# Table Rocks Curriculum

## Pollination Partners

**Objective:** In order to explore the relationships between flowers and their ***pollinators***, students will dissect flowers, construct flower models, and match each flower model with its correct ***pollinator***. This activity emphasizes flowers and ***pollinators*** native to the Table Rocks.

### Benchmarks Targeted: 2 (Grades 4-5)
### Oregon Standards Achieved:

**Subject Area:** Life Science

**Common Curriculum Goals:** Diversity/ Interdependence: Understand the relationships among living things and between living things and their environments.

**Benchmark 2:** Describe the relationship between characteristics of specific habitats and the organisms that live there. Describe how adaptations help a species survive.

**Common Curriculum Goals:** Organisms: Understand the characteristics, structure, and functions of an organism.

**Benchmark 2:** Group and classify organisms based on a variety of characteristics.

**Benchmark 2:** Describe the basic plant and animal structures and their functions

**Subject Area:** The Arts

**Common Curriculum Goals:** Create, Present, and Perform: Apply artistic elements and technical skills to create, present, and/or perform works of art for a variety of audiences and purposes.

**Benchmark 2:** Create, present and/or perform a work of art using experiences, imagination, observations, artistic elements, and technical skills to achieve desired effect.

## Length of Lesson: 3 to 5 hrs.

## Materials:

- ✓ Clipped specimens of a variety of flowers for the class to dissect
- ✓ Small scissors and tweezers for dissection
- ✓ Magnifying glasses or hand lenses
- ✓ Photographs or drawings of common flowers of the Table Rocks
- ✓ Wildflower field guides that include local species
- ✓ "Flower Description" cards (1 card per group of 2-3; eight provided with lesson)
- ✓ "Parts of a Flower" diagram (included at the end of the Botany chapter)
- ✓ "Pollinator Profile" cards (1 card per group of 2-3; eight provided with lesson)
- ✓ "Pollination Partners" answer key for teacher use (provided at end of lesson)
- ✓ Materials for constructing flowers: construction paper, pipe cleaners, play dough, cotton balls, and other art materials

## Key Vocabulary: *anther, bilateral, corolla, filament, nectar, ovary , ovule, petal, pistil, pollen, pollination, pollinator, radial, seed, sepal, stamen, stigma, style, tubular*

## Background:

***Pollination*** occurs when a flower receives pollen from another flower of the same species and fertilization occurs. ***Pollination*** is essential for our survival. Most of the foods we eat would not be possible without ***pollinators***! Natural fibers, fruits, vegetables, forest products (wood, rubber, vanilla), and flowers all rely on ***pollinators*** for their reproduction and survival.

To further explain the relationship between a plant and its ***pollinator***, you may wish to introduce the concepts of coevolution and mutualism. Coevolution happens when two organisms evolve in tight ecological interaction with each other and adapt to the changes in each other. These types of relationships occupy very specific niches in nature. For example, the Andrenid bee is the only ***pollinator*** of death camas and is immune to the poisonous nectar. Mutualism, on the other hand, is a relationship between two species where both benefit from the association. In mutualistic relationships between flowers and their ***pollinator*s**, flowers benefit by having their ***pollen*** efficiently distributed to other flowers of the same species, allowing them to reproduce. ***Pollinator*s** benefit by feeding on the nutritious ***pollen*** and ***nectar*** that flowers provide. Though they depend on and benefit from each other, flowers and their ***pollinator*s** are each pursuing their own goals, which are often opposed. For example, bees attempt to bring as much ***pollen*** as possible back to their hive for food, while flowers must ensure that some of the ***pollen*** on the bee's body is transferred to another flower. Some flowers have evolved elaborate mechanisms to dust a visiting bee with ***pollen*** on its back, where it cannot reach to clean itself with its legs.

The more exclusive the relationship between a plant species and its ***pollinator***, the better for the plant; If a ***pollinator*** visits only one species of flower, that flower is assured that its ***pollen*** will find its way to another of its kind. Many flowers have evolved to be highly attractive to one type of ***pollinator***, while excluding other animals from their ***pollen*** and ***nectar***. An exclusive relationship may benefit the ***pollinator*** as well, because it does not have to compete with other animals for ***pollen*** or ***nectar*** that its flower partner offers.

The following section outlines the typical characteristics of flowers dependent on various types of ***pollinator*s**. Emphasize to students how each of these characteristics favors a specific ***pollinator*** while excluding other potential ***nectar***/***pollen***-feeders.

- **Bird-Pollinated Flowers –**
  Birds are particularly drawn to red and orange flowers, as these colors appear to them very vividly. Bird-pollinated flowers often exhibit sharply contrasting colors (such as red and yellow, red and green, red and black, red and white, or blue and yellow); leading scientists to believe that in some cases the contrast may be as important an attractant as the colors themselves. Because most birds have a very weak sense of smell, bird-pollinated flowers are typically odorless. Anna's and Rufus hummingbirds are frequent ***pollinators*** spotted on the Table Rocks.

- **Bee-Pollinated Flowers –**
  Bees cannot see red. Therefore, flowers that depend on bees as ***pollinator*s** are usually yellow, purple, or blue. Additionally, bee pollinated flowers often have special patterns of UV reflectance that appear vividly to bees. Humans are unable to detect these patterns. In ***bilateral*** flowers with an upper and lower lip (e.g., monkey flower, blue-eyed mary, and Cascade downingia), the lower lip may function as a landing platform to support bee ***pollinators***. In some flowers, the ***stamen*s** (***pollen***-producing structures) are enclosed by the two lips, and bees are the only insects hefty enough to pry open the lips and access the ***pollen***.

- **Fly-Pollinated Flowers –**
  Most flies lack specialized sucking mouthparts and are restricted to feeding from shallow flowers where ***nectar*** is easy to reach. However, bee flies and hover flies have long mouthparts adapted for feeding from ***tubular*** flowers. Many fly-pollinated flowers (including the largest flower in the world, *Rafflesia arnoldii*, which grows in Indonesian rainforests and can be a meter across!) mimic the scent of feces or rotting flesh. Such flowers tend to be dull brown, purple, yellow, or spotted in color. Their scent attracts flies in search of rotting material to lay their eggs in.

- **Butterfly- and Moth-Pollinated Flowers –**
  In many butterfly-pollinated flowers, the ***petal***s (collectively known as the ***corolla***) are fused together to form a tube and the nectar-producing glands are hidden deep within the flower. Other butterfly-pollinated flowers have long, backward-pointing spurs and nectar is produced in the tips of these spurs. In either arrangement, the nectar is well-hidden from most would-be nectar-feeders, but is accessible to butterflies via their long tongue, which functions like a drinking straw. In fact, there appears to be a tight correlation between the depth of a flower's ***corolla*** tube or spurs and the length of the tongue of the butterflies which visit it. Many butterflies have a tongue nearly as long as their body! Butterfly-pollinated flowers often spread out at the lip to give the butterflies a convenient perch.
  Moths have long tongues just like butterflies (in fact, some tropical moths have tongues as long as 25 cm!). Moth-pollinated flowers tend to be similar in shape to those pollinated by butterflies. However, moths are nocturnal, and the flowers they pollinate usually open at night, are pale-colored, are visible in dim light, and often produce strong fragrances appealing to moths' keen sense of smell.

- **Beetle-Pollinated Flowers –**
  Beetle-***pollination*** is considered one of the most primitive, unspecialized forms of animal ***pollination***. Beetles lack specialized mouthparts to probe deep into flowers and they typically visit shallow flowers where the ***pollen*** (and, if present, ***nectar***) are easy to reach. Beetles rely more on their sense of smell rather than sight and their favorite flowers usually have a sweet scent but are not necessarily brightly colored. Several types of beetles can be found visiting many of the wildflowers at the Table Rocks.

- **Bat-Pollinated Flowers –**
  Bat-pollinated flowers (which occur, for example, in the cactus family) usually open only at night, when bats are most active. These flowers tend to be dull or pale in color and

have strong fragrances. They are typically large and sturdy to support the weight of a clinging bat. No bat-pollinated flowers occur here in our region but are common in the tropics and desert regions.

- **Wind Pollinated Plants**
  Wind pollination happens when pollen is blown from one plant to another. The pollen is often light, smooth, and produced in great quantities to increase the chance of pollination. Plants relying on wind for pollination often have long stamens and pistils in order to catch the floating pollen. They often lack petals and colorful flowers because they don't need to provide support for or attract pollinators. Examples of wind pollinated plants on the Table Rocks are ponderosa pine, Douglas fir, white oak, black oak, and numerous grass species.

- **Water Pollinated Plants**
  This type of pollination is not as common as the others listed above. It occupies a much smaller niche in nature. Water pollination occurs when pollen floats on the surface of a stream, pond, or vernal pool from one flower to another. An example of a plant found on the Table Rocks that has this type of pollination is the Water Starwort.

- **Human Pollinated Plants**
  Humans play a large role as **pollinators** of agricultural and horticultural plants. Humans also may brush up against wild plants causing pollen to become air born or carry **pollen** on clothing from one place to another.

## Procedure:

**Preparation:**
Use the "Parts of a Flower" diagram to familiarize students with the basic parts of a flower. Bring in several flowers of different shapes and colors (or pictures if you can't get actual samples). Ask students to vote for their favorite flower. When the votes are in, explain that not everyone voted for the same flower, as different people have different preferences. Insects and other plant visitors also have different flower preferences based on shape, color, scent, or size.

Use leading questions such as; "Why do plants make flowers? Where do ***seeds*** come from? Why do flowers usually have bright colors or sweet scents?" to bring students to the understanding that the purpose of a flower in the life of a plant is reproduction. In order for this to happen, a flower must receive ***pollen*** from another flower of the same species. The ***pollen*** from the ***anther*****s** of one flower is transferred to the ***pistil*** of another flower, where the ***pollen*** grains release sperm cells. These sperm cells then travel into the ***ovary*** where they fertilize the ***ovule*****s** to produce fertile ***seeds***. These ***seeds*** are then dispersed and grow into new plants. Use the "Parts of a Flower" diagram and actual flowers (or photos) to show students different flower parts and explain their functions. Introduce the class to the idea that different flowers are pollinated in different ways. Explain that flowers have evolved specialized ***nectar***-producing glands, shapes, colors, scents, and other characteristics to attract ***pollinator*****s** such as bees, butterflies, birds, or bats. The class will then be ready to 1) dissect a variety of flowers, locating the various organs within each, and 2) construct their own 3-D flower models that are each adapted to attract a different ***pollinator***.

**Activity**:
1) Distribute scissors, tweezers, hand lenses, and a copy of the "Parts of a Flower" diagram to each student. Have each student dissect at least two flower specimens that you have provided. Ideally, one of the flowers that they dissect should be the flower that they will be constructing a model of (see #2 below). Instruct them to identify the ***stamen*s** (including ***anther*s** and ***filament*s**), ***pistil*(s)** (including ***ovary***, ***style***, and ***stigma***), ***petal*s**, and ***sepal*s**, and to slice through the ***ovary*** to see the ***ovule*(s)** inside.

2) Divide the students into groups of 2-3 and give each group one "Flower Description" card and one plant book or field guide. Referencing the "Flower Description" card, their field guide, and the specimen that they have just dissected, students will use the materials provided to make an accurate, three-dimensional model of the flower described on their card. Instruct students that the flower should have all the basic flower parts unless the description states otherwise. Have them attach their "Flower Description" card to their final creation. Place the finished 3-D flowers in a central location in the classroom. Provide time for all the students to observe the flowers created by all groups.

3) Pass out a "***Pollinator*** Profile" card to each group. Explain that each group will now play the role of the ***pollinator*** described on their card. Have the students read over their card carefully. Instruct them to look for specific clues that will lead them to a particular flower. Helpful clues may include shape, size, or smell of the flower. Review the flower descriptions and ask the ***pollinator*s** to choose a flower that best suits their needs. When you say "pollinate," the ***pollinator*s** in each group can flap, buzz, or crawl to the flower that is best adapted for them to pollinate. Have them stand by their flower of choice while you review the ***pollinator***/flower pairings using the answer key included with this lesson. If students have selected a flower that they are not well-adapted to pollinate, have them figure out why and then move to a more appropriate flower.

## Extensions:

- Ask the students to study a flower in your schoolyard or nearby park over time and see what types of ***pollinator*s** visit it. Have them collect data to share with the class. Use student observations as a basis for comparing and contrasting visitation rates of different ***pollinator*s** to different flowers.

- Show students pictures of flowers that they haven't seen before and challenge them to guess which ***pollinator*s** might visit them (of course, most plants have more than one ***pollinator***). Alternatively, challenge students to create insects with adaptations suited to pollinate each of these new flowers.

- Do a lesson on the butterfly life cycle, emphasizing that a given species of butterfly may require very different food plants in the adult stage vs. in the larval stage. Many people hope to attract butterflies by planting ***nectar***-producing flowers in their garden, but often they overlook the inclusion of host plants for the caterpillar stage. The caterpillars of many butterfly species require very specific host plants. For example, desert parsley or biscuit root is the host plant for the Indra swallowtail butterfly, while buckbrush and mountain mahogany are host plants for tent caterpillars, which become Ceanothus silk

moths. Likewise, monarch butterfly larvae feed only on milkweed, incorporating toxins from that host plant into their bodies to make them poisonous to predators.

- Have students research the current threats to ***pollinators*** and the effects it may have on our everyday lives. Challenge students to come up with as many things they could do to slow this process or prevent it. A great resource for info is the website <http://www.fws.gov/pollinators/PollinatorPages/Threats.html>.

- Create a pollination garden on your school grounds. Plant native flowers and keep a record of visiting pollinators. A great website for native plant specimens is <http://www.plantoregon.com/>.

## Discussion Questions:

**Name three parts of a flower and describe the purpose of each.**
*Using the "Parts of a Flower" diagram and this lesson's vocabulary list, have students review the essential parts of a flower and their functions. You can test their understanding by asking them to identify the parts on the flower models they created.*

**Name at least 5 *pollinator*s.**
*Wind, water, birds, bees, butterflies, other insects, spiders, and humans can all act as* ***pollinators****.*

**What *pollinators* could/did we see on our Table Rocks hike?**
*Answer will be based on students' experiences. The possibilities include any listed in the previous question.*

**How do humans act as *pollinators*?**
*Humans have a huge role as* ***pollinator****s of agricultural and horticultural plants. Humans also may brush up against wild plants and carry* ***pollen*** *on clothing.*

**Explain how the *pollinator* and its preferred flower each benefit from their relationship.**
*Animals that visit flowers do so for their own needs. They typically visit a flower to collect a meal of* ***pollen*** *or* ***nectar****. While feeding, they are dusted with* ***pollen****, which they may transfer to the next flower they visit. Thus, the plant benefits by having its* ***pollen*** *transferred from one flower to another, so that the* ***ovules*** *will be fertilized and* ***seeds*** *can develop. Some plant species have evolved exclusive relationships with one particular type of* ***pollinator****, thereby maximizing* ***pollination*** *efficiency.*

**What would happen if a *pollinator* that is specific to one plant was eliminated?**
*The plant population would crash due to reduced reproduction. However, it might open the opportunity for a new* ***pollinator*** *species to begin pollinating that plant.*

## References:

Butler, Eva. "Life in Our Watershed: Investigating Vernal Pools." Mather Field Vernal Pools. Ed. Carol Witham. 2005. Splash: Protecting Water and Habitat Through Education. 8 August 2006 <http://www.sacsplash.org/mather.htm.>

"Celebrating Wildflower." USDA Forest Service. 25 February 2007. USA.gov. 20 February 2008 <http://www.fs.fed.us/wildflowers/pollinators/wind.shtml>.

Mitchell, Robert T. and Herbert S. Zim. Butterflies and Moths. New York: St. Martin's Press, 1990.

Neill, William. The Guide to Butterflies of Oregon and Washington. Englewood, CO: WestCliff Publishers, 2001.

Parella, Deborah. Project Seasons. Shelbourne, VT: Shelbourne Farms, 1995.

Pollinator Conservation Digital Library. David Siedband. 29 March 2007. North American Pollinator Protection Campaign.19 February 2008 <http://www.libraryportals.com/PCDL. >.

The Pollinator Partnership. The North American Pollinator Portection Campaign and The Coevolution Institute. 19 February 2008 <http://www.pollinator.org/index.html>.

Proctor, John and Susan Proctor. Color in Plants and Flowers. New York, NY: Everest House Publishers, 1978.

Thorp, Robbin. "Vernal Pool Plants and their Special Pollinators." California Vernal Pools: A Collection of Information and Resources. 7 January 2008. VernalPools.org. 19 February 2008 <http://www.vernalpools.org/species.html>.

**Flower Description Cards**

**Red Bells**: I have bell-shaped flowers with 3 ***petal***s and 3 ***sepals*** that look like petals that curve back at the tips. My flowers are scarlet red with yellow speckles and a yellow interior. They hang upside down or point sideways. My nectar-producing glands are deep within my flower, one at the base of each ***petal***.

**Blue-eyed Mary**: I have vividly colored flowers that look like a pair of lips. The upper lip has two rounded ***petals***, and is colored white. The lower lip has 3 rounded ***petals***, and is colored white in the middle and blue around the edges.

**Death Camas:** I have a cone-shaped cluster of small white flowers at the top of a thin stem. Each flower has 6 white ***petal***s, 6 ***stamen***s, and one ***pistil*** with three ***style***s. I am extremely poisonous! Even my ***nectar*** is poisonous, and there is only one ***pollinator*** that can drink it!

**White Oak:** I am a tree. My fruits are called acorns. My male flowers hang in long clusters called catkins, which dangle in the breeze. My female flowers are separate from my male flowers and are found in my upper branches. Both types of flowers are tiny and green, with 6 ***sepals*** but no ***petals***.

**Western Columbine**: I have 5 red ***sepals*** that spread out in a star shape. In between my ***sepals*** are the 5 ***petals***, which look like long, backward-pointing "spurs." These spurs are shaped like hollow cones and produce ***nectar*** deep in their tips. My delicate-looking flower hangs upside-down, with the ***stigma*** dangling below like the ringer of a bell.

**Indian Paint Brush**: I have bright red-orange flowers that are clustered on a tall stem called a spike. My flowers are shaped like long, narrow tubes. Beneath each flower is a special leaf that is also colored bright red.

**Water Starwort:** I am an aquatic plant rooted in the vernal pools. My floating, ***petal***-less flowers are well-adapted for ***pollination*** by water, which carries the floating ***pollen*** from one flower to another.

Cut here

**Morning Glory:** I have a large, shallow, dish-shaped white flower. My ***petals*** are fused to form one continuous surface, which is pentagon-shaped. Each flower has five ***stamens*** and one ***pistil***. My ***anthers*** are very easy for ***pollinators*** to reach.

**Pollinator Profile Cards**

*Note: Each pollinator has flower types that it prefers, but it may visit and pollinate many different types of flowers.*

I am a **monarch butterfly**. I have orange and black wings that I use to migrate long distances. Brightly colored flowers that stand out in a crowd are what attract me most. I unroll my long tongue, which works like a drinking straw, to sip *nectar* from flowers. Bell- shaped flowers are easy for me to sit on and drink from.

I am a **bumblebee**. I love bright, flashy flowers; however, I can't see the color red! Some flowers reflect ultraviolet light in special patterns that only I can see. I love to gather lots of *pollen* in the baskets on my legs as I buzz around. I bring this *pollen* back to my nest to feed my colony, but if I drop some of it, I might help *pollinate* a flower!

I am **the wind**. I don't care how a flower looks or smells; I'll blow its *pollen* around regardless! In fact, it's easier for me to blow the *pollen* if there are no *petals* to get in the way. Whoosh!

I am an **Andrenid bee**. I am immune to a very poisonous flower, and I am the only one who can drink its *nectar*! It has no other *pollinator* but me.

I am a **swallowtail butterfly**. I have yellow wings with black stripes, and near my wingtips are red and blue dots that look like eyes. I like to feed from delicate, brightly colored flowers.

I am an **Anna's hummingbird**. Red is my favorite color. Give me a flower with a tube full of *nectar* and I will keep coming back. I love plants that have lots of flowers displayed on one spike, because these types of flowers are easy for me to access.

I am **the water**. With the help of the wind, I carry floating *pollen* from one aquatic plant to another.

Cut here

I am a **flower beetle**. *Pollen* is my favorite food. I find flowers by smell rather than sight, so the flowers I visit are not necessarily brightly colored, but usually smell sweet. I like shallow, open flowers that make it easy for me to reach the *pollen*. Sometimes I'll munch not just on the *pollen*, but on the whole flower, *petals* and all!

# Table Rocks Flowers and Their Pollinators Answer Key

**For use by TEACHERS ONLY to correct students matches of flower description cards with pollinator profile cards.**

**Red Bells:** This flower is often pollinated by **monarch butterflies**, which are attracted to brightly-colored flowers. Monarchs have a drinking-straw tongue that they can unroll to drink nectar from the flower. Also, the curved-back tips of the red bells' petals provide a convenient perch for butterflies.

**Blue-Eyed Mary: Bumblebees** often pollinate blue-eyed Marys. Because bees cannot see red, flowers relying on bees as pollinators are often blue or purple.

**Death Camas:** Most potential pollinators avoid this highly poisonous plant because it has toxic nectar. There is, however, one pollinator that is adapted to tolerate it. This is the **andrenid bee**.

**White Oak:** The pollen of oaks is easily carried **by wind**, and can travel great distances.

**Western Columbine:** This flower is often pollinated by **swallowtail butterflies**. The red sepals form a star shape that is attractive to passing butterflies, and with their long tongue, butterflies are well-equipped to sip nectar from the deep, tubular spurs.

**Indian Paint Brush: Hummingbirds** are attracted to this flower. The tiny bird's long beak is adapted to extract nectar from the tubular red flowers.

**Water Starwort:** This aquatic plant's floating, petalless flowers are well adapted for pollination **by water**, which carries the floating pollen from one flower to another.

**Morning Glory:** My shallow, dish-shaped flower makes it easy for the **flower beetle** to reach my pollen.