Lessons to Grow By – Plant Parts

This month we are investigating important botany basics by studying plant parts. Take a look around your yard or a nearby green space and you will most likely notice a great diversity of plants. From tall trees with woody stems to the soft, creeping grass along the ground, plants can be found in a wide variety of colors, shapes, and sizes. Despite their differences in appearance, plants share a common set of parts. Learning about how the different parts function is essential to exploring plant growth and development. This foundational knowledge also contributes to our understanding of how to care for the plants in our gardens and environment.

Week 4: Sporangia, Cones, and Flowers

Learning Objectives:
This week kids will explore the different parts of plants whose purpose it is to help them make new plants through seeds and spores including:

- Sporangia: Plants like ferns and horsetail make new plants by producing spores in parts called sporangia.
- Cones: Found on plants like pine trees, cycads, and ginkgo trees, cones are structures that contain pollen and seeds.
- Flowers: Most of the plants in our world today make their seeds inside flowers, with the seeds surrounded by fruit at maturity.

Materials Needed for the Week

Activity 1: Sporangia – Fabulous Ferns

- Making New Plants Reading Page
- Fern leaves from outside or from the grocery store
- Hand lens (optional)

Activity 2: Cones - Pine Cone Exploration

- Pine cone samples
- Parts of a Pine Cone Worksheet
- Pine Cone Observation Worksheet
- 1 cup peanut butter or sunflower butter (optional)
- ½ cup songbird seed (optional)
- A mixing bowl (optional)
- Rubber spatula (optional)
- Cookie sheet (optional)
- Wax paper (optional)
- Thin ribbon or string (optional)

Activity 3: Flowers – Wind- vs. Animal-Pollinated Flowers

- Anatomy of a Flower Coloring Page
- A variety of flowers to observe (Try to include both animal- pollinated flowers (most colorful flowers) and wind-pollinated flowers (such as grasses))
- Flower Comparisons handout

Introduction

Just like animals, plants have evolved over time. One of the major changes in plants has been the development of different structures or plant parts they use to reproduce; that is, to produce offspring and create their next generation. The first land plants were spore-bearing plants. Relatives of present-day plants such as horsetails and ferns, they did not make true seeds but rather produced new plants via spores in structures known as sporangia (spore-ANN-gee-uh). Gymnosperms (JIM-no-sperms) were the next major group of plants to evolve. They produced true seeds in cone-like structures. After that came the angiosperms (ANN-gee-oh-sperms)— plants with “true flowers” that produce seeds within protected ovaries that developed into fruits. The ability to make seeds in flowers and be protected by fruit at maturity proved to be very advantageous for the plants' survival and distribution, so much so that now they're the most abundant type of plant on the Earth.

By studying various types of fossils, scientists have pieced together the following record of the appearance of terrestrial (land) plants:

Era	Period	Million Years Ago (mya)	Plant Life on Land
Precambrian		3800? to 543	
Paleozoic		543 to 248	The first land plants appeared, including mosses, horsetails (~400 mya), and ferns (~350 mya).
Mesozoic	Triassic	248 to 206	
	Jurassic	206 to 144	First seed-bearing plants emerged, including conifers such as bald cypress, ginkgos, and cycads (~200 mya)
	Cretaceous	144 to 65	True flowering plants appeared, including magnolias and palms (~140 mya)
Cenozoic		65 to present	

(Dates provided by the Geologic Time Scale from the Geological Society of America.)

Here is a brief overview of these three categories of plants along with the structures and processes they use to make new plants:

Spore-Bearing Plants

Spore-bearing plants do not have true seeds, but instead reproduce through spores in alternating generations. Ferns and horsetail are well-known plants in this category today.

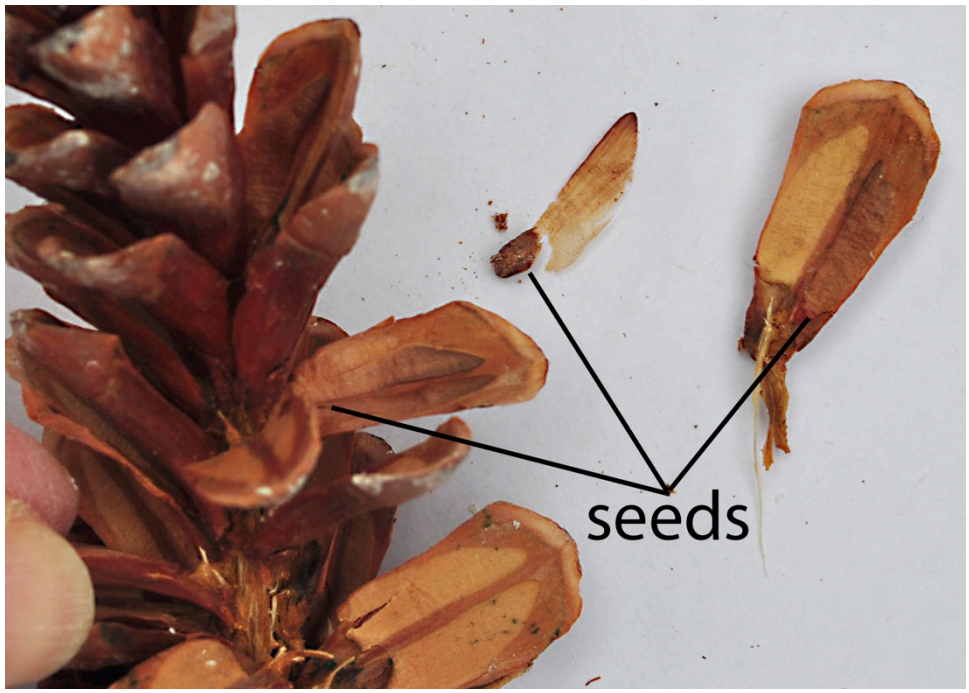
The life cycle of spore-bearing plants varies significantly from the cycles of other common garden plants. Their life cycles have two distinct generations. Using ferns as an example, the part of the cycle easily observed is the development of the green fronds or leaves. On the undersides of delicate fronds, microscopic, dust-like spores are encased in structures called sporangia. Clusters of sporangia called sori (SORE-ee) are the scale-like bumps one can see on the underside of the fronds. (Note that not all spore-bearing plants group their sporangia into sori.) When the sori turn brown (in natural settings, this is typically after midsummer), they are ripe and ready to release spores. If you use a hand lens to look

closely at sori, you may see some that are ragged looking; these have probably already opened and released their spores.

The fern spores fall to the ground and sprout when temperature and moisture conditions are right. But instead of producing fronds like they came from, spores develop into small, green, heart-shaped plants known as prothallia (pro-THALL-ee-uh). In this generation, reproductive organs form on the prothallia to produce features similar to the pollen and ovaries in seed-bearing plants, which combine with the help of moisture to form new spores. It's easy to miss this part cycle because prothallia are tiny and lie close to the ground. When these new spores are released, they grow into the familiar frond-bearing fern plant.

For more information check out KidsGardening articles Growing Baby Ferns at: https://kidsgardening.org/garden-activities-growing-baby-ferns/and Prehistoric Plants at: https://kidsgardening.org/lesson-plan-prehistoric-plants/.

Cone-Bearing Plants: Gymnosperms



Gymnosperms produce true seeds in cone-like structures. Gymnosperms actually have two different kinds of cones. One type of cone produces pollen. These cones are usually smaller and not as showy. They may not be on the plant for long periods of time and they release their pollen, usually in mass quantities, coating surfaces in a blanket of yellow. The tiny pollen grains travel on the breeze and are caught by the second kind of cone, the seed-making cone. This seed-making cones may stay on the tree for up to 10 years, with a wide variation in the amount of time it takes for seeds to develop. On pine trees, a common gymnosperm found in landscapes across the country, the seed-producing cones are the ones that have the traditional appearance we associate with pine cones.

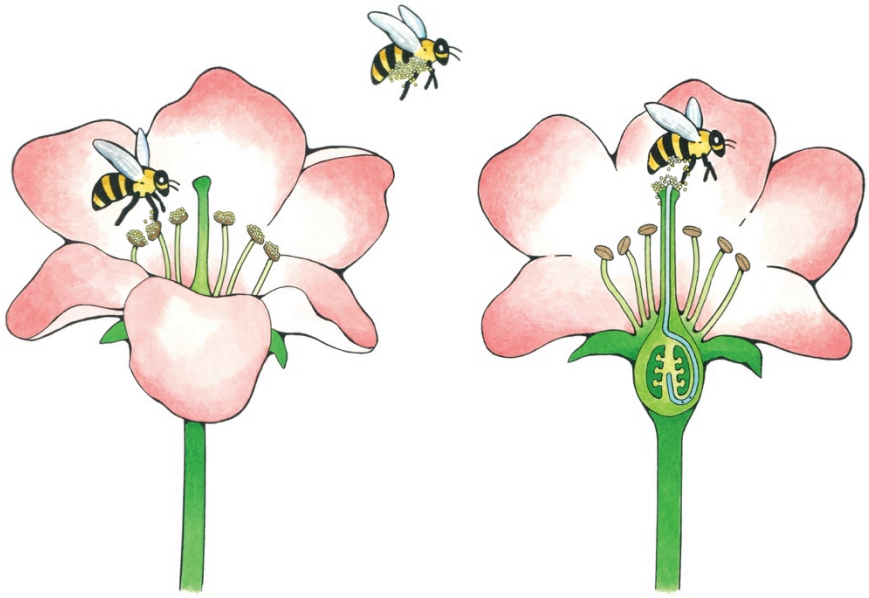
The word gymnosperm means “naked seed,” pointing out the fact that the seeds aren't covered with an ovary (fruit at maturity). Instead, the seeds are found at the base of the scales on the cone. Although they are not surrounded by fruit, the scales do provide some protection for the seeds, and the scales have the ability to open and close depending on environmental conditions. The scales prevent the seeds from dropping from the trees until they are mature and conditions are right for germination.

Plants that produce cones are commonly called conifers. Pine trees are types of conifers, and they are some of the more common gymnosperms found in our landscapes. Most conifers are evergreens with scaly and/or needle-like leaves. Some species are rugged enough to thrive in harsh environments, like on the top of mountains.

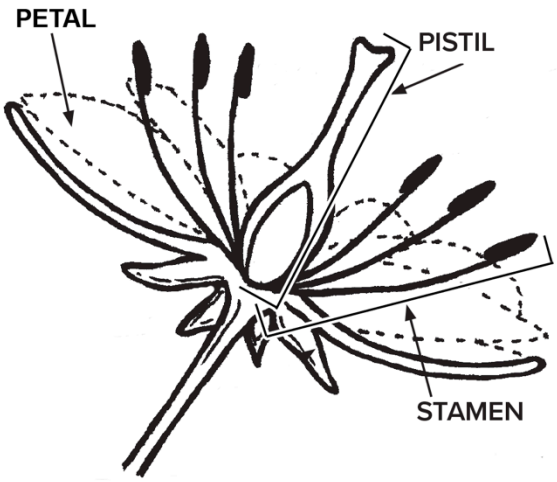
However not all gymnosperms are evergreen. Bald cypress and dawn redwood are deciduous conifers; they drop their needle-like leaves every fall. Gingkos are also gymnosperms; however, they have flat, fan-shaped leaves, are deciduous, and produce small pollen cones. Cycads are gymnosperms native to tropical and subtropic regions; they are evergreen with palm-like leaves and central cones.

Flowering Plants: Angiosperms

Angiosperms are flowering plants. Angiosperms produce seeds in ovaries found inside of flowers. The ovaries develop into fruit as the seeds mature. This advanced packaging can serve as protection for the seeds and also aids in distribution of the seeds. Both of these features are enhancements beneficial to overall survival of the species.



Although flowers come in lots of different shapes, sizes and colors, they all have similar parts. Flowers make pollen in parts called stamens. To create a seed, the pollen must be transported and joined with egg cells that are located in parts called pistils. The pollen is transported by animals (including insects and birds) or wind, depending on the type of plant. This process is called pollination. In depth materials about pollination and pollinators are available in Lessons to Grow By: Pollinators.



Let's look more in depth at the parts of the flower and the pollination process because it's the most common way for plants to reproduce. The pistil is made up of multiple parts: a platform called the stigma and the thin stalk that holds it up, called the style. The stigma is often sticky so it can trap pollen. At the base of the style is the ovary, which may or may not be visible. Inside the ovary are the ovules, which contain the eggs.

Pollination occurs when the pollen transfers from the stamen to the pistil. Once there, it will grow a tiny pollen tube down

the style into the ovary, where the eggs are located. Fertilization occurs when the sperm cell inside the pollen tube joins with an egg cell. Fertilized eggs grow into tiny embryos, which then develop into seeds. You can vary the amount of detail you share about this process with your child or students depending on their age.

Other important flower parts are the petals and sepals. In addition to surrounding and protecting the seed-making parts, some plants' flower petals act as beacons. Flowers that need pollinators to help them transport pollen are often brightly colored or patterned to attract the pollinators (usually birds, bees, and other insects). Some petals are arranged so that the flowers are broad and flat to provide good “landing pads.” Wind-pollinated flowers, such as those of corn and oak trees, on the other hand, usually have inconspicuous petals, if any. Sepals are green leafy structures surrounding the petals, which initially protected the developing bud.

Although angiosperms were last on the scene in terms of evolution, it is estimated that 80% of the plants on Earth today are flowering plants.

Activity 1: Fabulous Ferns

Ferns were once the primary vegetation covering the Earth! The ancient species were probably similar to tree ferns, now found only in some tropical regions. These dominant plants of the dinosaur era decomposed to become a major component of coal deposits, an important energy source for us today.

The ability of ferns to adapt and evolve has resulted in more than 12,000 known living species growing in climates from the tundra to the tropics. Some of the earliest species include the maidenhair ferns (*Adiantum* species), lady ferns (*Athyrium* species), and autumn fern (*Dryopteris erythrosora*). Fern leaves, called fronds, grow from rhizomes (underground stem structures that grow just below the soil surface). Ferns range in size and shape from low, mounding ground covers to the tree ferns mentioned above. Most ferns grow in woodlands and are well adapted to shady beds, and some thrive in indoor plantings.

1. Together or independently, read the Making New Plants reading page. Have your kids complete the reading comprehension questions and then discuss your answers together.

2. Use the background information found in the introduction to share how plants like ferns develop spores in sporangia to make new plants. Next, go on a hunt for fern sporangia/sori.

Fern spores are located on sporangia and the sporangia are clustered into sori that look like round bumps on the undersides of fern fronds. Sporangia/sori are most likely to appear on outdoor ferns from spring through summer (houseplant ferns may develop them at different times). Mature spores are dark colored, look firm and slightly fuzzy, and rub off easily onto your fingers.

If you don't access to an area with outdoor ferns or it is the wrong time of the year to find spores in your area, you can also very often find sori on leatherleaf ferns available at local florist and grocery stores. Leatherleaf fern is the most commonly used greenery in flower arrangements. The leaves may have sori in different stages of development. If you find leatherleaf fern leaves where the sori are present but not yet mature, place the stems in water and keep them in a warm location, and they may continue to mature for you.

3. Once you find sporangia/sori, allow kids to observe. What do they look like? What do they feel like? Were they hard to find? Are the ones you found mature? Can you see spores? If spores are present, talk about how they are different than seeds. Look at them through a hand lens if possible.

Extend the Activity: There are two ways to extend this activity. If you are able to collect fern spores, you can actually try to plant them to grow new ferns. Find full instructions at Growing Baby Ferns at: https://kidsgardening.org/garden-activities-growing-baby-ferns/.

If growing ferns from spores sounds too complicated, you can also explore ferns by collecting leaves from different types of ferns and pressing them to make your own herbarium sheets. Attach a pressed leaf to a sheet and make notes about the plant's characteristics such color, habitat, size, shape, and so on. Kids can also use pressed ferns to create artwork such as note cards, bookmarks, and hanging ornaments. And since ferns are plants that date from the Mesozoic Era, they may want to include dinosaurs in their art, too! For instructions on pressing plant leaves, check out Pressed Flowers and Leaves at https://kidsgardening.org/garden-activities-pressed-flowers-and-leaves/.

Activity 2: Pine Cone Exploration

1. A common decoration, pine cones are an easily recognized plant feature. However, most kids probably do not know that the pine cone is the structure pine trees use for making new seeds. Collect pine cones from the ground of your yard or natural area for kids to observe. Please note that in addition to being a home for seeds, they may also be a home for insects, so you may want to place them in a sealed plastic bag in your freezer for a few days before bringing them in. (Or conduct your explorations outside.)

2. Use the **Parts of Pine Cones Worksheet** as you inspect your collected pine cones. Are your cones pollen-producing cones or seed-making cones? Did you find different sizes and shapes of pine cones? How are they the same? How are they different? You can use the **Pine Cone Observation Worksheet** as a guide.

Be careful when handling the cones and scales. Many of the scales have sharp edges or end points. Ask kids why they think that would be a beneficial trait. *It is a way to help protect the seeds from hungry animals.* Carefully remove a few scales to see what you find underneath. *Possibly seeds.* Please note you may not find seeds inside of the pine cones that are collected from the ground since they might have released their seeds before being detached from the branch and/or have been eaten by animals.

3. As a last step, use your pine cones to help you identify what kind of pine tree they came from. You can use a printed tree ID guide or one of the many online identification tools available. Having examples of the needle bundles may also be useful for your search (the length of the needles and the number of needles in each bundle is an important ID tool also). The American Conifer Society offers an extensive online resource about pine trees at: https://conifersociety.org/conifers/pinus/.

Extend the Activity: Want to have some fun with your leftover pine cones? Make seed-encrusted pine cone ornaments to hang in your yard for the birds.

Materials Needed:

- Dried pine cones
- 1 cup peanut butter or sunflower butter
- ½ cup songbird seed (plus additional seed for sprinkling)
- Mixing bowl
- Rubber spatula
- Cookie sheet
- Wax paper
- Thin ribbon or string

Instructions:

- Attach a 10” length of ribbon to the top of the pine cone.
- In a mixing bowl add the peanut butter or sunflower butter and songbird seed, and then mix with the rubber spatula until combined.
- Place the cones on the wax paper-lined cookie sheet, and use the spatula to liberally cover them with the seeds.
- Once the cones are covered, add an additional sprinkling of seeds to their surfaces.
- Freeze the ornaments until firm and ready to hang. Store them in a cool place before hanging.

Activity 3: Wind- vs. Animal-Pollinated Flowers

1. Use the Anatomy of a Flower Coloring Page to introduce kids to the different parts of the flower. Explain that some flowers have all of these parts in one flower, but others may only have a pistil or a stamen. Note that although they have the same function, the parts may look very different on different flowers.

2. Use the background information in the Introduction to explain that in order to make seeds, the pollen that is produced in the stamen must be moved from the stamen to the pistil. There are a couple of ways this can happen. It can be moved by wind or water (usually wind). Or it can be moved with the help of pollinators, which include insects, birds, and other animals. Share the following characteristics of wind- versus animal-pollinated flowers:

Wind Pollinated Flowers	Animal-Pollinated Flowers
Small, numerous flowers	Flower size ranges from small (and if small they are usually found in clusters) to quite large
Petals are usually small and/or not present	Most have showy petals in a variety of colors
Stamen and pistils easy to access	Stamen and pistils often surrounded by petals
Usually no scent	May give off a scent – some pleasant, some not pleasant
Pistil(s) may not have nectar	Flowers have nectar
Abundant small, dust-like pollen grains	Pollen grains larger/thicker and sometimes sticky

3. Observe a variety of flowers in your garden or local green space or collect a sampling of wind-pollinated and animal-pollinated flowers for your kids to observe indoors. Use the Flower Comparison Worksheet to note the characteristics of each flower and make a hypothesis about whether they are pollinated by wind or by animals. Conduct research to discover if your predictions are correct.

Extend the Activity: Additional flower-related activities can be found in Week 1 of the Pollinator Lessons to Grow By module including instructions for dissecting a flower and making your own flower.

Digging Deeper

You can use the following resources to dig deeper into this week's lessons:

Books and Additional Resources

The Reason for a Flower by Ruth Heller

The Little Pine Cone by Ella Syfers Schenck and Chris Bauman

Fun Facts about Pine Cones from Michigan State University Extension:
https://www.canr.msu.edu/news/fun_facts_about_pine_cones

American Conifer Society's Conifer Database:
https://conifersociety.org/

Videos

National Geographic Time-Lapse: Watch Flowers Bloom Before Your Eyes:
https://www.youtube.com/watch?v=LjCzPp-MK48

Identifying Parts of a Flower from the Art Lady Channel:
https://www.youtube.com/watch?v=ZQAnJ8lCFc8

Daffodil Flower Dissection: https://www.youtube.com/watch?v=MSAVKlyZh6o

What is a Pine cone? https://www.youtube.com/watch?v=fxrMDZV0HWQ

Additional Related KidsGardening Lessons and Activities to Try

Prehistoric Plants: https://kidsgardening.org/lesson-plan-prehistoric-plants/

Growing Baby Ferns at: https://kidsgardening.org/garden-activities-growing-baby-ferns/

Pressed Flowers and Leaves: https://kidsgardening.org/garden-activities-pressed-flowers-and-leaves/

Leaf and Flower Prints: https://kidsgardening.org/garden-activities-leaf-and-flower-prints/

Petal Attraction: https://kidsgardening.org/lesson-plans-petal-attraction/

The Pollinator Patch: https://kidsgardening.org/garden-activities-pollinator-patch/

Lesson to Grow By: Pollinators https://kidsgardening.org/lessons-to-grow-by-pollinators/

Making New Plants

Plant Parts Week 4 reading page

All living things have ways to make more of themselves. Birds lay eggs, mammals have babies, and most plants make seeds.

Our green plant friends come in many different sizes, shapes, and colors so it should not surprise you that they also have many different ways to make new plants, too. Here are three ways living plants make new plants:

1. Plants make seeds inside of flowers.

A majority of plants in our world make flowers. Although we enjoy flowers because they are colorful and sometimes smell good too, the reason plants have flowers is to make fruit and seeds. Many of these fruits become tasty treats for us like apples, oranges, and avocados. However, it is the seeds that are prizes for the plant — the fruits are just packages to protect them. Inside those little seeds are tiny new plants.

2. Plants make seeds inside of cones.

Have you ever seen a flower on a pine tree? Not all plants make flowers and fruits. There are some plants that make their seeds inside cones instead. The cones are usually made up of scales that help protect the seeds growing in the middle. Pine trees and other conifers that stay green all year round are the most common cone-making plants, but there are a few others too.

3. Some plants make spores instead of seeds.

There is a third type of plant that does not even make true seeds; they make new plants by making spores. Spores are tiny and really hard to see. Spores are made in plant parts called sporangia (spore-ANN-gee-uh). Ferns are common plants that make new plants using spores.

What do all these plants have in common? All three have roots, stems, and leaves, too. Also in common, they all make their own food through the process of photosynthesis. However, they get the chance to

be unique when it comes to how they make seeds and spores. Flowers, cones, and sporangia are all very important plant parts because they make sure we will always have new plants in our world.

Reading Comprehension Questions

1. True or false: All plants make seeds.

2. Select the plant parts that make seeds:

- ☐ Cones
- ☐ Leaves
- ☐ Flowers
- ☐ Roots
- ☐ Stems
- ☐ Sporangia

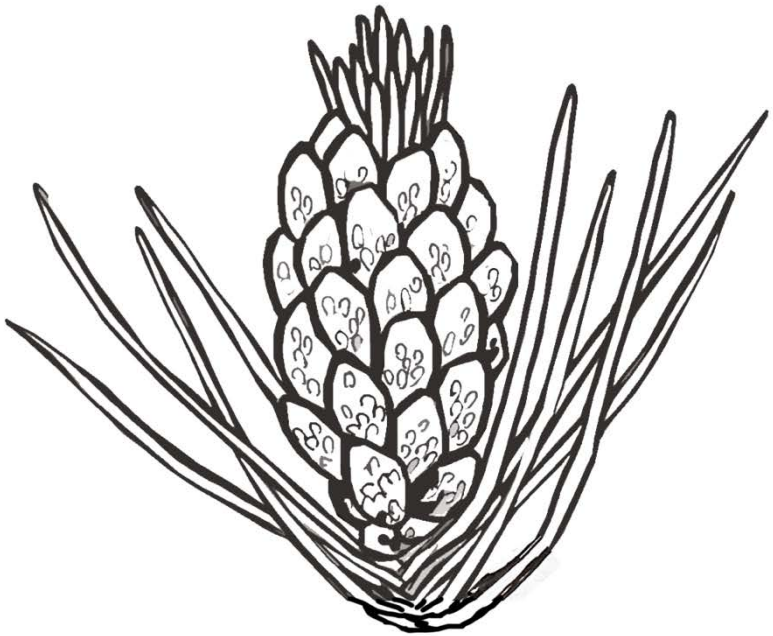
3. What do fern plants make that helps them make new plants:

- ☐ Fruit
- ☐ Seeds
- ☐ Flowers
- ☐ Spores
- ☐ None of the above

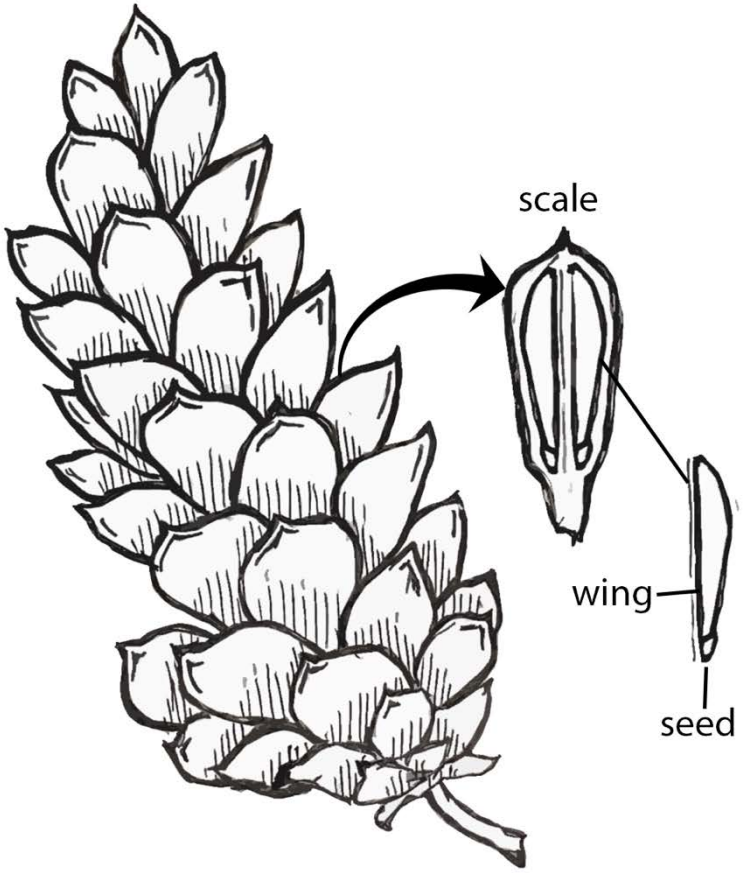
4. Why do plants make seeds?

5. What do flowers make to help protect seeds? Give an example.

Parts of Pine Cone Worksheet



Pollen-producing pine cone

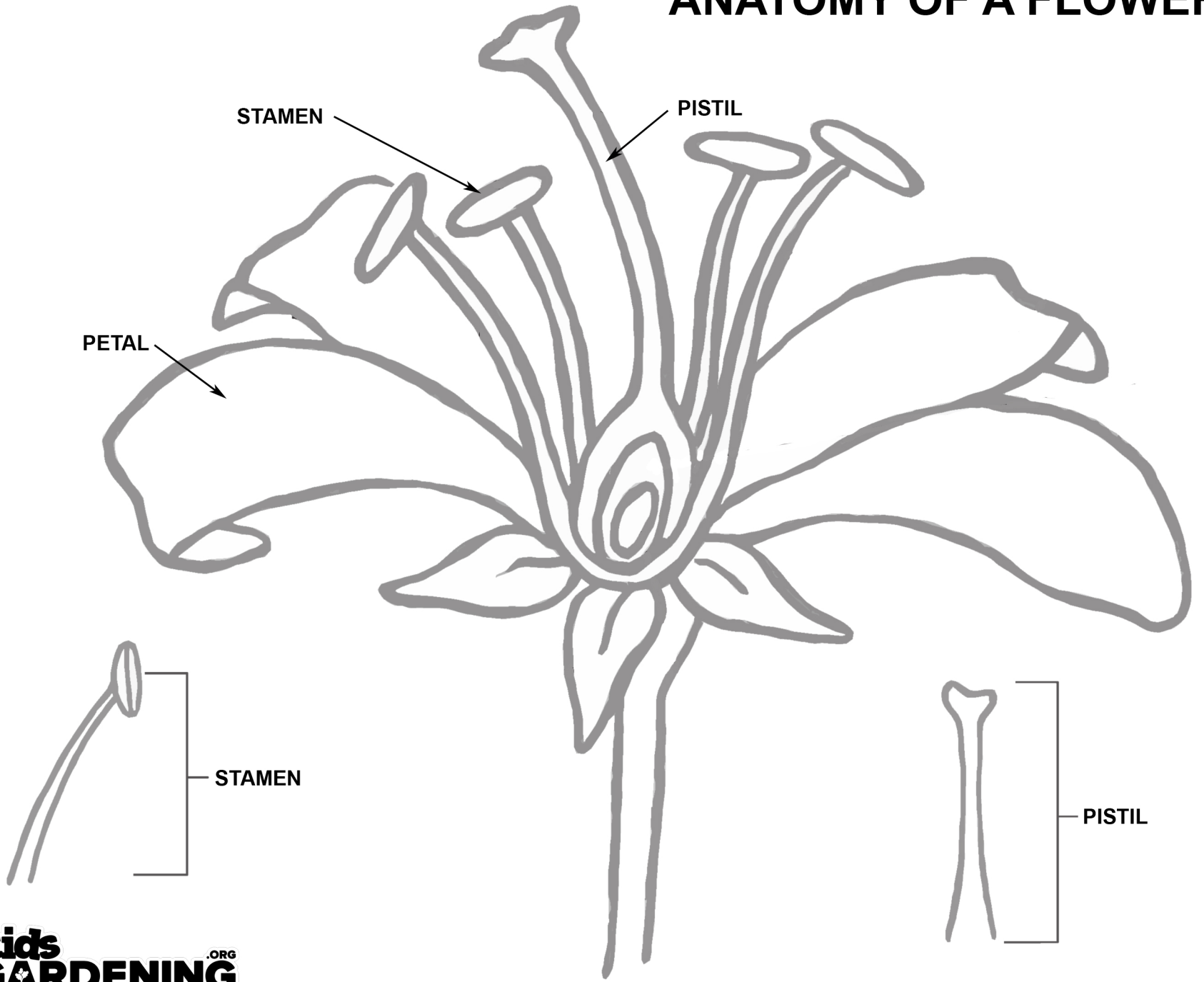


Seed-producing pine cone

Pine Cone Observation Worksheet

Sketch of pine cone	Sketch of one scale of your pine cone	How tall is your pine cone?	Is this a pollen-producing cone or a seed-making cone?	Describe your pine cone. What does it feel like? What color is it? Did you find any seeds or insects inside?	Do you know what kind of pine tree this cone came from?

ANATOMY OF A FLOWER



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Flower Comparison Worksheet

Sketch your flower or attach a sample if possible.	What do the petals look like? Are they showy? Describe below.	Can you find a pistil or pistils in your flower? How many? What size? Describe.	Can you find an anther or anthers in your flower? How many? What size? Describe below.	Does your flower have a scent? Can you find nectar? Any other traits that might attract a pollinator?	Do you think this flower is pollinated by wind or with the help of a pollinator?	Were you right?