

## Plants & Pollinators: 3<sup>rd</sup> Grade

**Objective:** As part of their butterfly science unit, students will review pollination and tour the garden to learn about the many different ways plants can be pollinated. Students will learn how plants and animals/insects have co-evolved over time, using specific adaptations to benefit both.

### 45 min lesson

#### Materials:

- 4 large hand-made paper flowers
- watering can
- strap-on butterfly wings (optional)
- real seasonal flowers/plants (as examples to demonstrate various adaptations: snapdragon (shape), lilly of valley or lilac (smell), various colors (yellow buttercup weed) flat landing pads, trumpet/tube shapes etc., houseplants: Stapelia/Orchid etc.
- honeysuckle flowers to taste real nectar (if in season) OR sugar water (ratio used in hummingbird feeders) with cups, straws to taste
- nasturtium or other flower seeds (optional) for planting

**5 min Intro:** prompt students to recall their previous fall science unit on plants...  
*What is pollination?* (When pollen grains from male anther reach female stigma and fertilize the ovaries or eggs that become seeds. Show them a diagram again with labeled flower parts)  
*Why is it so important?* (All life on earth depends on plants – provide oxygen, food, shelter for living things! – so if plants don't get pollinated they can't reproduce and the rest of us on earth are in trouble)

### Part I: 10-15 min

Students form a half circle standing in garden. Ask for 4 volunteers to be plants holding flowers (give each a tissue paper flower to hold, make sure there are 2 of same flower varieties for pollinating that look different though – one with a landing pad perhaps, one a tube shaped red flower)

Order volunteers: "OK plants – now go pollinate each other!" watch what happens...

Not allowed to move, right? You're stuck where your roots are! So how do plants do this? Prompt class for ideas....

How about some WIND? (go up and gently shake a student so pollen is dispersed – might go here, there, everywhere.... Will it travel to right flower or wrong different flower? Is this efficient?)

How about some WATER? (threaten to sprinkle water can over a student... rainwater can splash pollen grains in droplets of water onto other plants but even more inefficient method of pollination than wind, pretty rare in plant kingdom)

Wind and Water are non-living (abiotic) ways to pollinate but they are unreliable. WHO are the better pollinators? LIVING (or biotic) creatures like.... Butterflies! 90% of plants on earth are pollinated by living creatures!

Now ask for another volunteer to be a butterfly - Turn again to volunteer plants: "OK plants - now go attract some butterflies!" Which flower will the butterfly visit....? *Students brainstorm.* One with landing pad perhaps?

Plants must lure pollinators to them because they are still rooted/stuck in one place. How do they do this? By offering a REWARD like... what? **Food! (Nectar)** but how does butterfly know nectar is there? Plant must 'signal' the reward or trick insect into visiting by adapting! Plants do this by using....

**Color:** orange/yellow/pink/blue for butterflies, some flowers have stripes/lines in middle of flower/petals to direct insect to nectar too... like airplane landing strips!

**Odor:** sweet or musky smells (How do butterflies smell? with their feet!)

**Shape/Structure:** flowers all different shapes depending on who pollinates them! Might hide nectar so insects must travel a certain way to get it so pollen sticks to them etc.

## Part II 15-20 min

Students tour garden to see examples of plant/pollinator relationships...

1. **Bees/Wasps:** the best pollinators! Smartest, best memory, loyal etc. great eyesight but cannot see red! See UV spectrum (**buttercup** to a bee has dark center but not to our eyes: it looks solid yellow - center acts as a target/bulls eye for bee signaling where nectar is!)
  - Snapdragons** coevolved to snap down their top petal to deposit pollen on bee back - the weight of the bee is exactly the right amount to push down the lower petal and open up flower!!
  - Orchids** coevolved to look like another bee! Super specialist flowers; also attract wasps: But no nectar reward, pure trickery! Who is smarter - the orchid or the bee?!
2. **Moths:** smell with feathery antennae, attracted to pale white flowers and a musky sweet smell, why? They pollinate at night!
  - Madagascar Star Orchid** super specialized! Only one moth pollinator: Hawk Moth with a foot long proboscis. Why might such specialized adaptation be risky? Extinction for both if one dies off....
  - Tomatoes** are another host plant (any Nighthshade plant!) for another species of Hawkmoth (5 spotted Hawkmoth) called Tomato Hornworm caterpillar - HUGE! Adult moths feed on **Moonflower** nectar.
  - Honeysuckle** is host plant for caterpillar of Hummingbird Moth and smells strongest at night/in evening, Hummingbird Moths sound just like real

hummingbirds – flaps wings 30 times/second flies 30 mph (compare to real hummingbird stats)

3. **Birds (hummingbirds)** have beaks shaped to match the long tubes of flowers, attracted to bright colors like red, yellow, pink, orange. Do not have a good sense of smell. They don't need landing pad because they 'hover' to drink. Flap wings 80 times/second fly average 30 mph but can fly 60mph during courtship!  
--**Columbine, Trumpet Vine** often pollinated by hummingbirds
4. **Flies** do follow their sense of smell, but not for sweet smells! Not all flowers smell good! Some attract flies by have a rotting, stinky, meat smell!  
--**Stapelia** is a cool star-shaped flower that attracts flies by smelling like rotting meat, also has fine 'hairs' (like animal hairs) on its star-shaped petals.  
--**Corpse Flower** is most famous stinking flower! At botanical gardens, doesn't bloom often, people wear gas masks when it starts to smell, some people have passed out or thrown up from odor!! We have a relative of it in garden called *Amorphophallus konjac* that blooms in winter indoors...
5. **Mammals: Bats/rodents/monekys/humans** can also pollinate!  
Monkeys/lemurs often accidental pollinators. Most rain forest plants depend on bats to pollinate! Bats also go more by smell because they are color blind. They eat fruit/nectar and 70% eat insects (so accidental pollination if they go to a flower to catch the insect and get pollen on selves). They are strong fliers so can pollinate over far distances too for plants...  
--**Bananas** are pollinated by bats!  
--**Protea flowers** pollinated by rodents like gerbils, mice, rats, shrews. Flowers usually low to ground/brown color, accessible to rodents.  
--**Hybrid plants** are cross pollinated (hand pollinated) by humans to create new species of plants! People have been tinkering with nature for centuries...
6. **Butterflies** you have been studying... many plants in garden play hosts to larvae or attract butterflies by providing nectar!  
--**Sassafrass** – host for Spicebush Swallowtail larvae  
--**Milkweed** – host for Monarch larvae  
--**Joe Pye Weed** - attract monarchs/swallowtails for nectar  
--**Ironweed** – host for Painted Ladies and Sachem butterflies  
--**Butterfly Bush** – attracts Painted Ladies  
--**Rudbeckia** – host for American Snout  
--**Globe Thistle (Echinops)** – attracts painted ladies  
--**Echinacea** – attracts Swallowtails  
--**Cabbage (Brassicac)** – host for cabbage butterfly larvae!
7. **Ants** not true pollinators but have evolved a **symbiotic relationship** with certain plants too! **Peony** flower buds have petals very tightly wound. The peony excretes nectar on the outside of the flower bud for ants (yes, nectar can be produced anywhere!). The ants eat this and gradually help loosen the bud to

bloom. They also protect against other insects eating the bud. Ants also protect certain caterpillars and aphids too by 'milking' them for a sweet substance they secrete. Their presence keeps other predators away.

8. **\*\*Carnivorous Plants** like pitcher plants also need to be pollinated. They put their flowers high on stalks above their deadly pitchers so they don't accidentally lure/trap the same insects they want to pollinate them! Flowers often come in early spring before their pitchers mature. After flowers die back they begin trapping and digesting insects by fooling them into thinking they have nectar in their 'pitchers'...
9. Last but not least... **Beetles** are first/oldest group of pollinators on earth because they've been around longer than bees, butterflies, birds, mammals etc. They go back to time of dinosaurs, as do **Magnolias**, one of the first flowering plant species to evolve, which is why Magnolias are still pollinated by beetles today!

### **Part III 5-10min**

So we've learned that plants and pollinators mutually benefit one another! Now if you help me plant nasturtium seeds for next year's 3<sup>rd</sup> graders, I will 'reward' you with a sip of nectar: and we both benefit!!

Students plant seeds and receive taste of nectar – taste either real honeysuckle flower or sugar water substitute.

WHY is pollination so important?! All life on earth depends on it.... no plants, no oxygen, no food, no YOU!

**Expansion activity:** *Smithsonian 'Design Your own Flower' worksheet as pair work.*  
Also show students videos of Hummingbird Moth: <https://www.youtube.com/watch?v=EYLtpqkMSvU>  
and amazing Madagascar Star Orchid: footage starts at 4:00min mark:  
[https://www.youtube.com/watch?v=nSiGo6Pb\\_wE](https://www.youtube.com/watch?v=nSiGo6Pb_wE)

## Pollination: Information/Resources

So how do plants get pollinated? Through vectors – a vector moves pollen from the anther to the pistil! 2 types of vectors –

- 1) **abiotic!** Or non-living: **wind** (anemophily) is main one but also **water** (hydrophily) by splashing raindrops, or a few rare **explosive anthers** (can be self-pollinating on same plant) but this is less precise.
- 2) **biotic!** Or living: insect or animal transfers pollen across plants/flowers! 90% of plants depend on animals for pollination. Botanists even have fancy words for the most common groups of pollinators:

### *Insects*

Butterflies: Psychophily

Bees: Melittophily (Orchids) – bees are most efficient pollinators!!

Beetles: Cantharophily

Flies: Myophily (Stapelia Gigantia!)

Moths: Phalaenophily (night blooms!)

### *Animals*

Birds: Ornithophily (hummingbirds-passiflora, aloe-sunbird in S. Africa)

Bats: Chiropterophily (moonflower!)

Other mammals like lemurs, geckos, possums, even humans are pollinators! (giant gecko of New Zealand pollinates the Pohoutokana Tree, bush mouse pollinates Protea/Potea?) Balck Lemurs – traveler's Palm - Madagascar

So imagine again you're a plant - how would you attract a pollinator? You might be stuck in one spot but you are smart! You have to give your pollinator a reason to visit your flowers, a **reward** – nectar!

So over time, plants evolved to look or smell a certain way to attract pollinators, creating specific rewards to attract specific pollinators. They need each other! They co-evolved to form a relationship with each other!

### **Main attractions? Color/shape (structure)/scent!**

- **colors** some UV colors only insects can see – we can't! bees cannot see red but they see yellow interior of a buttercup as darker yellow than we do. They like blue and violet colors. Flowers pollinated at night usually pale or white so more visible.

Hummingbirds attracted to red flowers (bee balm!) and red flowers typically loaded with carbohydrate rich nectar which is high energy source for **hummingbirds** –

they flap their wings 80 times per second – hover like an insect! So fast you can't see -**smells:** bees and butterflies like sweet smells, moths/bats like fruity/musky/yeasty smells, flies like rotting meat smells, birds have poor sense of smell so rarely a reward for birds. Honeysuckle's smell is strongest at night to attract nocturnal

moths who smell with their feathery antennae. Stapelia gigantea and Amorphophallus konjac (Giant flower in Chicago of rotting meat smell:

[https://en.wikipedia.org/wiki/Amorphophallus\\_titanum](https://en.wikipedia.org/wiki/Amorphophallus_titanum)

[http://www.chicagobotanic.org/titan/sprout\\_titan\\_arum](http://www.chicagobotanic.org/titan/sprout_titan_arum)

**-structures/shapes:** use petals as landing pads or petals have stripes or other markings/ lines to guide insects to nectar (violet!) . When bee lands on snapdragon lower petal its weight causes a stamen to swing down and dust the bee with pollen. Orchids evolved to look like another insect so wasp/bee tries to 'mate' with it.  
**-Taste/food:** high sugar content – sweet!

Some plants are **generalists** (pollinated in many ways) but others are **specialists** (their flowers fit a certain species of animal or insect e.g. bird of paradise flower heliconia)

### **Cool adaptations!**

\*bee vibrations (buzzing!) at a certain frequency will cause anther to 'explode' called buzz pollination! Carpenter Bee & Gentian flower

\*bills of hummingbirds fit specific flower shapes

\*carrion flowers smell like rotting meat to attract flies

<https://www.theguardian.com/science/2011/oct/09/orchid-sex-botany-ziegler-pollan>

\*Orchids are super specialized evolved flowers

\*ants & pointsettia – extra nectaries for ants to keep them busy

**Carnivorous Plants** – fool insects into thinking they have nectar!! Slice into a pitcher plant from garden –

<http://insider.si.edu/2015/06/how-carnivorous-plants-avoid-eating-their-pollinating-insect-friends/>

**6 basic shapes of flowers** – certain shapes attract certain pollinators: show one example of each

- 1) bowl-shaped: oldest/simplest – bees and flies like them, not good for insects with long proboscis (poppy)
- 2) bell or funnel shaped: nectar at base in small amounts so pollinator keeps returning
- 3) tubular shaped: very specialized pollinators (hummingbirds!)
- 4) brush-shaped: all stamens, very few petals – bats pollinate
- 5) flag shape – leguminosae (irregularly symmetrical) bean flowers
- 6) gullet – complete bilateral symmetry (lips and throat like **snapdragons!**)

[http://northernwoodlands.org/outside\\_story/article/ants-small-workers-with-large-roles](http://northernwoodlands.org/outside_story/article/ants-small-workers-with-large-roles)

**SYMBIOSIS:** or how plants and animals/insects depend on one another – they develop a symbiotic relationship: look at peony and ants! It is a symbiotic relationship. The peony produces nectar from unopened buds that ants love to eat. In many of those species ants will feed on the nectar and while they are at it they will attack any other animals that might damage the plant by feeding on it. So, the ants get an easy meal and the peony gets a dedicated team of bodyguards to keep their flowers from being eaten.

The ants are drawn to the tightly furled peony flowers by a sweet nectar exuded from the waxy, red-rimmed bud scales. In return for this high-energy food, the

nectar-seeking ants gently probe the clenched petals, loosening the folds and helping the flowers open. Some gardeners say the ants only encourage and hasten a process that would otherwise happen on its own, while others insist that, without the ants eating away the waxy scales and traipsing between the petals, the buds would not be able to open at all.

In either case, the ants also guard the peonies against harmful insect pests that would otherwise damage the plants and diminish the ants' proprietary nectar supplies, leaving gardeners with nothing more than chewed, unopened buds. The moral of the story: set aside the pesticide; far from being a problem, these ants are part of the solution.

#### **Ant-caterpillar symbiosis:**

<http://texasbutterflyranch.com/2013/02/15/a-lesson-in-symbiosis-friendly-ants-protect-caterpillar-from-mean-ants-2/>

**Also ant-aphid symbiosis:** <http://www.gardeningknowhow.com/plant-problems/pests/insects/controlling-aphids-and-ants.htm>

**Mimicry** – Hummingbird moth mimics hummingbird – sounds like a hummingbird! Flap over 30 times per second but only lives 5-10 weeks, fly 30 miles an hour.

<https://www.youtube.com/watch?v=EYLtpqkMSvU>

[http://www.fcps.edu/islandcreekes/ecology/hummingbird\\_moth.htm](http://www.fcps.edu/islandcreekes/ecology/hummingbird_moth.htm)

[https://en.wikipedia.org/wiki/Hummingbird\\_hawk-moth](https://en.wikipedia.org/wiki/Hummingbird_hawk-moth)

**Students tour garden** to find **plants** butterflies either

- 1) lay eggs on (these are host plants that the caterpillars/larvae will feast on) or
- 2) drink nectar from (why do plants produce nectar? What is it?)

A: Spicebush Swallowtail – lays eggs on the host plant **Sassafras**

C: Monarch – lays eggs on the host plant **Milkweed**

A/C: **Joe Pye Weed** – produces nectar that both Monarchs and Swallowtails like to drink

B: **Butterfly Bush** – also attracts lots of Butterflies with its nectar, esp. the Painted Lady (which kids have in class) these lay eggs on Cudweed or Ironweed as a host plant instead

F: **Ironweed** – attracts other butterflies too like the Sachem

D: **Black-eyed Susan** flowers – attract American Snout and other butterflies

D: **Mexican Sunflower/Echinacea (Purple Coneflower)** – attracts Eastern Tiger Swallowtail

E: **Tomato hornworm** turns into a type of Hawkmoth

<http://www.mastergardenerssandiego.org/faq/item.php?ID=53>

G: **cabbage butterfly!**

[http://www.fcps.edu/islandcreekes/ecology/cabbage\\_white.htm](http://www.fcps.edu/islandcreekes/ecology/cabbage_white.htm)

Many other flowers attract Butterflies in garden – but usually they only lay eggs on specific plants they know their caterpillars will eat – called HOST plants.

**Part III: Students plant flower seeds** of plants that will attract butterflies and other beneficial insects to the garden!

--Nasturtium (which the kids dissected and ate in fall!)

--Coreopsis, Larkspur, Cosmos

**Part IV: Students sip sugar water (nectar!) from thin straws –**

butterfly proboscis! Or hummingbird beak! OR make sponge sips for butterflies

<http://www.wildbirdshop.com/Birding/humfeed.html>

<http://premeditatedleftovers.com/gardening/make-butterfly-nectar/>

<http://www.treehugger.com/lawn-garden/make-food-struggling-monarch-butterflies-recipes-your-leftovers.html>

**Last thoughts...**

So as you sip nectar.... Think about where we humans would be without plants and pollinators? What would the world be like without butterflies and honeybees? Do you still think plants are dumb?

\*\*hand out/take back to class: design a plant based on your pollinator preferences!

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**Pollinator info:**

**Butterflies:** guided by sight and smell (similar to bees) but some can actually see red! Attracted to bright orange, yellow, pink, blue. Flower have flat rim (sunflower) with long tubular corollas for long tongues. Asclepias (milkweed), Zinnias, Buddleia.

**Moths:** flowers that open at night (Moonflower) with musty, fermenting odors. Light colors (yellows, whites, pinks, greens but pale) evening flowered primrose, nicotiana, night-blooming cactus. **Hawkmoth & Orchid:** coevolutionary!

<http://1888orchids.blogspot.com/2007/12/madagascar-star-orchid-and-giant-hawk.html>

video: <https://www.youtube.com/watch?v=iMz6lApJgu4> better footage: [https://www.youtube.com/watch?v=nSlGo6Pb\\_wE](https://www.youtube.com/watch?v=nSlGo6Pb_wE)

**Bees:** most intelligent, efficient, loyal and discriminating pollinators, most important to plants and have existed more than 80 million years! Great eye sight and perception, keen smell sense too. **Asteraceae** flowers perfect for bees! Pollen sticks to bristles on legs.

**Beetles:** highly developed sense of smell but poor vision and clumsy, flowers light color but strong odor, musky or rotting. Some beetles eat nectar or pollen, some chew on petals. Beetles also attracted to heat (thermogenesis – plants trap heat – Cycads heat up, beetle pollinated) Also **magnolias!** Main pollinator:  
<http://pollinators.blogspot.com/2011/06/magnolias-and-beetle-pollination.html>

**Birds:** might eat insects on flowers, hummingbirds are main pollinators in N. America. Excellent color vision: like bright yellow, red, pink, orange but poor sense



of smell. Usually large flowers like trumpet vine (long tubes for beaks). Pollen sticks to feathers not bills. Nectar has high sugar/carb content. **Hummingbirds!** can fly as fast as **60 miles per hour** during courtship displays, but their average flying speed is closer to **30 miles per hour**.

**Bats:** 70% eat insects, some vampire bats drink blood, tropical bats eat fruit and nectar. Strong fliers so can pollinate great distances! In rain forest, fruits are VERY dependent on bats – bananas, avocados, mangoes, agave, saguaro cacti. Dull, white flowers open at night but strong odor – more attracted to smell than color. Flowers have large sturdy structure and bats hang or hover to sip with long tongue. Color blind! **Bats & Agave** – one can't live without the other!

**Mammals:** often 'accidental' pollination like with monkeys/lemurs who forage for food. Smaller rodents also forage (shrews) and eat insects on plants. **Protea flowers:** Several species of gerbils, mice, rats and shrews visit flower-heads of some Protea species and Hook Pincushions. Rodents are attracted by a strong musty odour, and a reward of syrupy sugar which is secreted in large quantities. In order to prevent birds and insects from stealing this nectar, rodent-pollinated (therophilous) proteas have inconspicuous brown or black involucre bracts. Flower-heads are usually hidden inside the bush at ground level, where they are accessible to rodents. The insides of the involucre bracts may be pale white and the tips of the flowers may be shiny red - both serve to guide the rodent to the nectar in the dark. The nectar is contained within the tepal tube, and the distance between the pollen presenter and the nectar is the same as the length of the rodent's snout (about 10 mm) allowing pollen to be deposited on the head. The nectar is rich in cane sugar (sucrose). Since most therophilous proteas flower in spring, nectar is available during the rodents' breeding period. <http://www.proteaatlas.org.za/pollinat.htm>

**Resources:**

<http://pollinatorlive.pwnet.org/teacher/lessons.php>

**Where is nectar produced?**

[http://www.learner.org/jnorth/tm/monarch/nectar\\_diagram.html](http://www.learner.org/jnorth/tm/monarch/nectar_diagram.html)

Nectar is produced by glands called nectaries. Nectaries can be located on any part of a plant, but the most familiar nectaries are those located in flowers (called "floral nectaries"). Depending on the species, a flower's nectaries can be located on its *petals*, *anthers*, *stamens*, *sepals*, *pistils*, *styles*, *ovaries* or other parts of the flower.

