Pollinator Activity Guide

Next time you see a student crunching on an apple or savoring a chocolate bar, remind them that they should thank a pollinator for providing their snack. More than 150 of our common food crops, from avocados to zucchini, rely on pollinators to move pollen among flowers to facilitate fertilization, which ultimately leads to the development of fruits and seeds. Pollination by bees, hummingbirds, moths, bats, butterflies, flies, and beetles ensures the continued existence of millions of plant species, and in turn, of most animal species, including humans – in fact, one of every three mouthfuls of our food depends on them!

Most pollinators are small and quiet and may easily be taken for granted, but a process and players so essential to our survival certainly bear some investigation. The following lesson plans offer hands-on activities for understanding and appreciating the dance of flowers and their pollinating partners, and culminates in the planning of a schoolyard pollinator garden.

Lesson 1: Make a Flower

Overview: Students create model flowers in preparation for studying pollination.

Objective: To become familiar with flower anatomy and function.

Materials

- Flower Anatomy reproducible
- Assorted craft materials such as pipe cleaners, feathers, pompoms and glitter
- Classroom supplies: tape, crayons, scissors

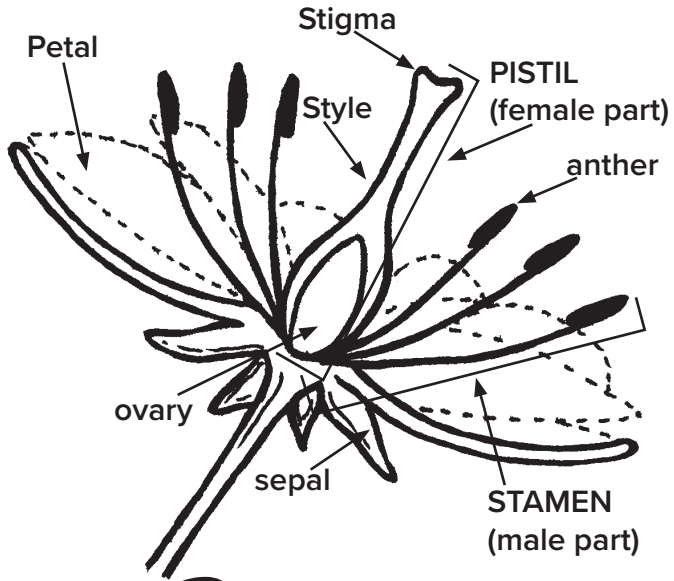
Background: Flower Structure Up Close

Although flower structure can vary greatly, all share some basic parts. Follow along on the Anatomy of a Flower reproducible as you read this background information.

The female organ, the pistil, is generally in the center of the flower. The platform at the top of the pistil — often sticky so it can trap pollen — is the stigma, held up by the tube-like style. The style leads down to the ovary, inside of which are the ovules, containing female egg cells.

The male parts, the stamens, typically surround the pistils. The anther on top of the stamen, held up by the stem-like filament, produces pollen, which contains male sperm cells.

Pollination is the transfer of pollen from male to female flower parts. When a grain of pollen lands on the stigma, a tiny pollen tube grows from it and probes down the style into the ovary. Sperm cells then travel through this tube from the pollen grain to an ovule, and there join with an egg cell in the process called fertilization. The fertilized ovule will become a seed, and the ovary a fruit. Without pollination and fertilization, fruit and seed production cannot occur in most plants.



Other important flower parts are the petals and sepals. Petals are often brightly colored or patterned to attract pollinators (birds, bees and other insects) and 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.

Laying the Groundwork

Give each student a copy of the Anatomy of a Flower reproducible. Ask, *Do all flowers look like this? Do you think all flowers have the same parts? Name some different flowers that you're familiar with. How are they different from, or how do they resemble, this drawing?* Tell students you'll discuss the purpose of these plant parts later in the activity.

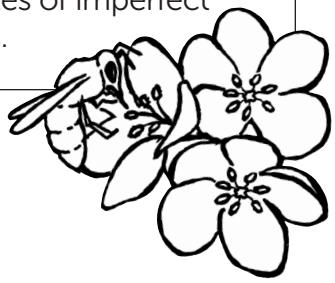
Exploration

1. Provide students with craft materials to create models that contain the same parts as the illustration. Emphasize that they don't have to look like the picture, but must have the same parts because each one is critical to the plant's survival. Encourage students to color and draw patterns on their petals as they wish, and vary the length and position of stamens and the arrangement of petals. Ask them to name their flowers and to imagine that they are fragrant (students should be prepared to describe the fragrance, e.g., smells like raspberries/ chocolate/ bubble gum).
2. When they've completed the models, hold a "flower show." Invite half the class to be presenters at the show and the other half to be "visitors." Ask presenting students to name their flowers and describe their fragrances to visitors. Consider asking presenters to identify different flower parts by name, then switch roles so everyone has a chance to present.
3. After the show, discuss the qualities of different flowers. Ask, *Why do you think many flowers are so colorful and smell so nice? What have you observed outdoors that might help answer this?*

   Share the information that flowers produce seeds for new plants. Pollen must be transferred from the anther to the stigma in order for the plant to produce seed. Ask, *How do you think this pollen gets moved from one flower to another? What have you ever observed to make you believe this?*
4. Hand out the Apple Pollination Cycle reproducible to aid the discussion. Ask, *Given the information in this diagram and what we've discussed as a group, how might you adjust the design of your flowers?*

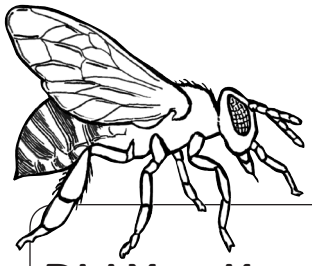
Male or Female?

Perfect flowers have both pistils and stamens. **Imperfect flowers** are either male or female, and pollen must somehow make its way from the male to the female flower. But even in many perfect flowers the parts are arranged to keep pollen from easily reaching the ovary of the same flower. This prevents self-pollination, ensuring a mixture and diversity of genes and, therefore, increased health of the species. Peas and beans are examples of perfect flowers, while cucumbers are examples of imperfect flowers.



Making Connections

1. **Discussion questions:**
   - *Why are some stigmas sticky?*
   - *Can you guess why some petals have designs such as spots or stripes?*
   - *If you were a pollinator, what type of flower would attract you? Why?*



Did You Know?

There are about 4,000 species of native bees in the U.S., ranging in length from less than one eighth of an inch to more than one inch. Most of these bees are "solitary" nesters and, having no hive to defend (as do non-native honeybees), they are unlikely to sting!

2. As a class, generate one list headed "Things We Know about Flowers" and one headed "Questions We Have about Flowers." Have students identify questions they can answer through experimentation and those they need to research. As your flower studies progress, add to the lists and shift statements and questions from one column to the other.

Branching Out

- Pick several different flowers or obtain some castoffs from a florist. Invite students to observe each with hand lenses. Have students identify the flower parts and then compare each structure on the different flowers. (Students can gently pull apart half the flower for a better view of its parts.)
- Soak a few whole dried cloves in water overnight. Try to identify the parts of these dried flower buds.
- Conduct an outdoor "flower hunt." Give pairs of students cards with directions such as "Find a flower that . . . has pistils and stamens that are hard to see; . . . smells sweet; . . . has loose pollen; . . . has no petals; . . . is on its way to becoming a fruit."
- Using cotton swabs, ask students to collect pollen from plants in the schoolyard. Demonstrate how to do this gently to avoid damaging the plant. Bring samples back to the classroom to observe and describe. Look at the samples under a microscope if possible.
- Have pairs of students group flowers in different categories (e.g., by color, smell, or shape). Challenge other pairs to guess what trait was used to create each grouping.
- Ask students to identify and compare flowers that they suspect are wind-pollinated with those that are pollinated by birds or insects. Ask, *What leads you to suspect wind pollination? What differences do you notice between wind- and creature-pollinated flowers?*
- Make a snack featuring flowers, including cauliflower or broccoli, artichokes, and nasturtium or chive flowers. Ask, *What other flowers do we eat? What characteristics of these edible flowers attract pollinators?*
- Collect samples of poetry and music that refer to flowers. Identify which attributes are being described. Ask, *How do these flower characteristics please us? How do they help the flower?*
- Play flower charades and have students act out flower part names.
- Press flowers or flower parts between newspapers weighted with books. When dry, use clear contact paper to mount your specimens on paper, cardstock, or index cards. Use as wall hangings, placemats, bookmarks, or cards.

Lesson 2: At Blossoms Restaurant
— Understanding Flower-Pollinator Pairings

Did you know?

Pollinators are essential to the survival of more than ninety percent of the estimated 400,000 flowering plant species on the planet today.

Overview: Each student assumes the role of a flower or pollinator and visits a "restaurant" where flowers are on the menu. Pollinators consider their preferences using the clues and pictures on the Pollinator Profile cards included at the end of these lesson plans. Flowers describe their "specials" using the clues and pictures on the Flower Profile cards.

Objective: To understand how a specific flower attracts a specific pollinator, and how that pollinator is suited to the job based on the flower's structure and needs.

Materials

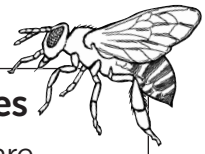
- Pollinator Profile cards
- Flower Profile cards
- Crayons or colored markers
- Journals

Background

Although bees are the best-known pollinators, many other animals visit flowers in search of nectar and inadvertently pollinate them. Pollen dusts these visitors' bodies and then brushes onto the female parts of the next flower they investigate. Over hundreds and thousands of years, many flowers and pollinators coevolved and have developed special relationships. A pollinator capable of detecting certain colors or scents, or possessing structures that best fit certain flowers, passes these advantages on to its offspring. Over many generations these traits have become well established. Meanwhile, flowers also evolved, adapting specific characteristics that suit particular pollinators.

To compete for the attention of pollinators, flowers have evolved ingenious methods to entice creatures to their sugar- filled nectar and protein- and vitamin-rich pollen. In exchange, the unsuspecting creatures unintentionally act as pollen- carrying liaisons between blooms that would otherwise never touch. The amazing diversity of flowers results from their unique adaptations to lure a range of pollinators (or to ensure that wind or water carries pollen). Every aspect of a flower, from the designs on its petals to the timing of its blooming, is vital to the process.

The Pollinator Profile cards describe some generalized characteristics and preferences of various groups of pollinating creatures. The Flower Profile cards illustrate and describe a few distinctive flowers that these pollinators are attracted to. Make it clear to students that these are just examples and not the definitive list of pollinator-plant pairings.

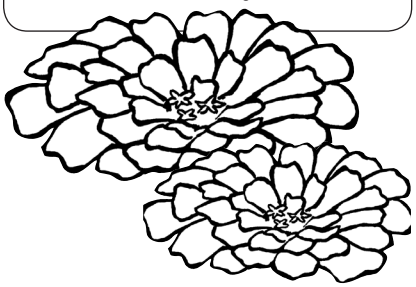


Respecting Bees

If some students are concerned about bees, remind them that these insects only become aggressive if you approach their nest or hive or harass them in some way. When bees are foraging they're intent on their business and not interested in people! To make yourselves inconspicuous, wear light-colored clothing and don't wear floral fragrances.

Flower – Pollinator Pairings

Magnolia – Beetle
Monarda – Hummingbird
Moonflower – Moth
Saguaro – Bat
Snapdragon – Bee
Trillium – Fly
Zinnia – Butterfly



Laying the Groundwork

Ask, *What do animals need to survive? (food, water, shelter, places to raise young) Which of these things do flowers provide? What parts of flowers do pollinators eat? What do flowers need? What does the pollinator provide in return?*

Exploration

1. Divide the class in half and hand out the Pollinator Profile cards to one group and the Flower Profile cards to the other. (Depending on the size of your group, some students may have duplicate cards, but make sure that each Pollinator Card can be matched with a Flower Card.) Ask students to color the images. Pollinators can be any color, but to make this activity work the flower colors must reflect the descriptions on the cards.
2. Next, tell the class that the flowers operate a restaurant called Blossoms, and the pollinators are their customers. Invite the pollinators and flowers to mingle and compare the clues on their cards to discover which flowers have the traits that specific pollinators like. Based on the clues, have students record the names of the pollinators or flowers they think make good partners on the back of their cards. When everyone is done, discuss what you've learned as a class.

Making Connections

1. **Discussion questions:**
   What do you notice about the flowers preferred by different pollinators?
   What characteristics do they have that seem to "match" their animal partners?

   What do you think would happen if . . .

   . . . bees and other insects couldn't detect color?

   . . . motor oil were splashed on a flower's stigma?

   . . . pesticides toxic to bees and butterflies were sprayed on plants?

   How do people take advantage of particular adaptations that flowers use to attract pollinators? (make perfume from flower fragrances, use colorful or unusual flowers to beautify landscapes, plant pollinator favorites, e.g., mints, in gardens to encourage pollination of crops)

   Do you think bees or plants benefit more during pollination? (This is a good question for debate, with no right answer.)

   Which plant parts would you not expect to find on flowers pollinated by wind? Why?

   Why do you think flowers produce thousands of pollen grains, even if they produce only a few eggs that need fertilization?

Explain to the class that the Western prairie fringed orchid can only be pollinated by the long-tongued hawk- moth. Ask, *What are the dangers of having such a specialized pollination relationship?*

2. As a class, generate one list headed "Things We Know about Pollinators" and one headed "Questions We Have about Pollinators." Have students identify the questions they can answer through experimentation and those they need to research. As your studies progress, add to the lists and shift statements and questions from one column to the other.
3. Create Pollinator Journals (using purchased journals or by stapling copies of the Pollinator Journal reproducible together) and tell students they will use them for some of the Branching Out activities (below) and for Lesson 3.

Branching Out

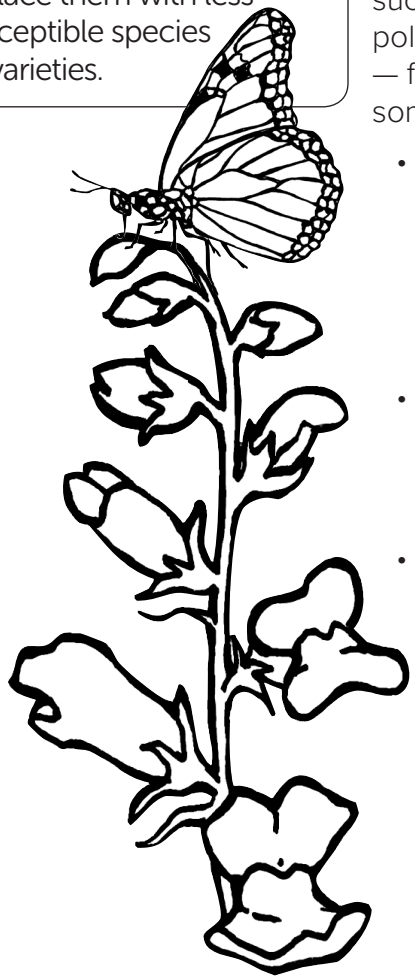
- In your garden, try removing a different part from each of several flowers while the flower is still on the plant. Observe the plant as it continues to grow over several days or weeks. Describe what happens to the plant's development when it's missing a part of the flower.
- Keeping in mind what you've learned about pollination, write a description of a flower-of-the-future and illustrate it. Describe how this flower is adapted to specific conditions and means of pollination.
- Research how pesticides can affect pollinators. Next, imagine that you're a pollinator concerned about pesticide use and write an editorial for the fictional National Pollinating magazine.
- Research how different cultures use flowers (e.g., in their diets, for medicines, or for dyes).
- Take a walk outdoors and identify different traits that flowers have developed to lure pollinators. Identify flowers that you suspect are wind-pollinated.
- Research the origins of different flower names or the historical significance of different flowers. Design cards that include illustrations of these flowers and their names.

Did you know?

Hummingbirds lap up flower nectar at about 13 licks per second!

Healthy Pollinator Gardens

Do not use pesticides and herbicides near pollinator gardens. Even organic pesticides derived from plants and microbes can be as harmful to pollinators as they are to pests. Herbicides may wipe out key plants (weeds) that are important food sources for pollinators. Diverse plantings are less likely to have severe pest problems and are more likely to attract pests' natural enemies: predatory insects and birds. If certain plants become plagued with pests, replace them with less susceptible species or varieties.



Lesson 3: Planning a Pollinator Garden

Overview: The class designs a pollinator garden with the aim of helping preserve struggling native pollinator populations. You may simply use this activity as an academic exercise, but if you can find a way to implement your designed garden, students will benefit not only from their real-life observations and explorations, but also from increased pride in their environmental stewardship.

Objective: To learn about native pollinators and their habitat needs and to collect the necessary information to create a schoolyard habitat.

Materials

- Internet access and reference books for research
- Pollinator Journals

Background

You don't need a lot of space to start a pollinator garden. Even a few containers of flowers can attract hungry bees and butterflies. To design a successful pollinator garden, students must use what they learned about pollinators in the first two lessons and provide for basic wildlife needs — food, water, shelter, and places to rear young — in their plan. Here is some information to get you started:

- Food sources (host plants). Although pollinators in adult stages thrive on flower nectar and/or pollen, the larval stages usually require plant leaves. In your planning process, consider allowing a section of your schoolyard to revert to wild grasses, weeds, and wildflowers (e.g., milkweed and Queen Anne's lace) to provide this food, then locate your pollinator plot nearby.
- Water. Be sure to include a water source in your design. Butterflies, for instance, sip at shallow pools, birdbaths, and mud puddles; some bees and wasps use mud to build homes. Mud puddles also provide important minerals for some pollinators.
- Nesting sites and overwintering materials. Think about the kinds of places and materials insects and birds need for building nurseries and spending down time, and allow room for them in the plan: flowerpots with drainage holes bottom-up on the ground; small piles of twigs and brush; mud puddles.

Laying the Groundwork

If possible, have students spend at least a couple of sessions observing flowers and their visitors in the schoolyard, at a nearby park, or at home.

Ask the following guiding questions:

- What types of insects or other animals are visiting which flowers?
- Are some flowers visited more often or only by certain creatures?
- Is there more activity at certain times of day?
- What kinds of paths do the insects take as they move among flowers?
- Which insects hover and which perch?
- How do the flowers they visit seem designed to support these habits?
- Does a mixed planting draw more different kinds of pollinators?

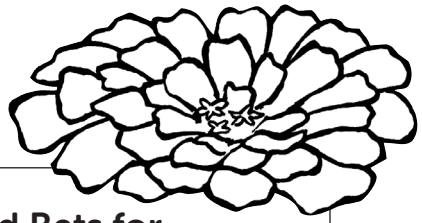
Students' observations should lead to fertile questions, some of which they can answer through systematic observations and some through further research.

Exploration

1. If you don't already have a garden site, have the class scope out a location that receives at least six hours of full sun each day. If space is limited, design a container pollinator garden (use a rich, well-drained soil mix when planting).
2. Research pollinator species native to your region. Also, research specific plants and habitat features these creatures need in order to thrive and reproduce. The Pollinator Partnership offers free Ecoregional Planting Guides that are an excellent resource for your search. These guides include in depth information on pollinators and recommended plants.
3. Create a list of pollinators you hope to attract and the plants you need to attract them. In general, the greater the variety of plants you offer (trees, shrubs, perennials, annual flowers, and herbs), the more pollinators you'll attract. Since pollinators have different needs during different life cycle stages, maintaining diversity also makes your site more widely appealing.

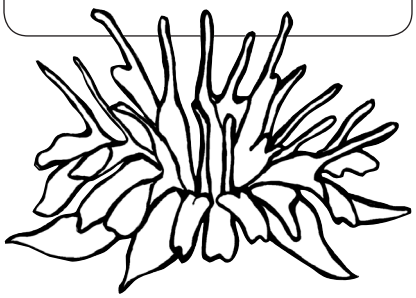
   Consider the following when creating your plant list:

   - Use as many plants native to your region as possible. Native plants have evolved closely with native creatures and are well suited to meet their needs. In fact, some pollinator species are entirely dependent on the availability of certain native plants. (In addition to the Pollinator Partnership Ecoregional Guides, your state's agency of natural resources or conservation and native plant societies are excellent resources.)



Good Bets for Pollinators

- **Aromatic herbs:** coriander, catnip, mint, parsley, lavender
- **Annuals:** marigold, phlox, bachelor's button, zinnia, cosmos, salvia, sweet alyssum
- **Perennials:** bee balm, Shasta daisy, aster, coneflower, lobelia, butterfly weed, goldenrod



Note: Never dig plants from the wild unless the area is slated for destruction and development and even in that case, make sure you have permission from the landowner. The best source for native plants is a local nursery or native plant association that offers plants that have been grown, not gathered.

- Whether you use native or nonnative plants, look for old-fashioned varieties. Many newer varieties have been bred to look or smell nice for humans and may lack accessible nectar or pollen for animal partners.
- Choose a range of flower shapes and sizes to suit the feeding preferences of a variety of pollinators.
- Include a range of flowers that bloom at different times throughout the season to accommodate individual pollinators' preferences and provide a sequence of pollen and nectar sources throughout different life cycle stages. For instance, flowering shrubs and trees tend to blossom early in the season, providing nectar or pollen when other food is scarce. On your list, note the mature plant size and growing needs (soil, moisture, sun exposure) of the various plants in preparation for the next step: drawing a plan.

4. Challenge individual students or teams to draw a site plan, positioning plants from their list based on the characteristics they've noted: size and growth requirements, plus which flowers might look nice together. Young children can draw a two-dimensional, frontal view of their garden. Older students can create an aerial-view landscape design on a piece of graph paper. Explain how to use the blocks on the graph paper to scale the drawings.

Making Connections

1. Discussion questions:

   Why are native plants so important to our pollinators?

   Why is it important to include a variety of plants in our garden?

2. Learn about the Pollinator Partnership's S.H.A.R.E. program (http://share.pollinator.org/). S.H.A.R.E., Simply Have Areas Reserved for the Environment, was created to encourage individuals, schools, community organizations and businesses to set aside space in their landscapes for pollinators. Search their online map to find registered habitats in your area. Discuss the importance of gardens for migrating pollinators. If you decide to install a pollinator garden, register your site with S.H.A.R.E to help them accomplish the Million Pollinator Garden Challenge.
3. Revisit your "What We Know…" and "Questions We Have…" lists from the previous activities. Has the exercise of planning a pollinator garden helped to answer some of your questions?

Branching Out

- Choose a favorite fruit, vegetable, or nut crop, and research it and its pollinating partner(s) for a report or presentation.
- Discuss changes brought to your region by colonizing humans and how those changes have altered pollinator habitats. Ask, *How might things look if pollinators had been on the "planning commission" all along?*

If you do build a garden:

- Study the life cycles and anatomy of pollinators that visit.
- Create a brochure for your pollinator garden that includes plant descriptions, which plants attract which pollinators, the importance of pollinators, and information on how to start a pollinator garden.
- Invite the community to guided tours of your garden.
- Write a press release about the project and share it with local newspapers and TV and radio stations.

Resources

The following websites provide exemplary materials to further support your pollinator explorations:

National Pollinator Garden Network:
http://millionpollinatorgardens.org/

Pollinator Partnership:
http://www.pollinator.org/

Pollinator Partnership EcoRegional Planting Guides:
http://www.pollinator.org/guides.htm

Pollinator Partnership Learning Center:
http://www.pollinator.org/usefulresources.htm

Kidsgardening.org – Creating a Pollinator Garden:
http://www.kidsgardening.org/classroom-projects/creating-pollinator-garden

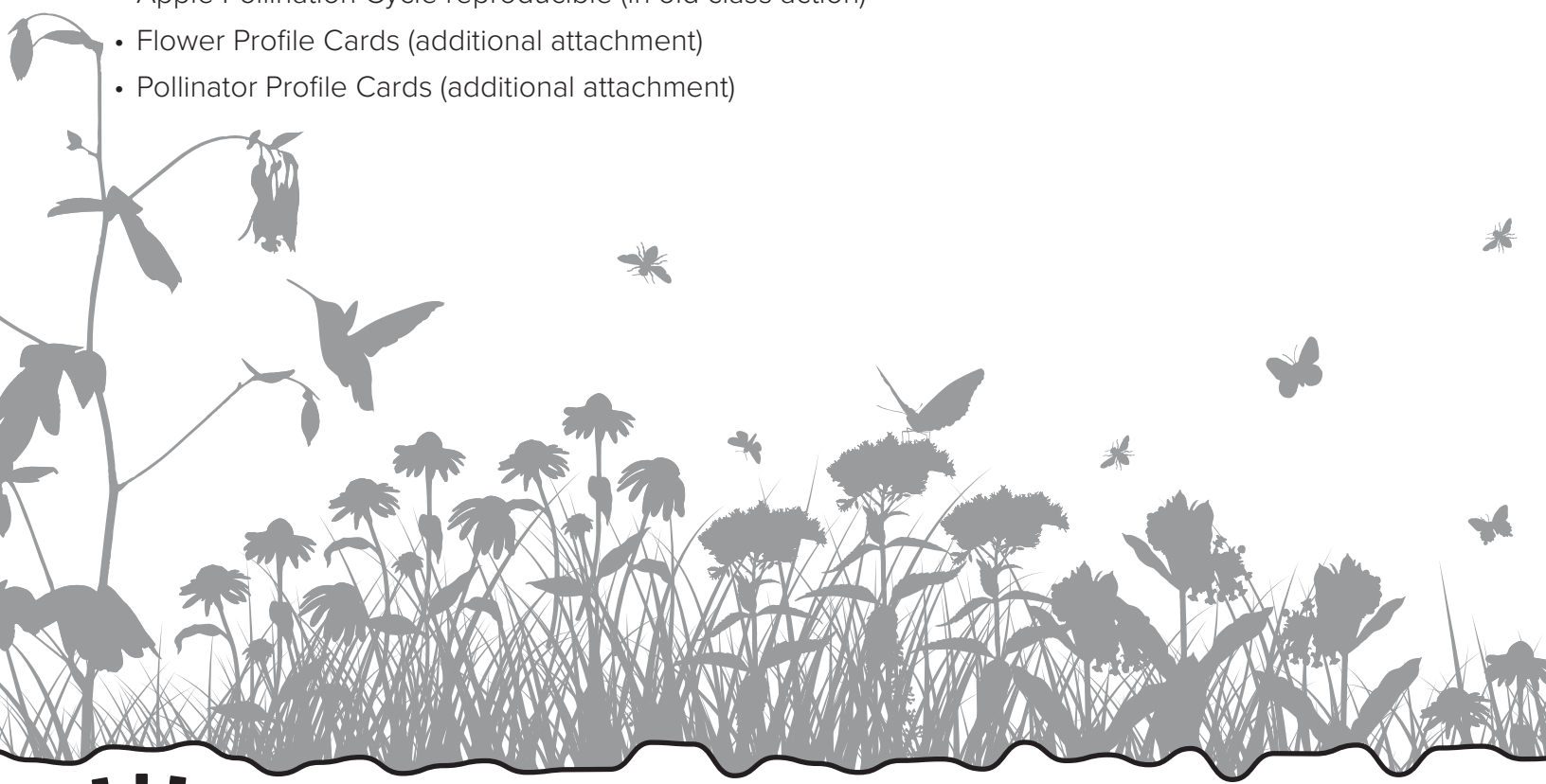
North American Pollinator Protection Campaign:
www.nappc.org

Nature's Partners: Pollinators, Plants, and You Curriculum from NAPPC:
http://pollinator.org/nappc/PDFs/curriculum.pdf

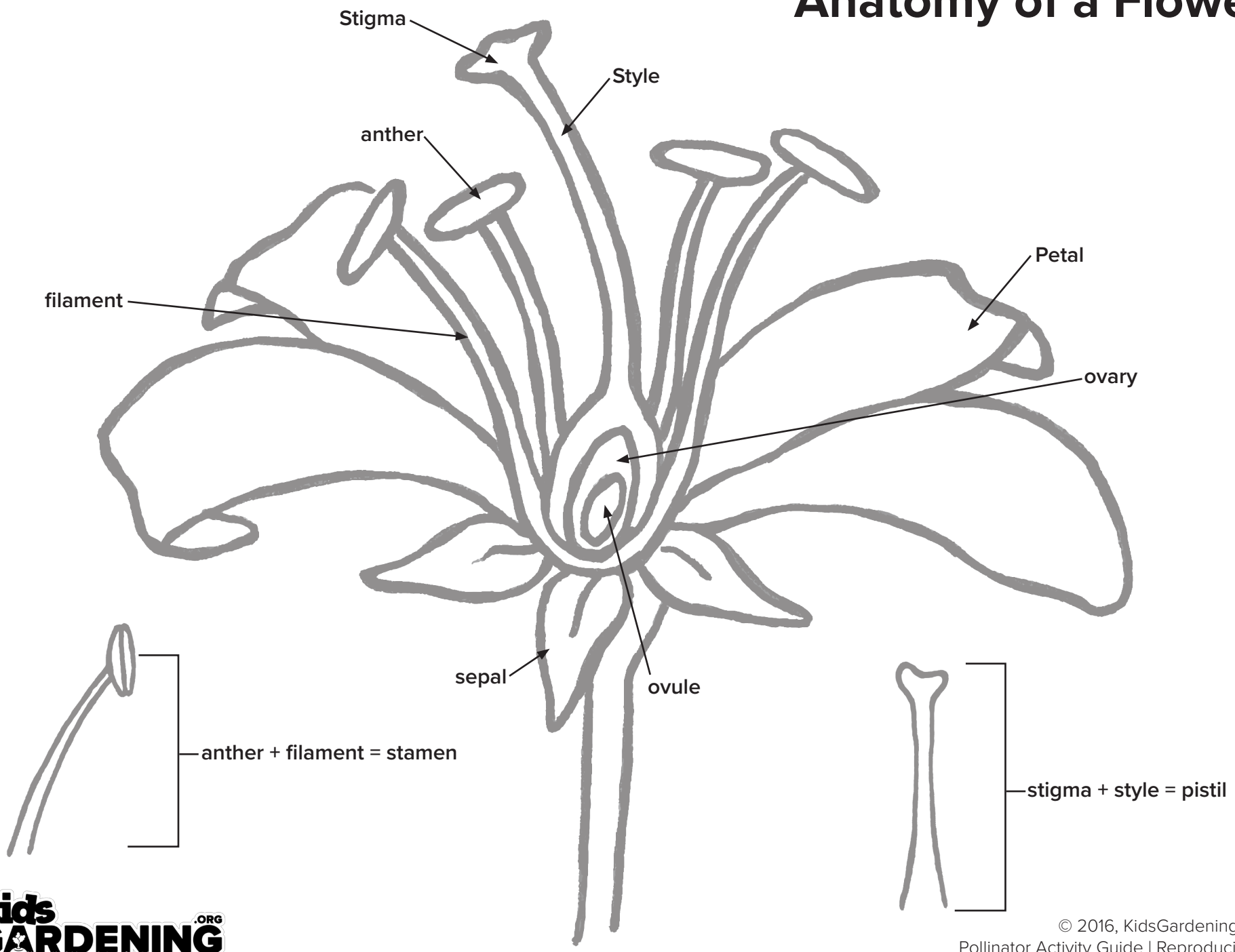
USDA Forest Service — Pollinators:
www.fs.fed.us/wildflowers/pollinators/index.shtml

Appendix Materials

- Anatomy of a Flower reproducible (in old class action)
- Apple Pollination Cycle reproducible (in old class action)
- Flower Profile Cards (additional attachment)
- Pollinator Profile Cards (additional attachment)

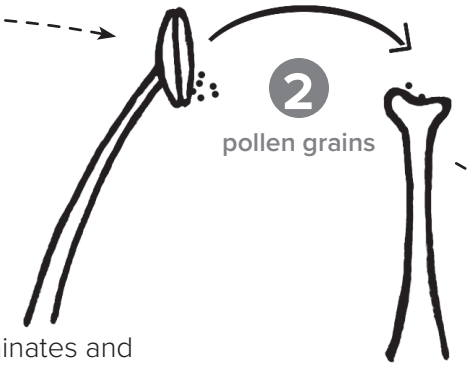


Anatomy of a Flower



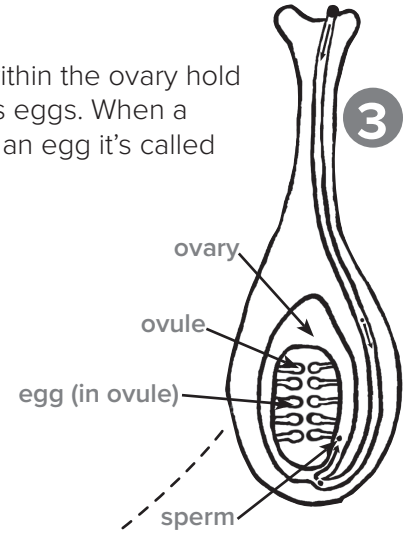
Apple Pollination Cycle

1. A pollinator, such as this honeybee, transfers pollen from one flower's stamen to another flower's stigma.

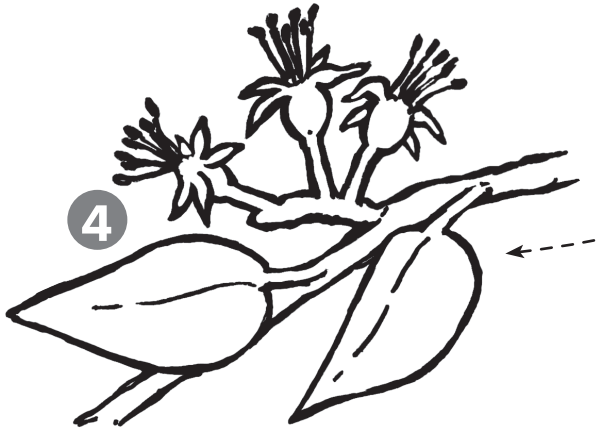


2. The pollen grain germinates and the sperm it contains travels down the flower's style until it reaches the ovary.

3. Multiple ovules within the ovary hold the apple flower's eggs. When a sperm fuses with an egg it's called *fertilization*.



4. Once the flower is fertilized, the petals wither and drop and the ovary begins to enlarge and develop into the apple fruit.



5. Each fertilized ovule develops into a seed.

kids GARDENING .ORG
HELPING YOUNG MINDS GROW

MONARDA

My petals are tubeshaped.

I have lots of nectar.

My petals are bright red or purple.

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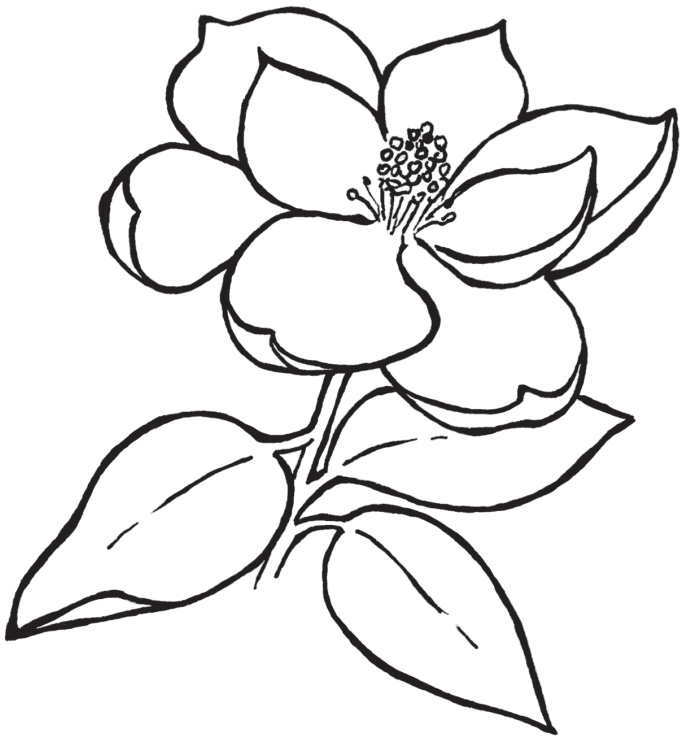


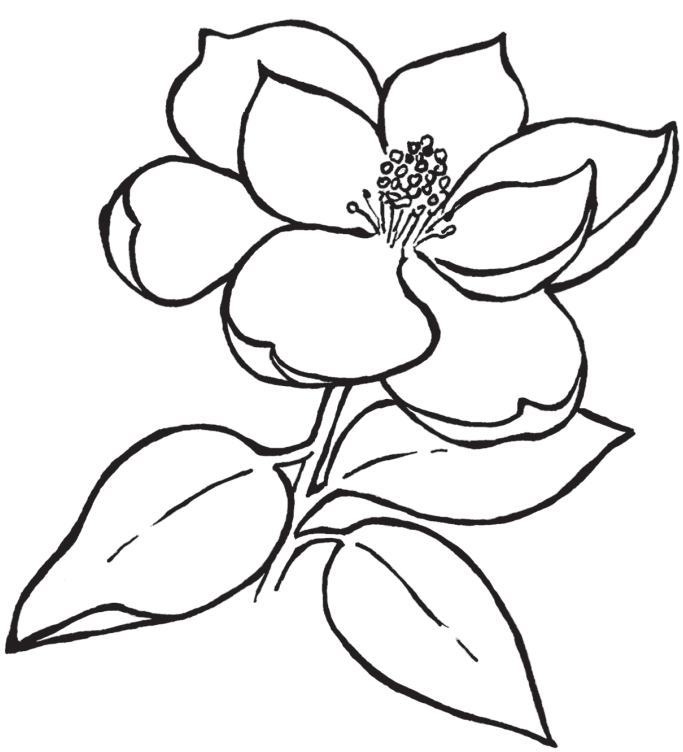
MAGNOLIA

I'm bowl-shaped.

My petals are white.

I open during the day.

I have lots of pollen to offer.



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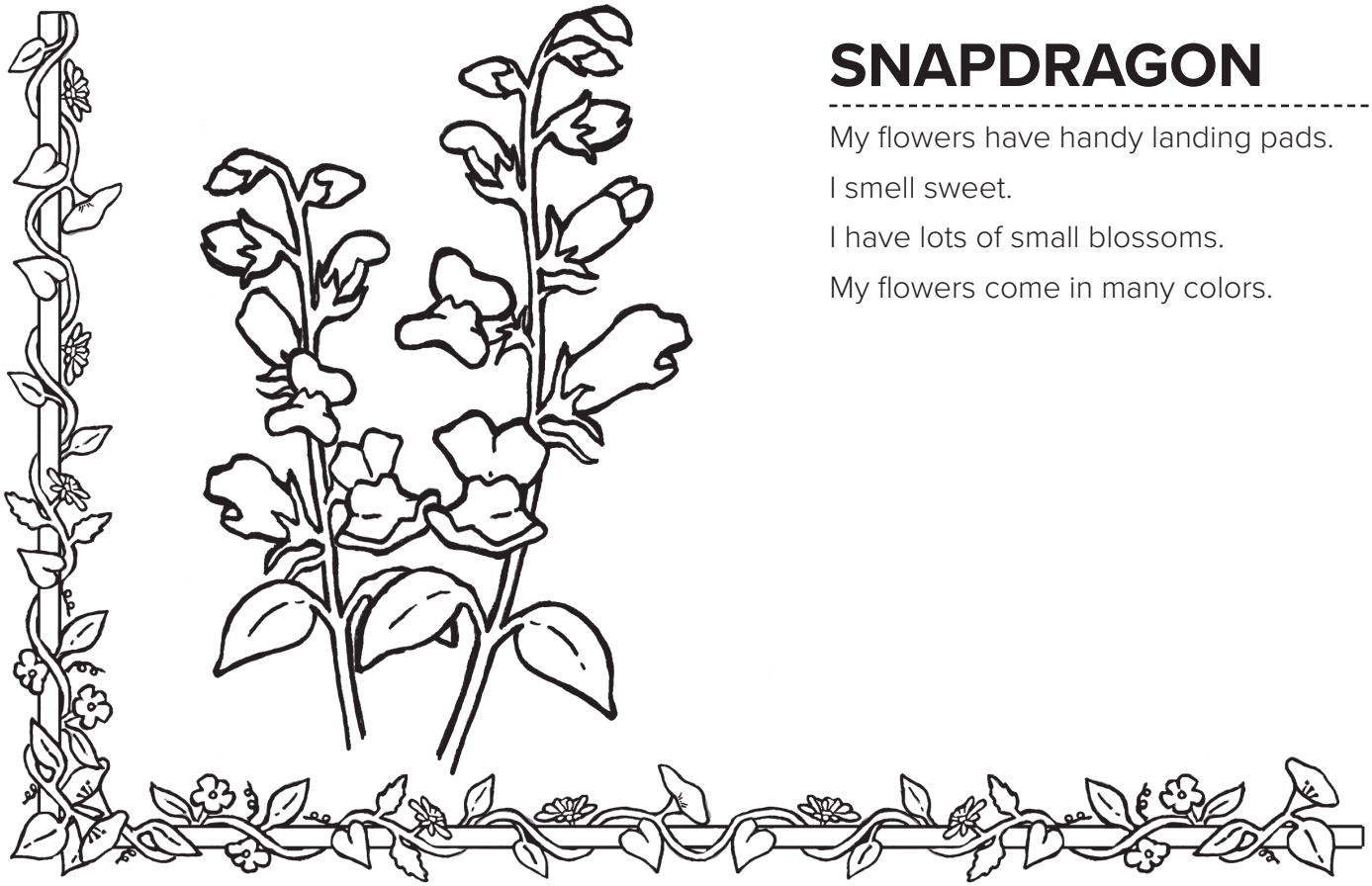


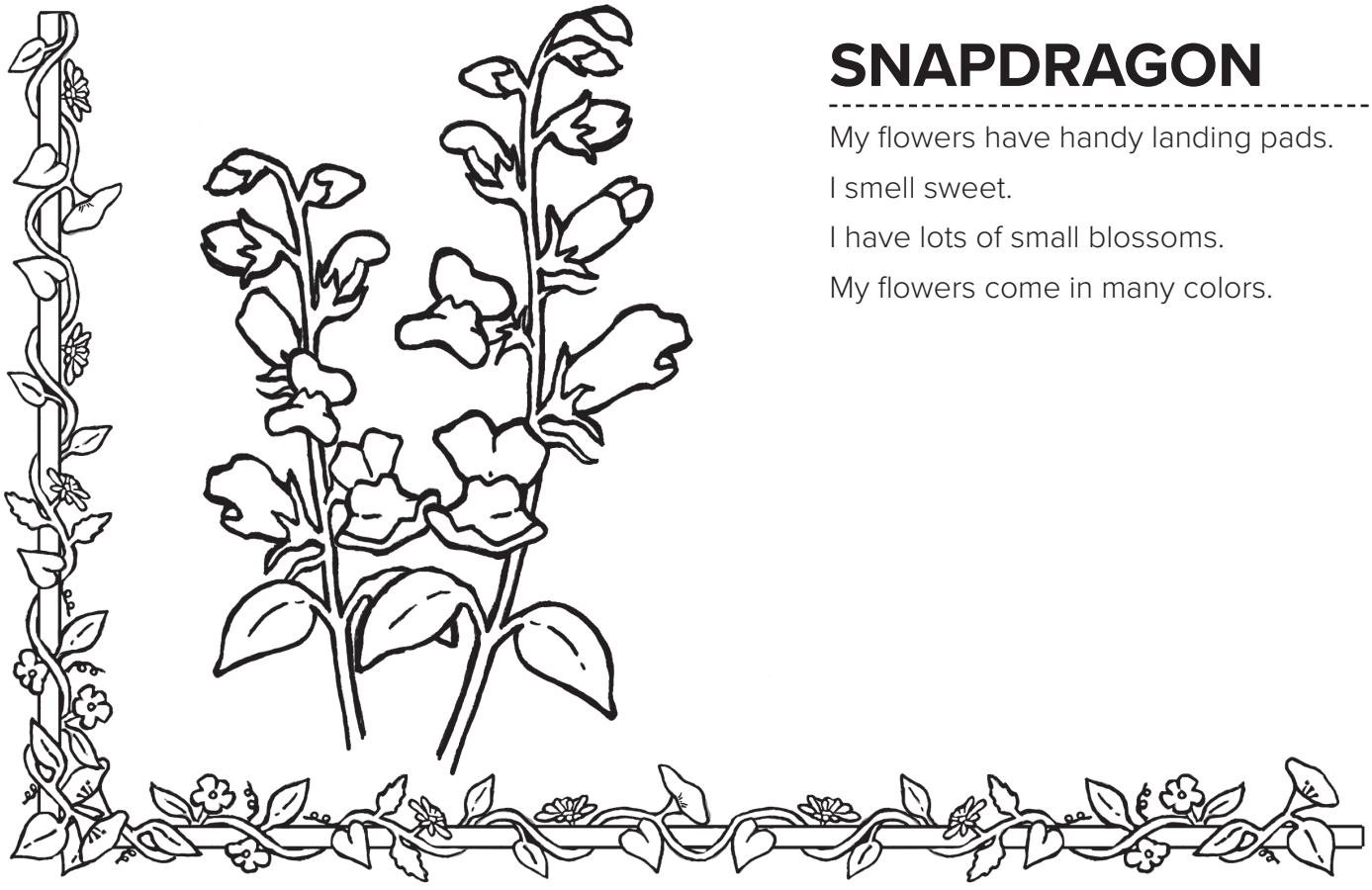
SNAPDRAGON

My flowers have handy landing pads.

I smell sweet.

I have lots of small blossoms.

My flowers come in many colors.



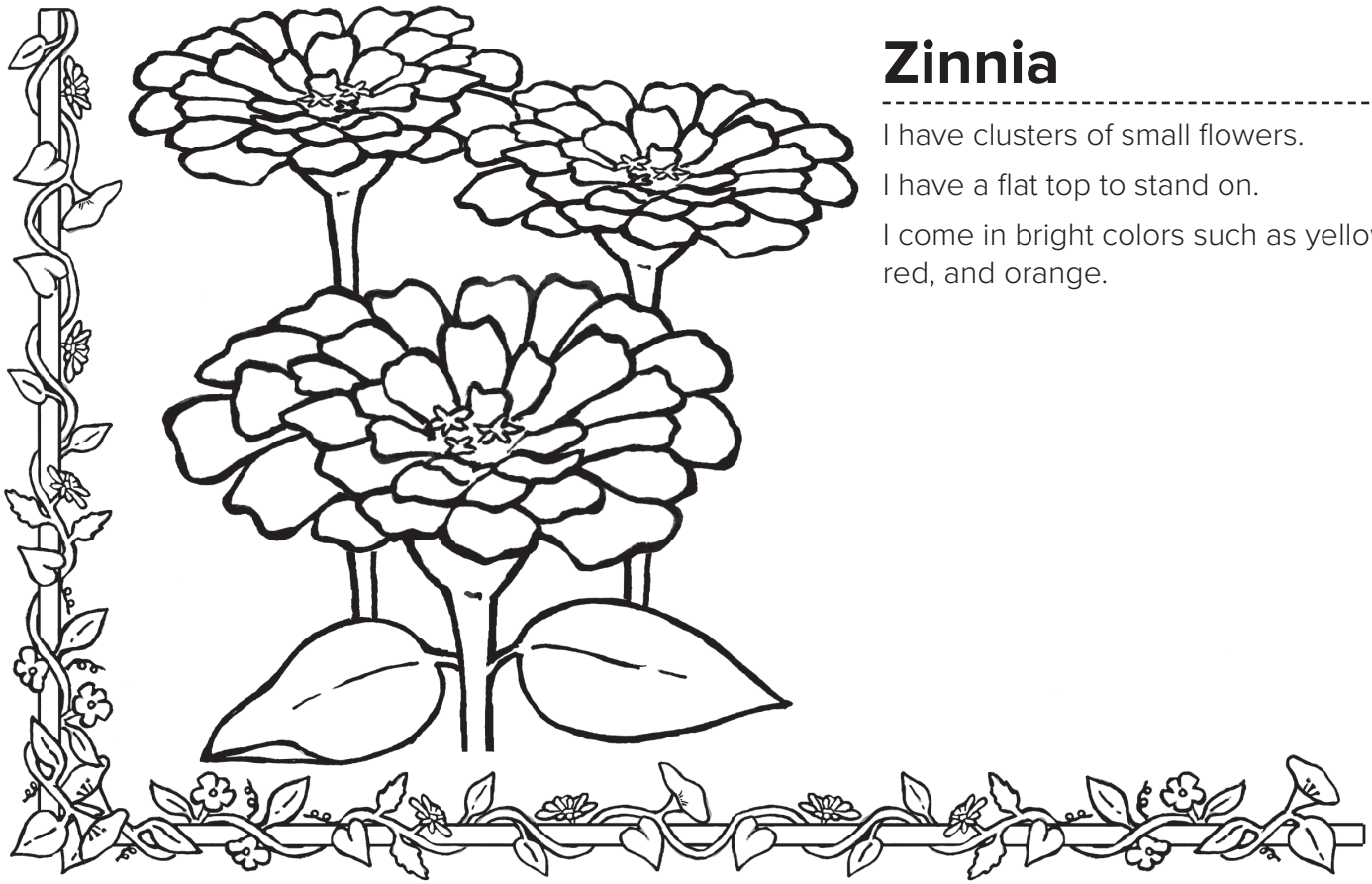
SNAPDRAGON

My flowers have handy landing pads.

I smell sweet.

I have lots of small blossoms.

My flowers come in many colors.

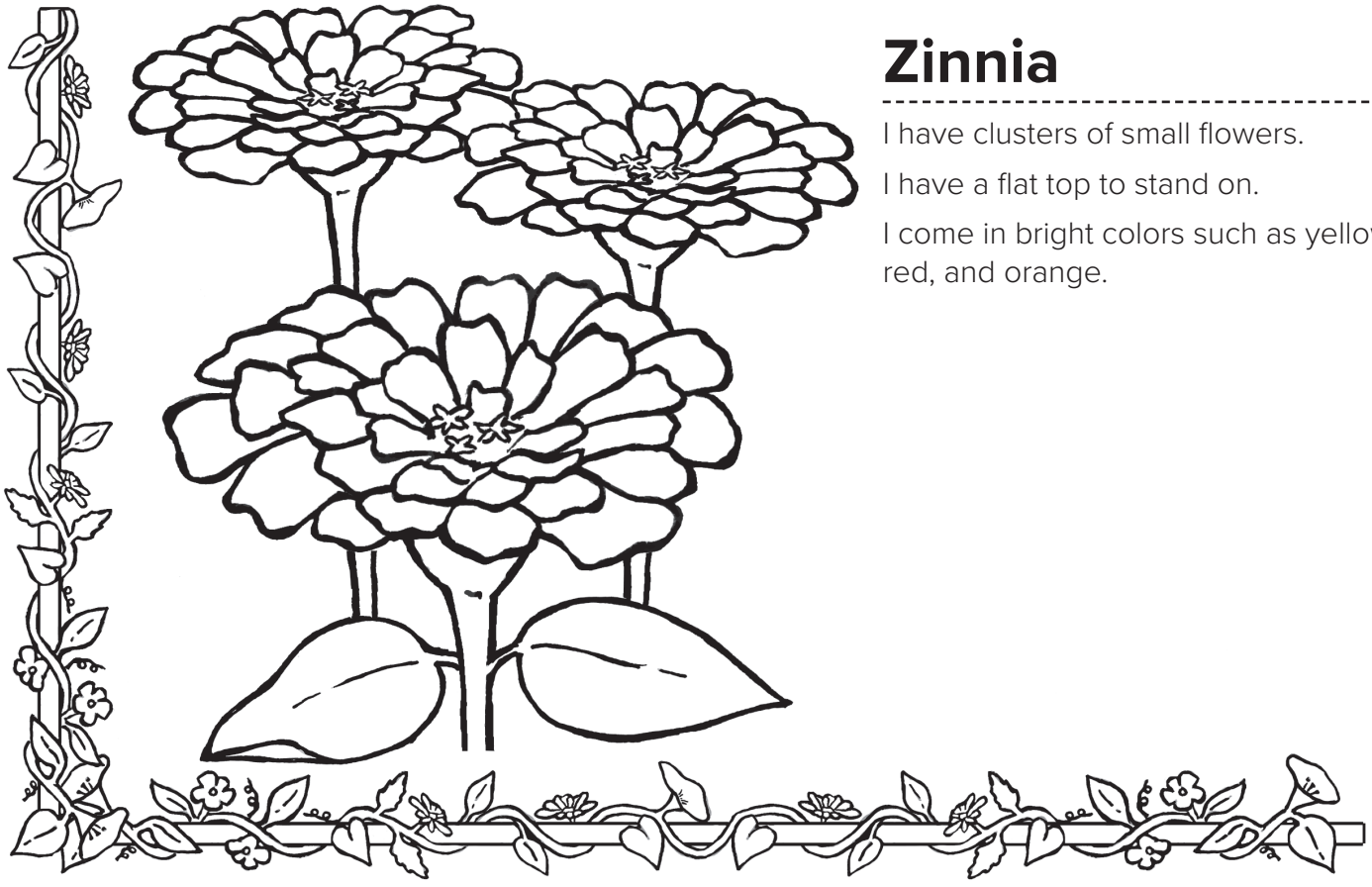


Zinnia

I have clusters of small flowers.

I have a flat top to stand on.

I come in bright colors such as yellow, red, and orange.



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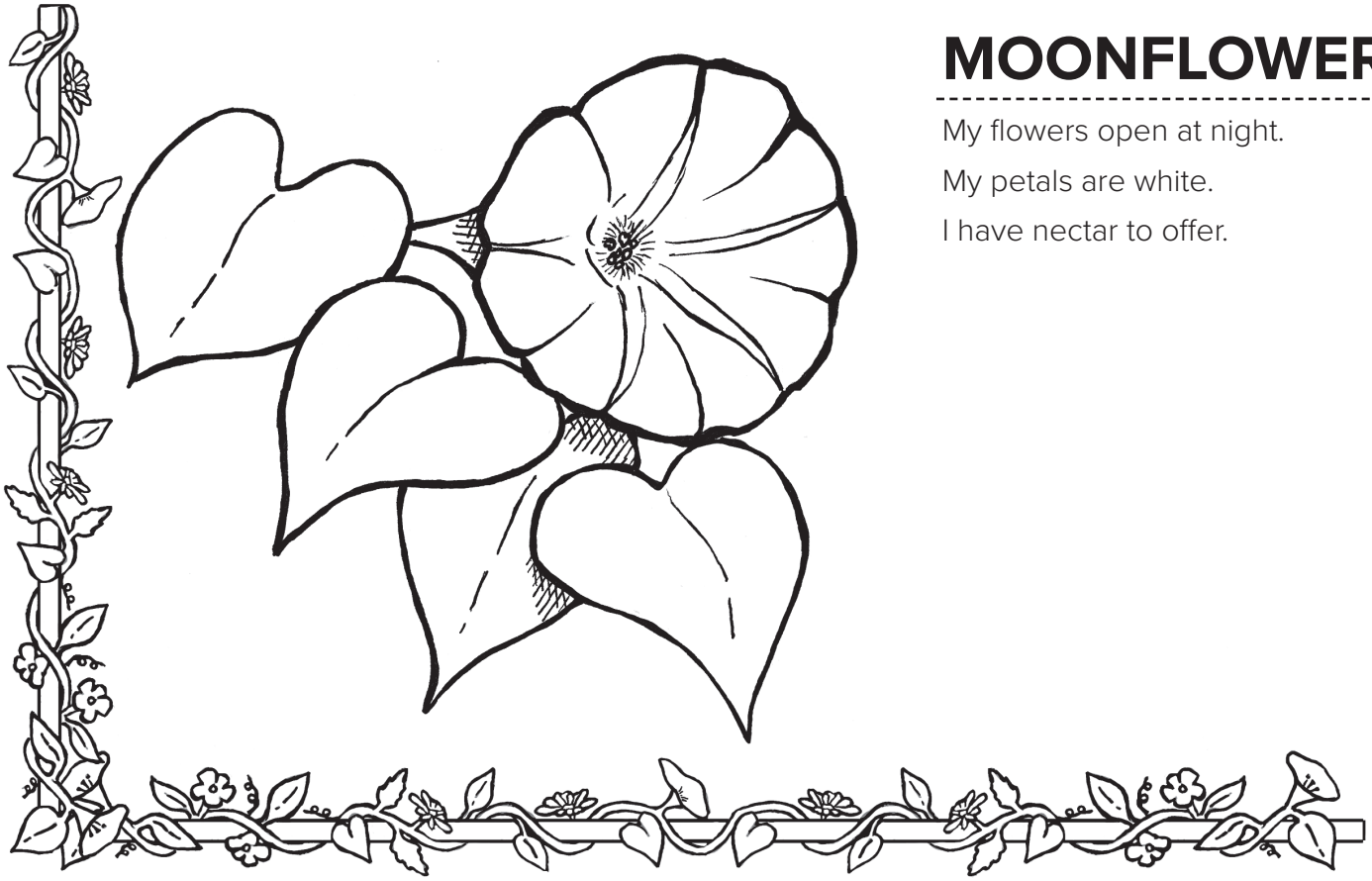
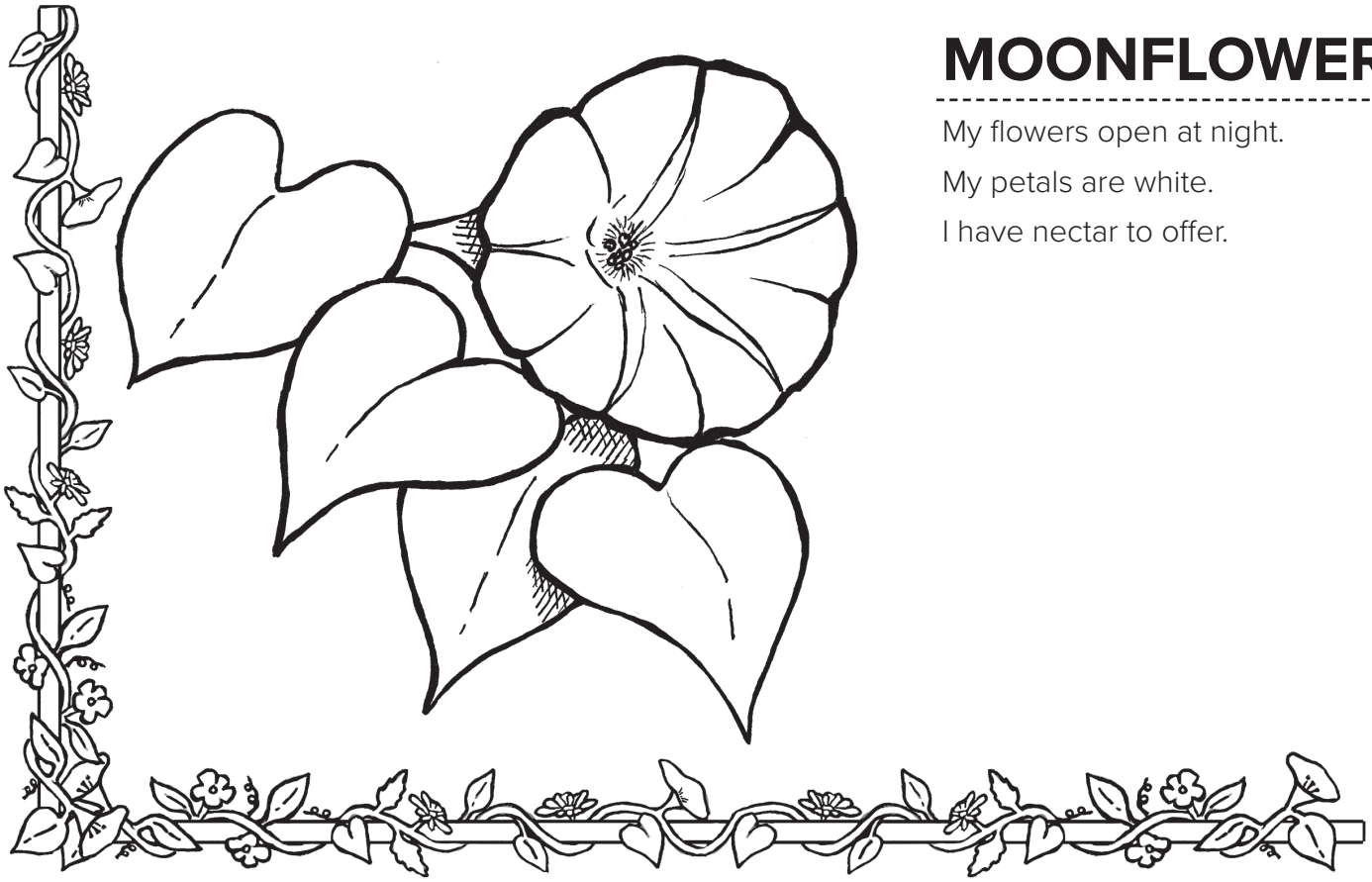


MOONFLOWER

My flowers open at night.

My petals are white.

I have nectar to offer.



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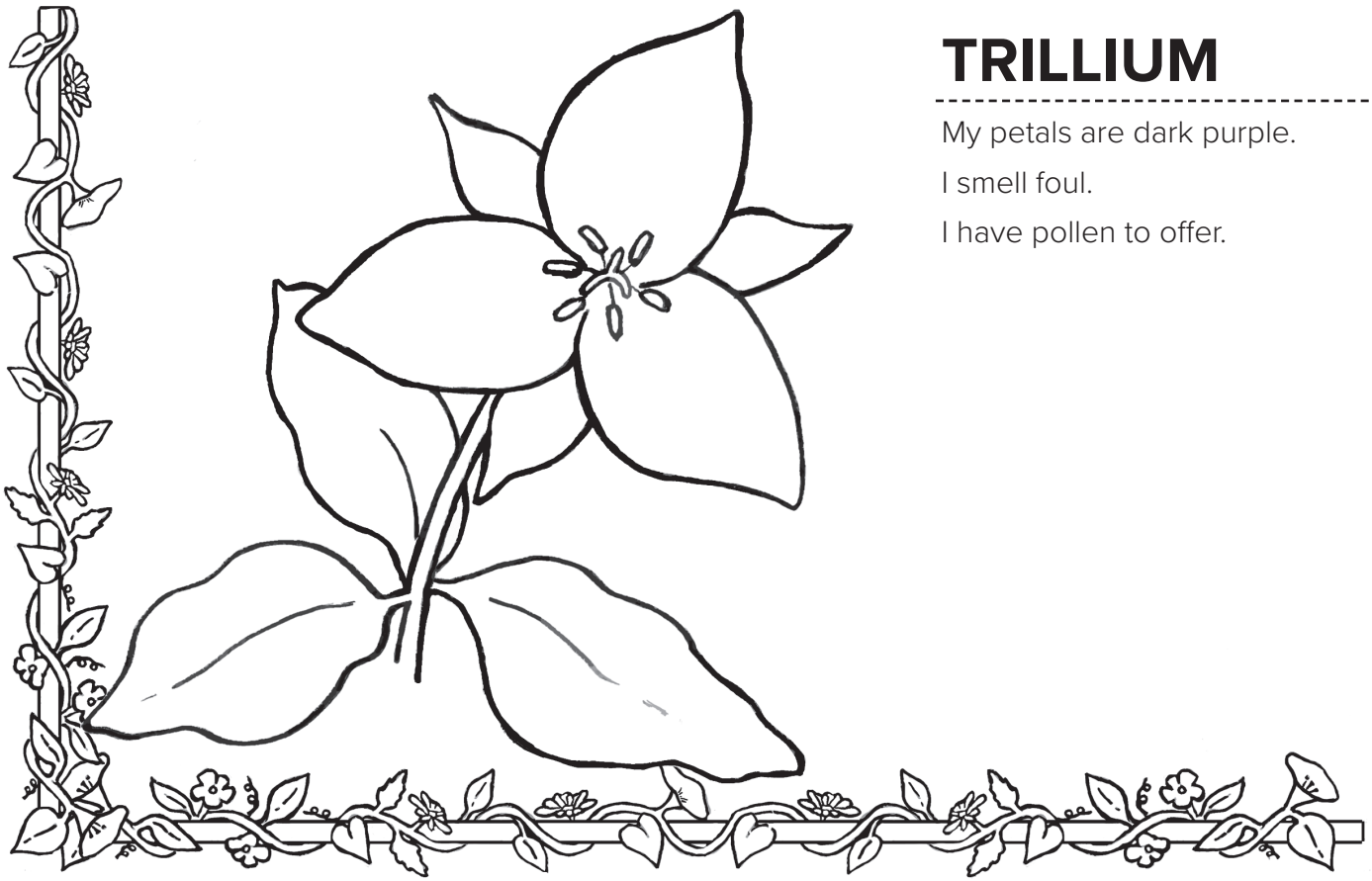
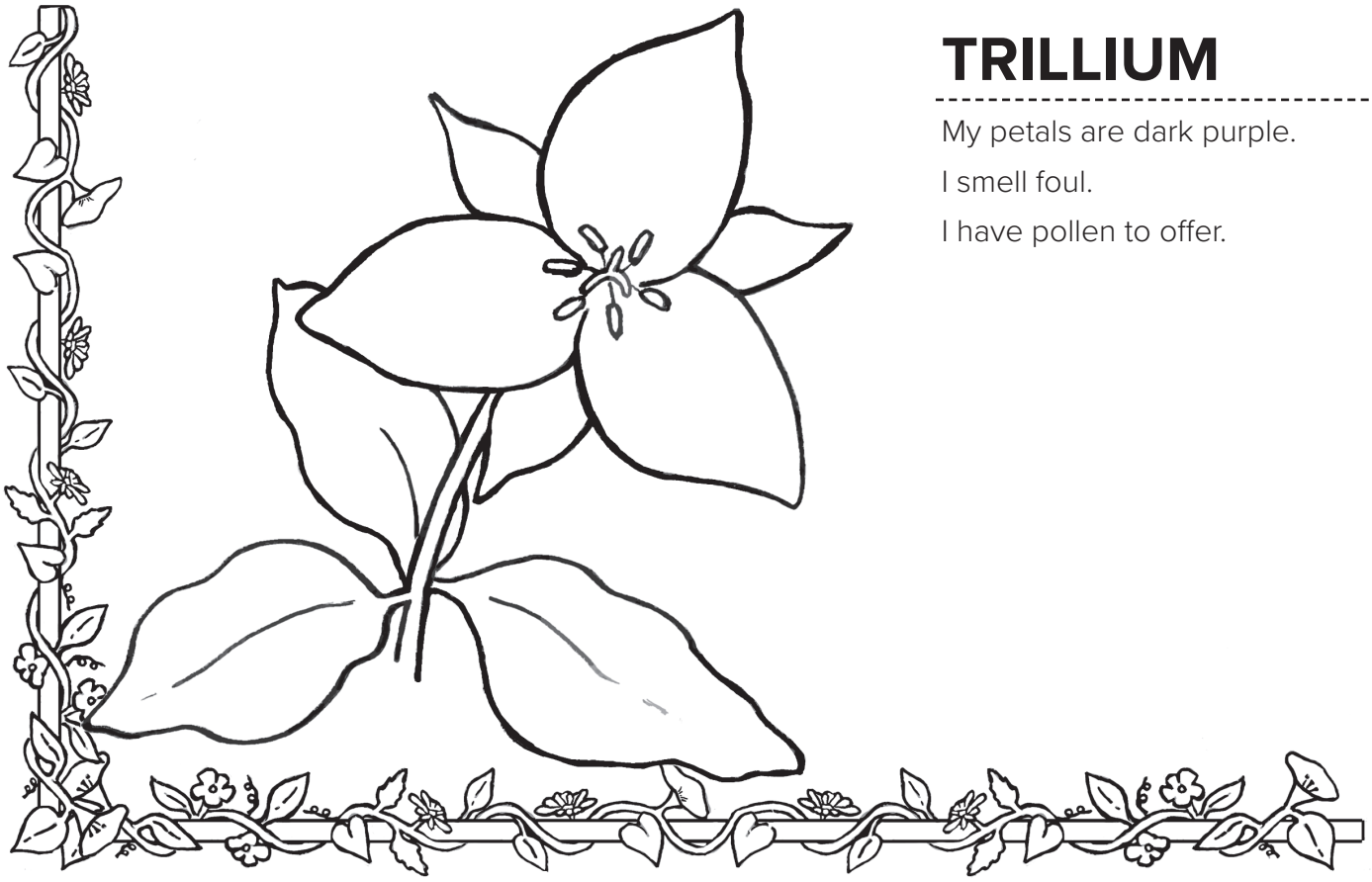


TRILLIUM

My petals are dark purple.

I smell foul.

I have pollen to offer.



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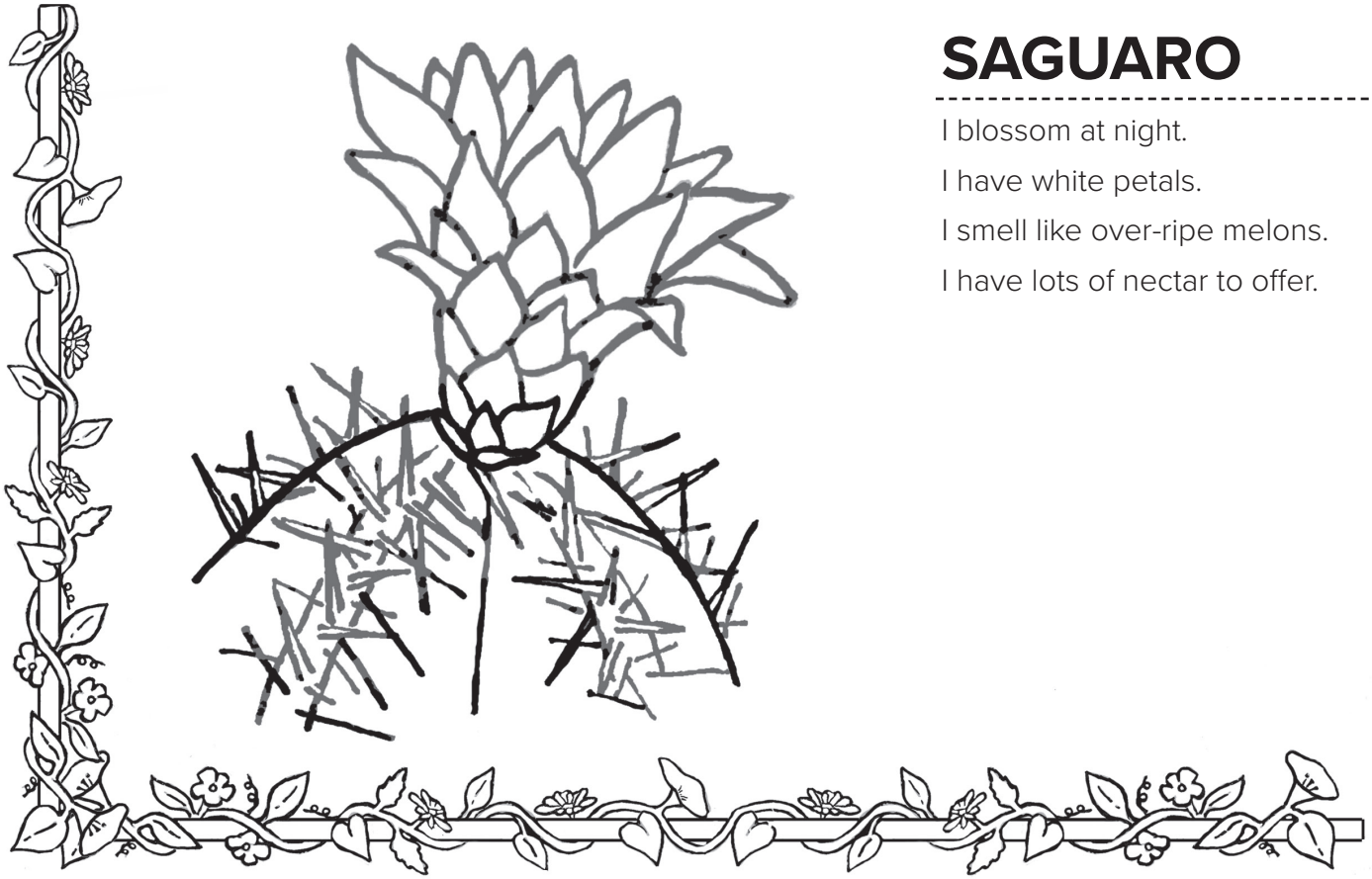


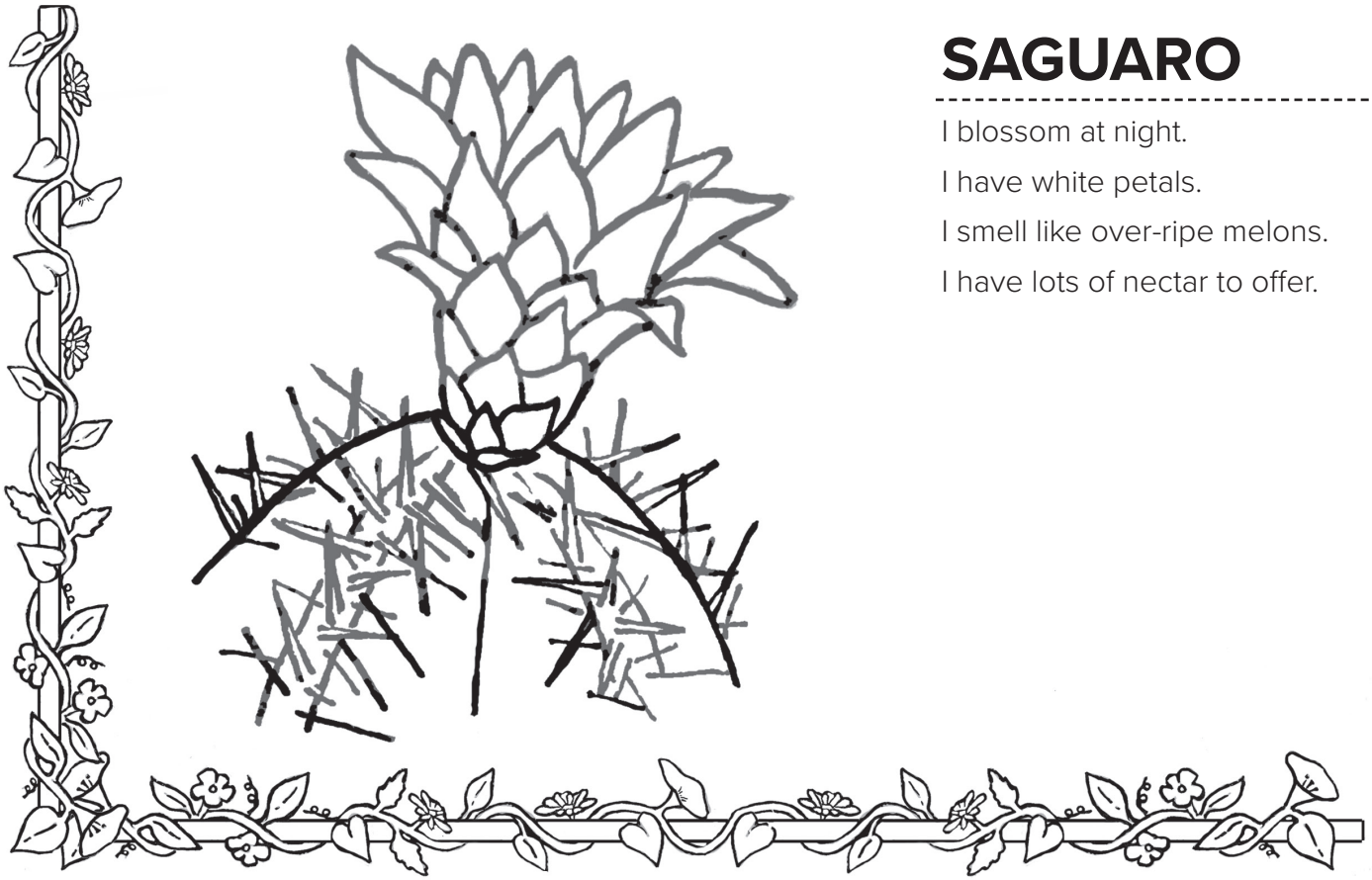
SAGUARO

I blossom at night.

I have white petals.

I smell like over-ripe melons.

I have lots of nectar to offer.



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BAT

I feed on nectar.

I like fruity fragrances.

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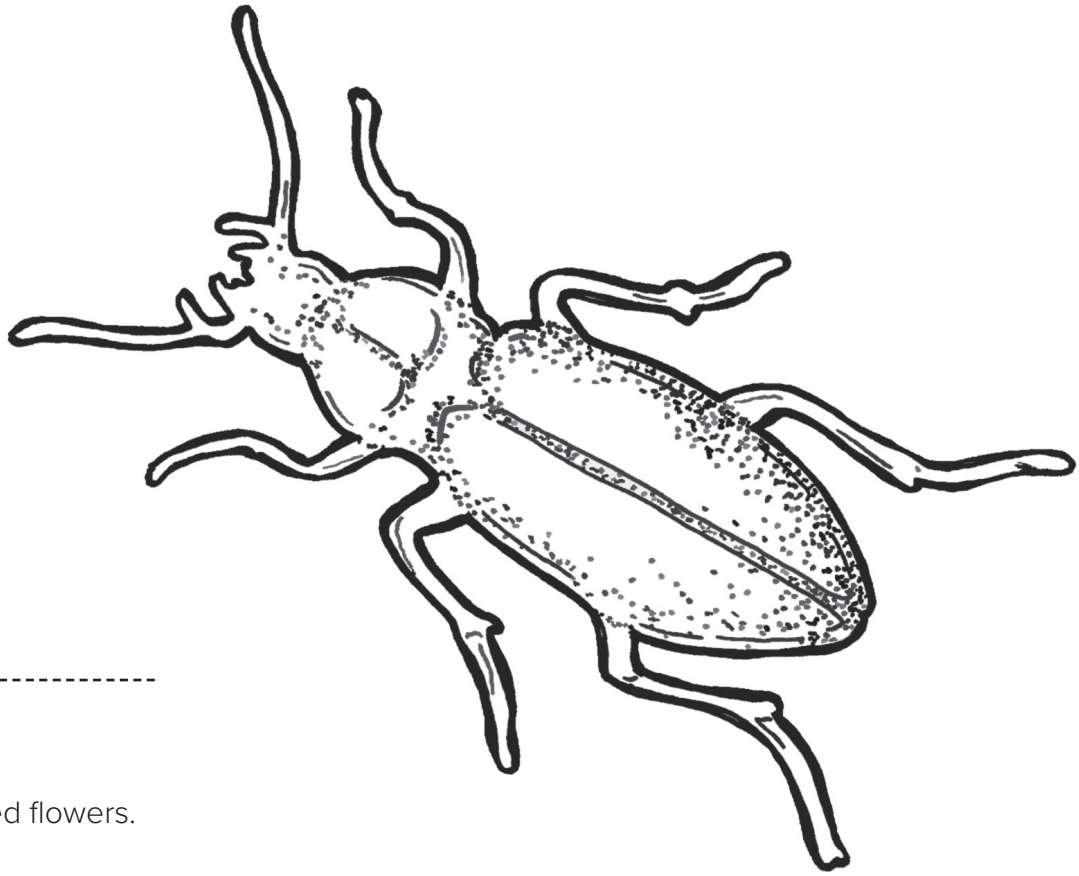
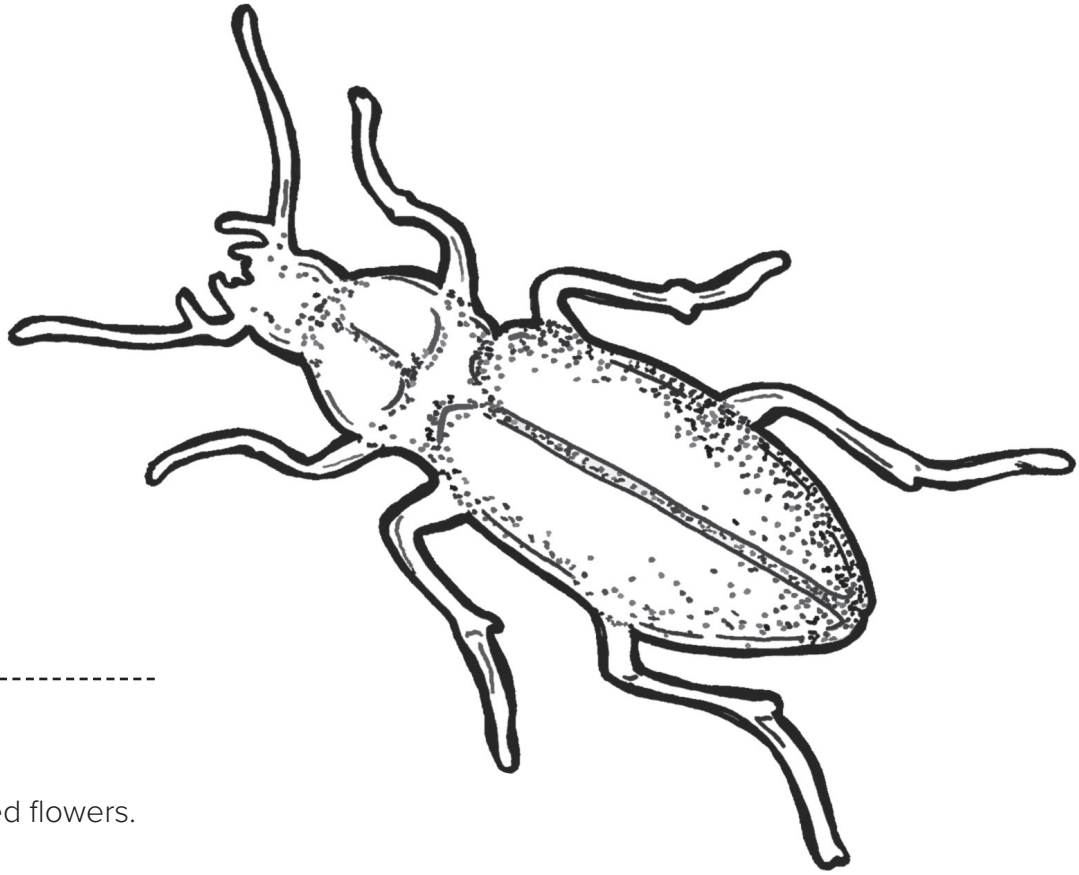


BEETLE

I eat lots of pollen.

I like white flowers.

I like, open, bowl-shaped flowers.



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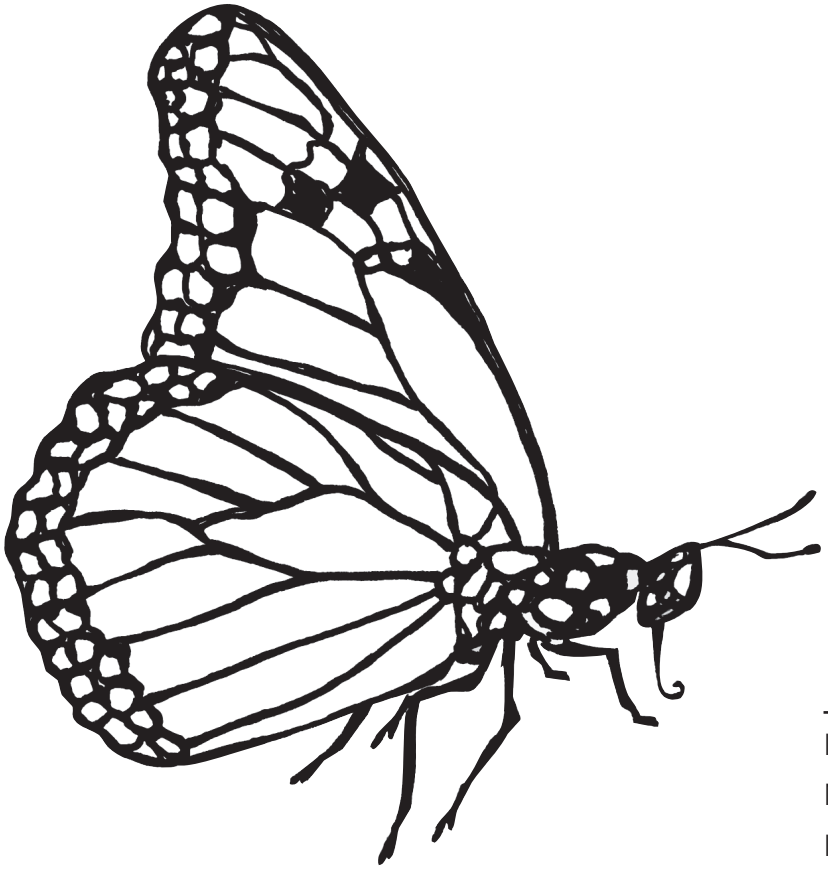
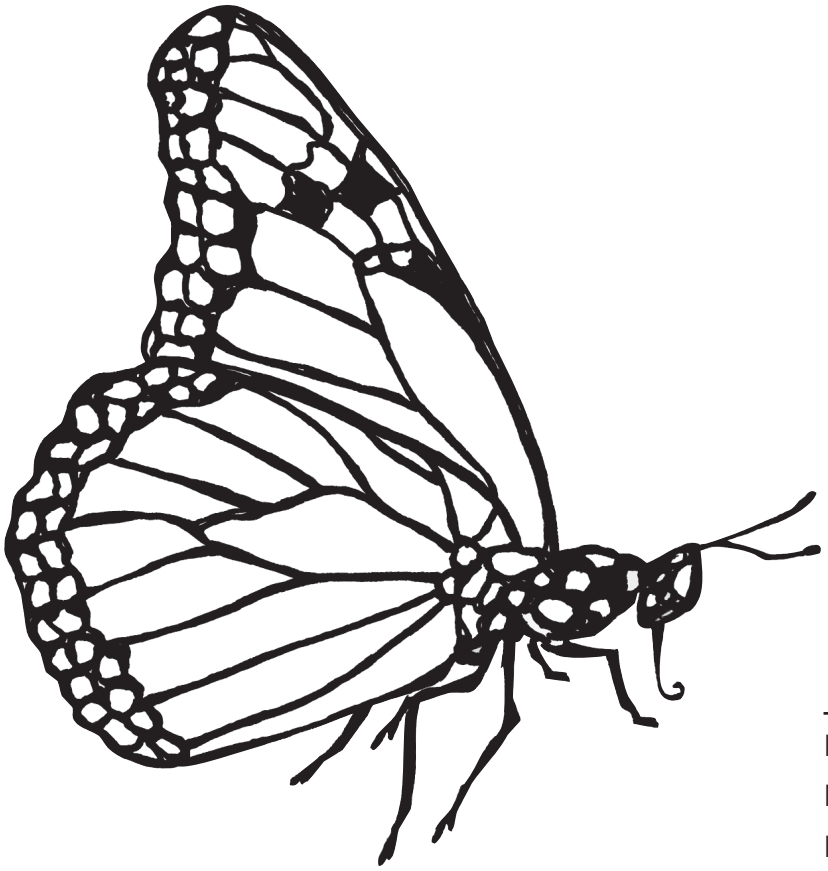


BUTTERFLY

I'm attracted to bright flowers.

Nectar is my main food.

I need a place to stand while I eat.



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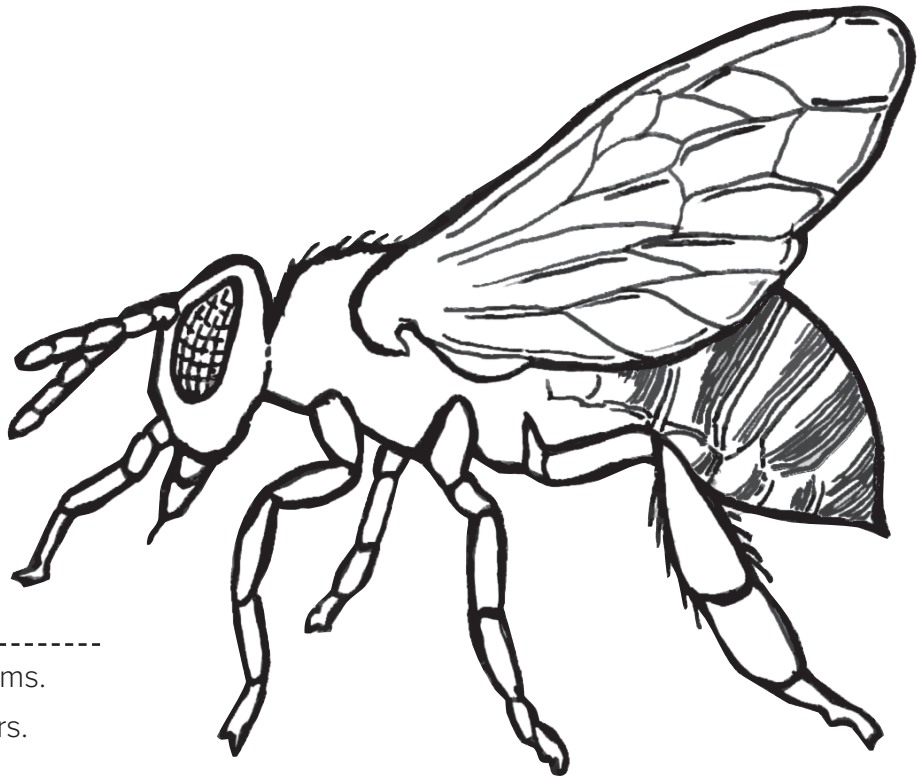


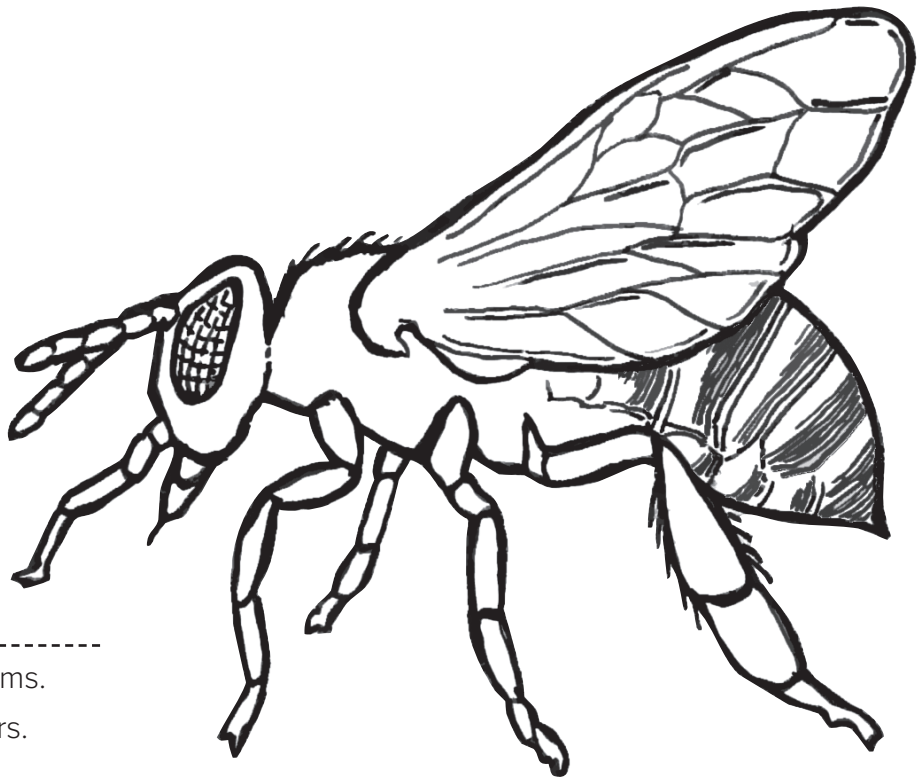
BEE

I like sweet-smelling blossoms.

I like clusters of small flowers.

I eat nectar and pollen.

I like having a place to land while I eat.



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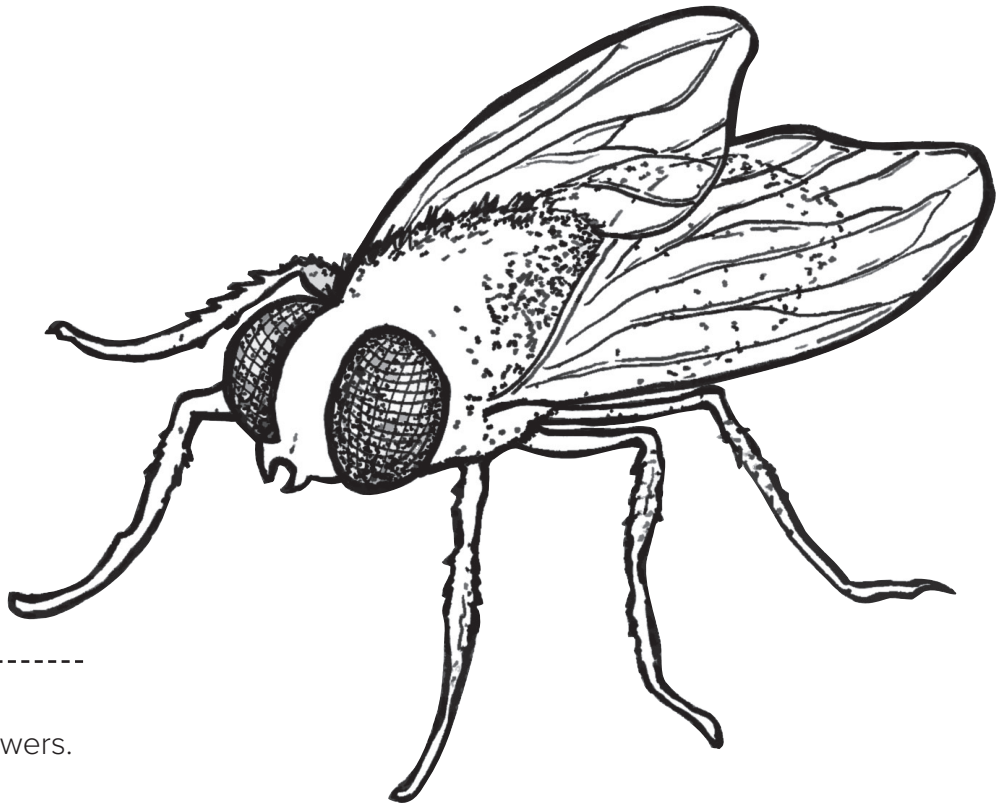
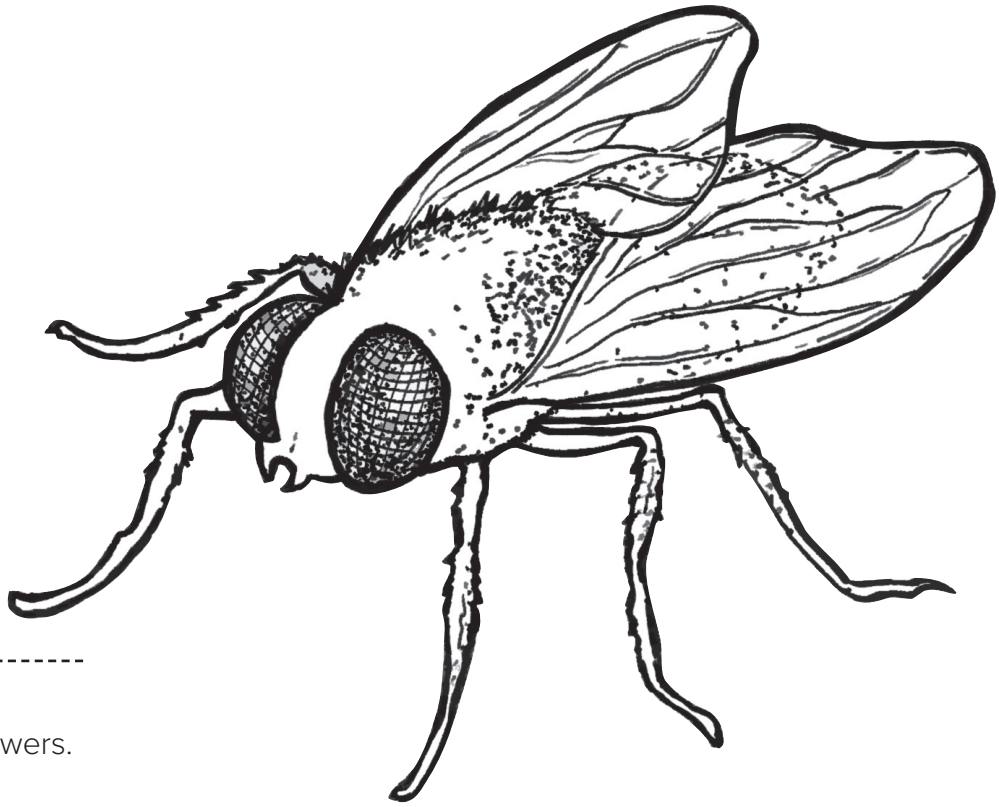


FLY

I eat pollen.

I like dark or pale-colored flowers.

I'm attracted to foul odors.



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I hover to eat.

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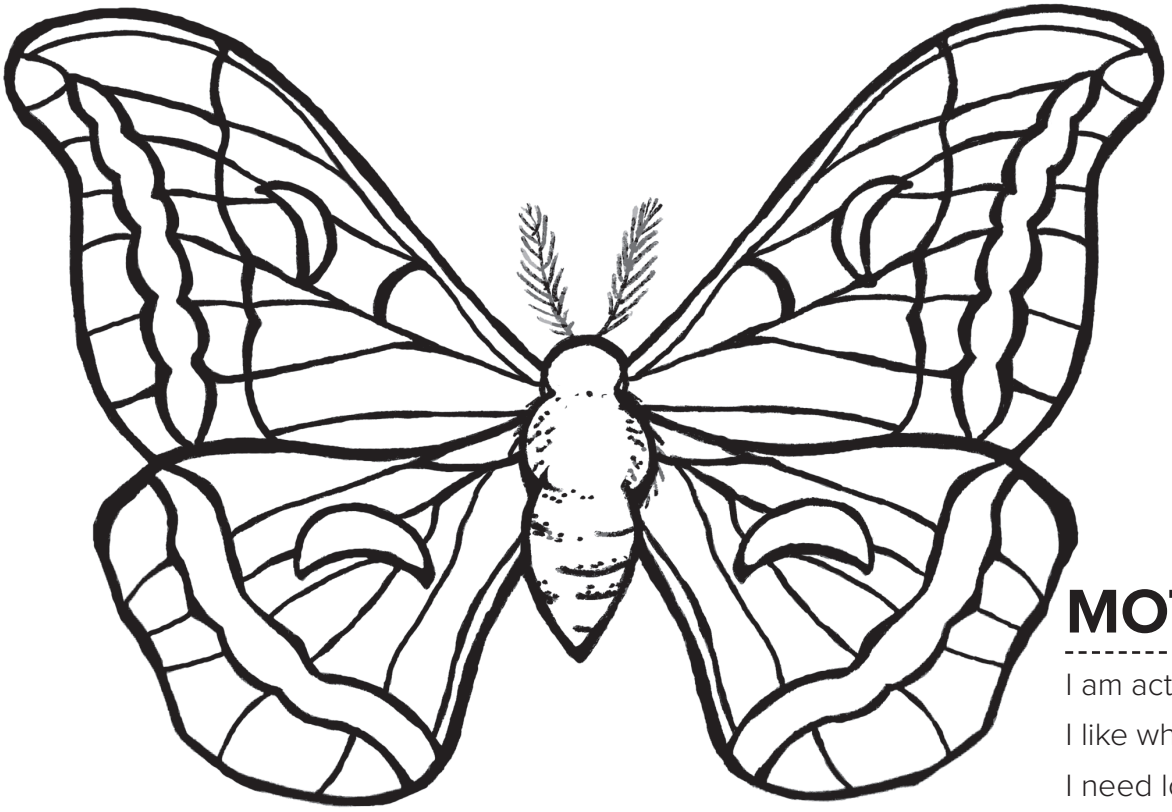
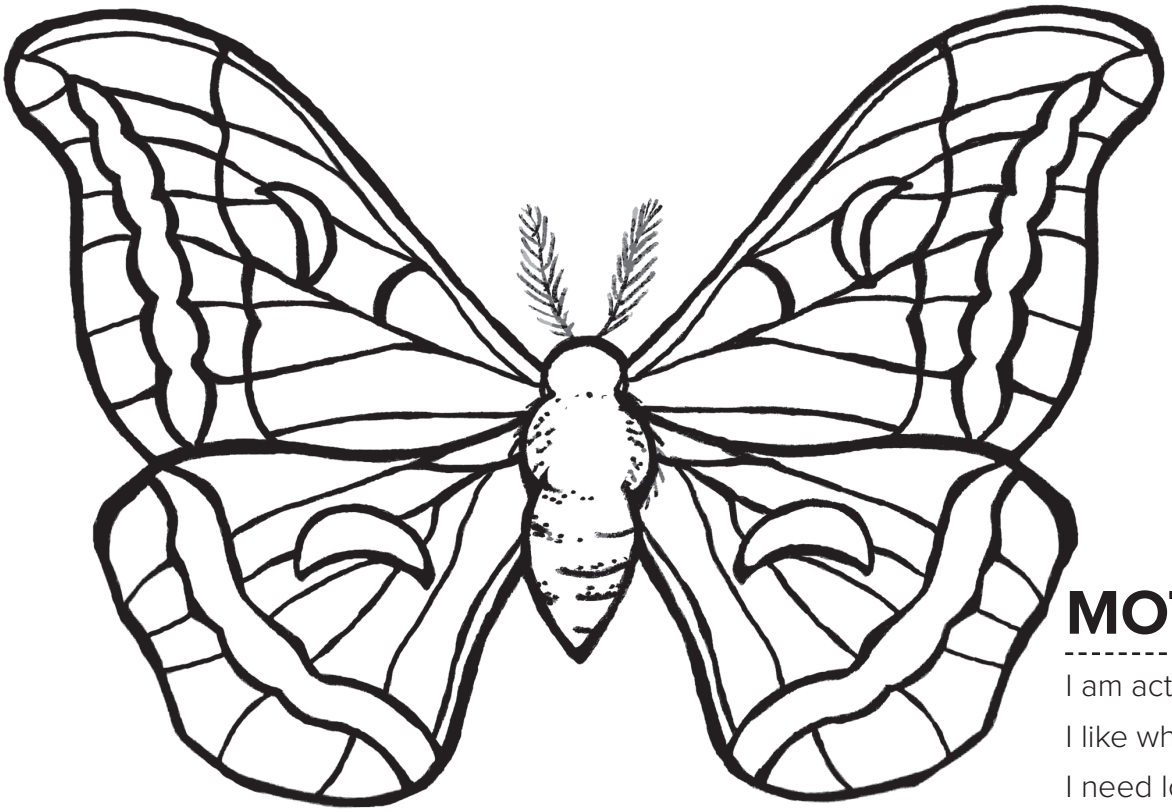


MOTH

I am active at night.

I like white flowers.

I need lots of nectar.



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