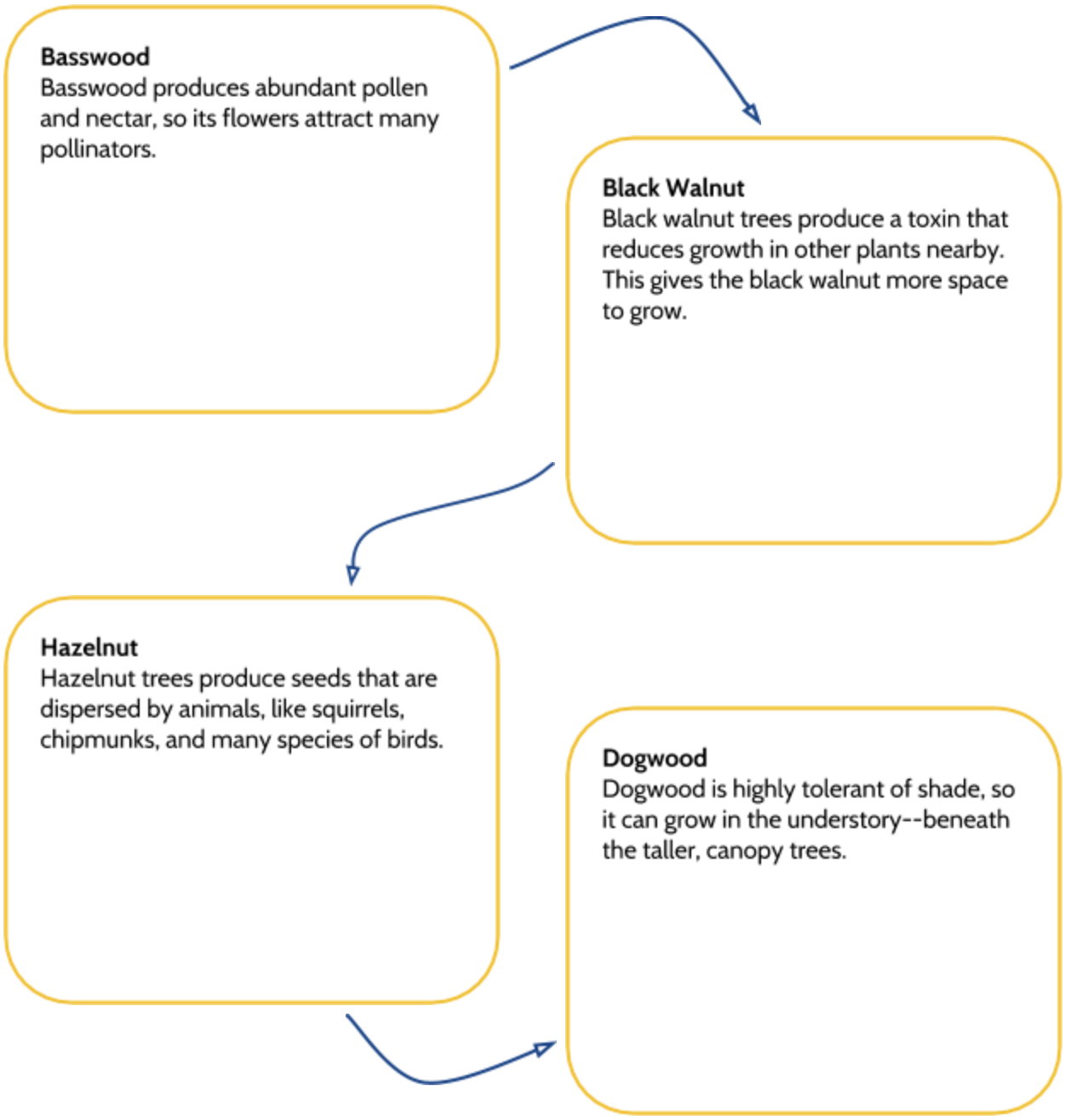
Michigan is located in the temperate biome and has many native plant species. Today you'll explore the Sam Graham Trail to discover some of Michigan's native trees. Look for the markers along the trail--they'll tell you the names of the trees featured here. As you stop to observe each one, think about some of the adaptations that help it survive here. Record and draw your observations in the box that corresponds to each tree you visit.

Silver Maple
Maple trees have special seeds called samaras. Sometimes we also call them helicopters because they have wings that allow them to float through the air.

Tuliptree
Tuliptree has thick bark, which reduces the loss of moisture and protects the tree from cold during the winter.

Musclewood
Musclewood leaves turn orange and scarlet in the fall, then drop off the tree. This prevents damage due to freezing.

Cottonwood
Cottonwood needs lots of sunlight to grow. It can grow very quickly as long as it is in a sunny, open spot.



What other adaptations do you think plants need to grow in Michigan?

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Silver Maple
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Students can look on the ground for samaras, although they should be careful to avoid the poison ivy on the sides of the trail. Floating on air is a useful adaptation for seeds because it means they can travel longer distances from the parent plant. This reduces competition between the parent and offspring and allows the species to spread to new areas.

Tuliptree
Tuliptree has thick bark, which reduces the loss of moisture and protects the tree from cold during the winter.

Michigan and other temperate regions can experience huge seasonal temperature fluctuations. Freezing during the winter can damage the living tissues of trees, so most trees here have thick bark that protects them from the cold. It also reduces the amount of moisture lost to evaporation. Students can feel the thick ridges of the bark of the tulip tree, and compare it to the smoother bark of trees in the conservatory.

Musclewood
Musclewood leaves turn orange and scarlet in the fall, then drop off the tree. This prevents damage due to freezing.

The broad leaves of deciduous trees allow them to capture lots of sunlight, but they are more susceptible to damage from freezing during the winter. Deciduous trees break down the chlorophyll in the leaves and re-absorb as much of the nutrients as possible, resulting in the loss of green color. Then they drop the leaves off for the winter--when the tree will be dormant--and regrow them the next spring.

Cottonwood
A cottonwoods needs lots of sunlight to grow. It can grow very quickly as long as it is in a sunny, open spot.

In the right conditions, cottonwoods can grow 100 feet in just 15 years. However, they need full sunlight to do this. A cottonwood tree cannot survive in the shade! We call trees like this "shade intolerant." Have students look all the way up at the top of the tree. Are there any other nearby trees that are taller than the cottonwood? If not, there is no shade blocking the sunlight from reaching its leaves.

Basswood
Basswood produces abundant pollen and nectar, so its flowers attract many pollinators.

The US Forest Service has identified 66 different species of insects that pollinate basswood trees! Pollination is a special relationship between plants and their animal pollinators. The pollinators get nectar and pollen as food, and the plants need pollination in order to make seeds and reproduce. Bees are the most common basswood pollinators, and many humans enjoy eating honey made from basswood nectar.

Black Walnut
Black walnut trees produce a toxin that reduces growth in other plants nearby. This gives the black walnut more space to grow.

Black walnuts release a toxin called juglone into the soil, which affects many, but not all, other species of trees. Plants that are sensitive to juglone might wilt, turn yellow, grow more slowly, or even die. This toxin is a way for the black walnut tree to reduce competition in the immediate area for resources like space, sunlight, nutrients, and water.

Hazelnut
Hazelnut trees produce seeds that are eaten by animals, like squirrels, chipmunks, and many species of birds.

Students can compare this method of seed dispersal to wind dispersal (described above for the silver maple). Rather than having their seeds blown away by the wind, trees like hazelnut produce seeds that are attractive to animals. After the seed passes through the animal's digestive tract, it is deposited wherever they leave their waste. This allows the new tree to grow far away from its parent.

Dogwood
Dogwood is highly tolerant of shade, so it can grow in the understory--beneath the taller, canopy trees.

Students should look up to the top of the dogwood tree. Is it the tallest tree they can see? Probably not! This means it is growing in at least partial shade. Of course, these trees still need light to survive, but dogwoods are adapted to grow well in the shade of the understory. They are therefore called "shade tolerant." Students can compare this adaptation to the shade intolerant cottonwood tree they saw earlier.

What other adaptations do you think plants need to grow in Michigan?

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