Urban Pollinator Program
Curriculum Guide
K-12

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How to Use This Curriculum Guide

The Urban Pollinator Curriculum Guide is an instructional resource for educators who want to enrich their curriculum and learn about pollinators and their importance to the Earth. It can be used by teachers who have planted a pollinator garden, have access to a pollinator garden or as a standalone resource.

Supporting Standards

The activities found in the Urban Pollinator Program Curriculum Guide are intended for use in the classroom and informal settings. The instructional materials are designed to support North Dakota Life Science Academic Standards appropriate for grades K-12. The activities can easily by adapted to meet the learning requirements. The activities may be integrated into existing curriculums or an entire set of activities may serve as the basis for a specific course.

Organization of Materials

The Urban Pollinator Program curriculum is divided into three sections: (1) Pollinator Plants (2) Pollinators (3) and Sustaining Pollinators.

Section One: Pollinator Plants

Activities found in this section are lessons that focus on the different types of pollinator plants, parts of plants and flowers, and where pollinator plants can be found in North Dakota.

Section Two: Pollinators

This section introduces the different types of pollinators, how they impact the world, and where they can be found.

Section Three: Sustaining Pollinators

Activities found in this final section are designed to take students from understanding scientific concept to implementing action to sustain pollinators.

Organization of Each Activity

Each activity includes a statement of the instructional objective, background information, a list of materials, any preparation educators need to do prior to completing the activity, step-by-step instructions, and extensions or additions to the activity. Activities may be adjusted by educators for use with broad grade levels as appropriate.

About the Student Page

Student pages are designed to be reproduced and used in the classroom by students to orgranize information, record data or complete the lesson. Use them as they are or as a model.

Outside or Inside?

Many lessons can be done both inside or outdoors. Some activities are just outside while others have two parts, with the first part indoors and the second outside. The best location of an activity is indicated by a symbol in the upper right corner of the page.

Classroom activities = 

Outdoor activities = 

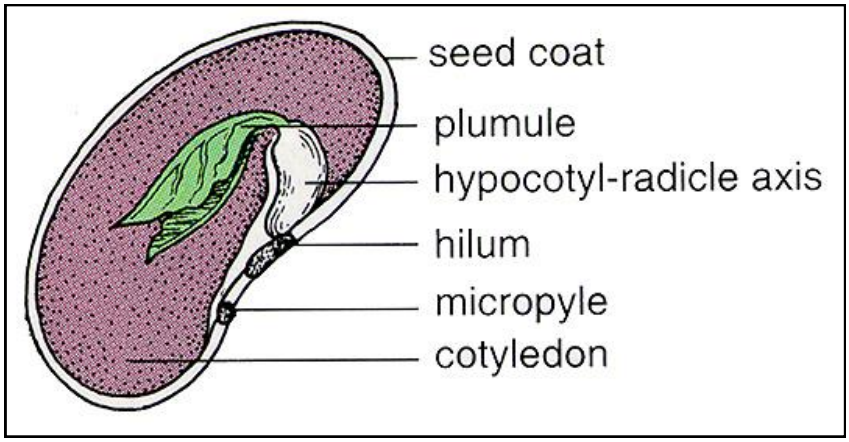
Pollinator Plants

Inside the Seed

Objective: Students will learn the anatomy and functions of seeds.

Materials: Bean seeds, magnifier, paper and pencil.

Background: Inside each seed is a plant embryo. Water triggers germination in the embryo. Then the complex starches in the cotyledons and endosperm are changed into usable sugars and sent to the embryo.



The embryo's root, called the radicle, begins to grow and push into soil, where water and minerals are available for future food production. The seed's first leaves are cotyledons and are pulled up through the soil by the stem. From there they expand and turn green.

Procedure: Before the activity, soak all beans overnight. This will cause the beans to expand, splitting the outer coat. The halves are easily pried apart.

Give each student two bean seeds. Have students remove the seed coat and pry apart the halves. Have students use magnifiers to observe the plant embryo inside the seed. Explain the function of each seed part.

Fold a damp paper towel to fit flat inside a sandwich bag. Place beans in the bag and tape to a window with the beans facing inside the room. Have students keep a plant journal, recording daily observations and drawing pictures of the changes that bean seeds go through as they grow. Use **Plant Journal** as a template for the student's journal.

Plant Journal	Plant/Seed Description (draw or describe the seed)
Day 1	
Day 2	
Day 3	
Day 4	
Day 5	

Flower Dissection

Objectives: Students will become familiar with flower parts from simple flowers.

Materials: Simple flowers, tweezers, white paper, clear tape and pencil.

Background: Simple flowers are the oldest varieties of flowers. They have many petals the same shape.

Simple flowers contain only a single flower. Flowers come in a variety of shapes, and some species display unusual structures, such as composite flowers containing hundreds of tiny individual florets, or the inconspicuous flowers of grasses and many deciduous trees. Simple flowers are one easily recognizable type of flower.

Simple flowers occur singly, rather than in clusters. Their petals tend to emerge in a circular pattern from the center of the flower, and if you divide the flower in half at any point, you will find symmetry. Simple flowers generally have between three and six petals. Examples of simple flowers include strawberry, violet, lily, water lily, geranium and buttercup.

At first glance, a compound or composite flower like the aster would appear to be a simple flower, but they are not. Their sepals are really bracts, modified leaves, and often are layered. Their "petals" are individual flowers (ray flowers), which also have stamens and pistils and their heads (disk flowers) are made up of many tiny individual flowers, each of which produce their own seeds. Some composite flowers have only ray flowers, like dandelions and some have only disk flowers, like thistles, but most have both, like sunflowers, daisies and zinnias.

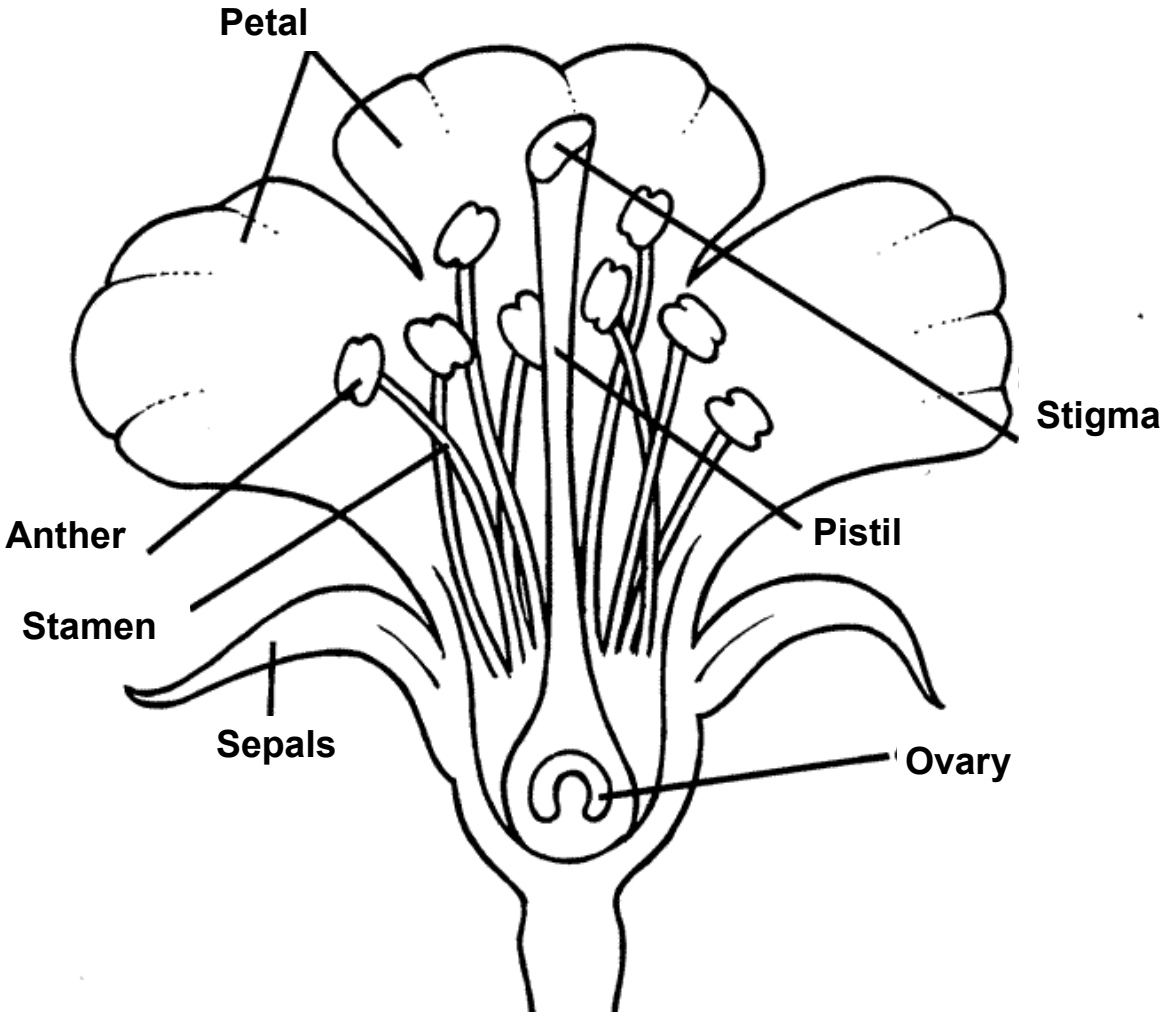
The sepals are small green floral parts that protect the developing flower bud like a suit of armor and are the outermost flower parts and create a whorl called the calyx. When the flowers bloom, the sepals usually remain green and are thicker than the petals.

Petals function to use their shape, size and color to attract pollinators. These showy parts together make up the corolla.

Stamens are the male part of the flower that make and hold the pollen. Stamens consist of a filament growing with a pollen bearing anther. Stamens can stand free or are sometimes fused together.

A pistil is the female part of the flower. It has a sticky top (stigma) to capture pollen. Once the pollen is on the pistil, it travels down to the ovary and fertilizes the waiting egg, which eventually forms a seed. A pistil consists of an ovary, which contains the egg-bearing ovules, and a style, the elongated tube connecting the sticky stigma to the ovary.

Flower Diagram



Procedure:

Divide students into groups of two or three students. Explain the difference between simple and compound flowers. Use the flower diagram to identify different flower parts and each part's function.

Pass out simple flowers and tweezers to each group. First use tweezers to remove the outer green petal-like structures, or sepals. Have students tape the sepals to the white paper and label them.

Next, have students remove the petals, stamens and pistil. Carefully tape and label them on the white paper.

**Before taping down the stamens, shake some of the pollen grains from the anthers onto the paper and tape down with clear tape.

If students have different flower types, have them compare and contrast shapes, colors, size, etc.

You may want to demonstrate the flower dissection before students begin.

Pollinator Garden Quest: *Flowers*

Directions Have students observe plants and pollinators in your neighborhood, on a field trip or in your pollinator garden only to complete the pollinator garden quest. Be sure to set a time. Students can work individually or in small groups.

Describe a flower that is blooming. Can you identify it? What color is it? Draw the flower:	Describe something that smells good. What does it smell like? Draw:
Find three different shaped leaves. What plants do they come from? Draw the leaves:	Describe something that is not living. How can you tell is not alive? Draw:

Sorting Soil

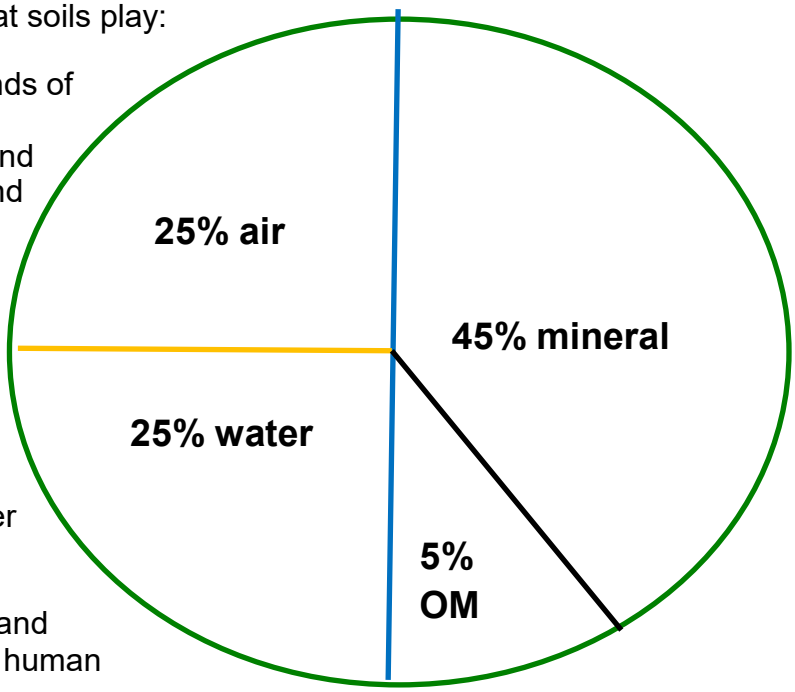
Objective: ***Students will learn the different soil components.***

Materials: Six different soil samples, bag of potting soil and sorting page.

Background: The four main components of soil are rocks (minerals), water, air and organic material (leaves and decomposed animals, etc.). The fifth component of soil, which isn't always recognized, is the living world that exists under the ground, or the biological component. Rich garden soil is approximately 45 percent rocks and minerals, 5 percent organic matter and 25 percent each water and air. All soils have some mixture of the five basic components.

Soil performs many critical functions in almost any habitat (badlands, prairie, wetlands, woodlands or riparian). There are seven general roles that soils play:

- Soils serve as medium for growth of all kinds of plants.
- Soils modify the atmosphere by emitting and absorbing gases (carbon dioxide, methane and water vapor) and dust.
- Soils provide habitat for animals (such as badgers and mice) to organisms (such as bacteria and fungi), that account for most of the living things on Earth.
- Soils absorb, hold, release, alter and purify most of the water in terrestrial systems.
- Soils process recycled nutrients, including carbon, so that living things can use them over and over.
- Soils serve as engineering medium for construction of foundations, roadbeds, dams and buildings, and preserve or destroy artifacts of human endeavors.
- Soils act as a living filter to clean water before it moves into an aquifer.



Soil Types

People describe soil types in all kinds of ways such as heavy, light, sandy, clay, loam, poor or good. Soil scientists describe soil types by how much sand, silt and clay are present. This is called texture. It is possible to change the texture by adding different things. Changing texture can help in providing the right conditions needed for plant growth.

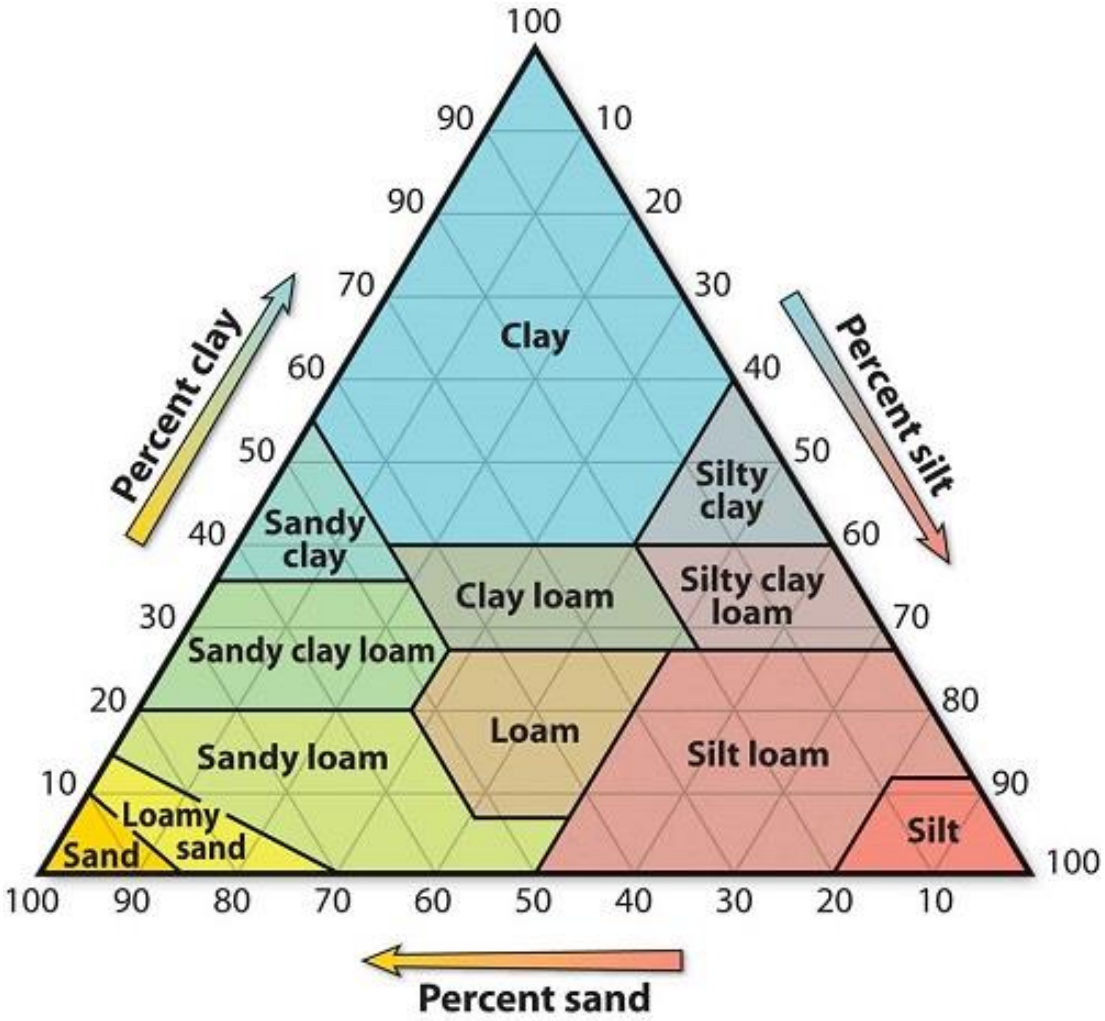
Sand is the largest particle in the soil. When you rub it, it feels rough. This is because it has sharp edges. Sand doesn't hold many nutrients.

Silt is a soil particle and is between sand and clay in size. Silt feels smooth and powdery. When wet it feels smooth, but not sticky.

Clay is the smallest of particles. Clay is smooth when dry and sticky when wet. Soils high in clay content are called heavy soils. Clay also can hold a lot of nutrients, but doesn't let air and water through it well.

Particle size has a lot to do with a soil's drainage and nutrient holding capacity.

Soil textures can be classified using the soil texture triangle.



Soil scientists classify soils based on the following characteristics:

- Soil biology
- Fertility
- Particle density
- Salinity
- Bulk density
- Horizons
- Particle size distribution
- Structure
- Chemistry
- Infiltration
- pH
- Temperature
- Color
- Magnetism
- Porosity
- Texture
- Consistence
- Moisture
- Quality

Procedure:

Divide students into small groups. Give each group one of the collected soil samples and a sample of potting soil.

Have each group sort the soils on the soil sorting page. Students can sort samples by separating twigs, leaves, pebbles, rocks, animal parts and live animals. Place each group of items onto the section on the sorting page. Once all groups have sorted their soil samples and potting soil sample, have the class compare soil samples. Students should be able to focus their responses by using the student page below.

Student Page

Describe each soil. How are each of the soils different?

How are each of the soil samples the same?

Does the potting soil have something that is important to plants? What?

Could different types of soils be better for growing different kinds of plants? How?

Soil Sorting Page

Leaves 	**Twigs** 	**Soil sample** 
Pebbles 	**Rocks** 	
Animal parts 	**Live animals** 	
Unidentified items		

Pollinators

The Key to a Butterfly

Objective: Students will identify the parts of a butterfly and use them for classifying different butterflies.

Materials: *Butterflies, Moths, Damselflies and Dragon Flies of North Dakota Field Guide*, paper and writing utensil.

Background: Taxonomy is the scientific classification used to classify all living things. The system used today is called the Linnaean system of binomial nomenclature and was developed by Carolus Linnaeus of Sweden (1707- 78). He separated plants and animals according to physical similarities he saw and gave each species a name. Using Latin or Greek, Linnaeus classified species using seven main categories from general to most specific: kingdom, phylum, class, order, family, genus and species. Butterflies are classified:

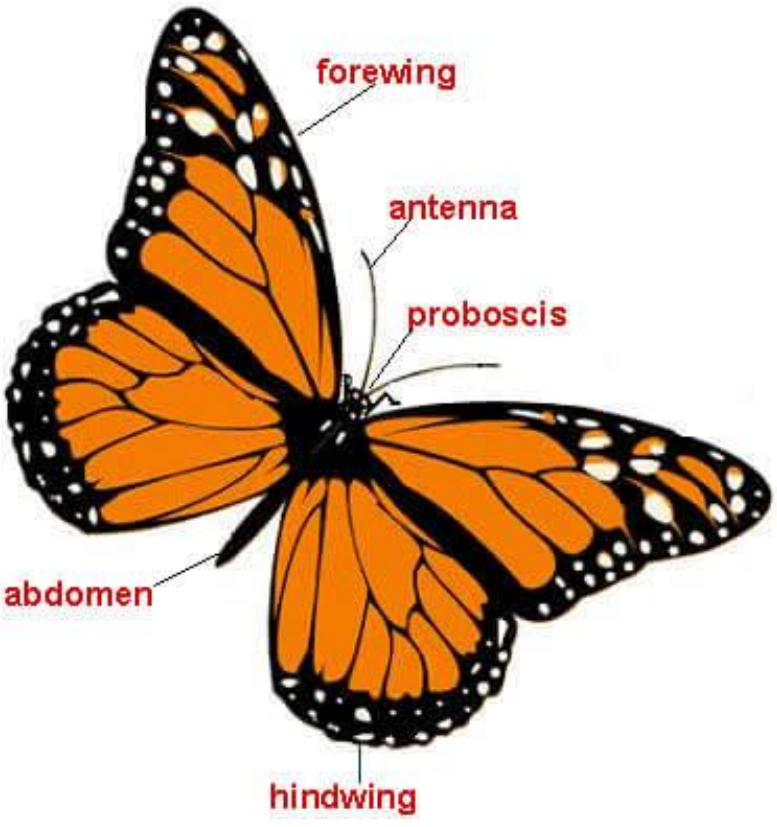
Kingdom: *Animalia*
Phylum: *Arthropoda*
Order: *Lepidoptera*

Procedure:

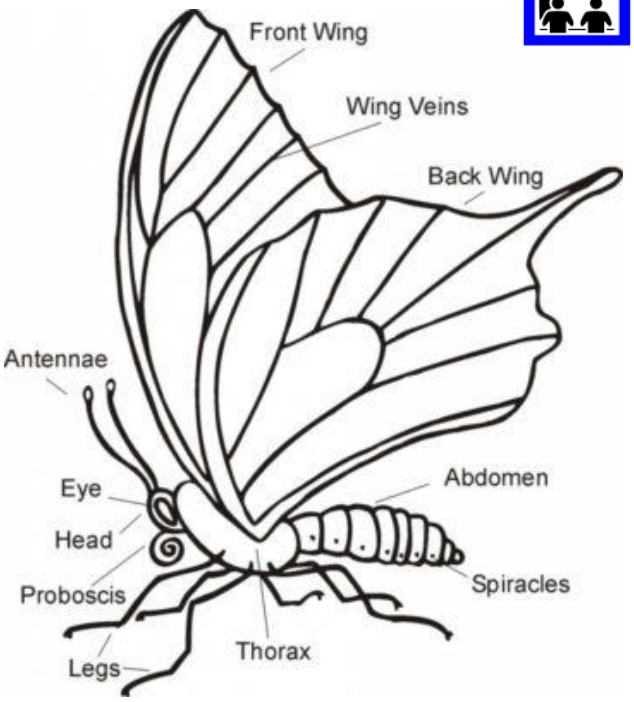
Before you begin, download the *Butterflies, Moths, Damselflies and Dragon Flies of North Dakota Field Guide* from: *https://gf.nd.gov/publications/506*. Cut out the pictures of individual butterflies from the field guide. You will need one set for each group of students.

Discuss general classification with students. Can the class define classification? Why do we classify things? Looking at biology, explain that scientists use classification to organize the organisms and to see how they relate to each other and to identify organisms. Classification makes things easy to find, study and talk about. If we look at all things in life, we can see that our computer files are organized by type and subject, and food items are organized in a grocery store. Ask the students if they can think of other things that are organized.

Make sure students are familiar with butterfly anatomy. This will help when differentiating between different butterfly families or taxa. Have students sort the pictures of butterflies into taxa or family. The names of the butterflies are not important. Have students work in small groups. Give each group a set of butterflies. Remember, things are classified by appearance or function. This includes color, size, wing shape, body size, etc. The point of this activity is to act as researchers attempting to create a usable classification system. Students should be able to explain why each butterfly is classified.



Anatomy of a Butterfly



Objective: Provide students with the means to learn the different parts of a butterfly.

Background: Butterfly anatomy is made of distinct parts, with each serving a unique purpose to the organism.

Antennae: They have many functions including pheromone detection, which is used for mate location and recognition. Think of them as butterfly radar.

Front wing and back wing: Students should be able to mark location on a diagram.

Wing veins: The pattern of veins is different for every genus of butterfly, and is one of the main criteria used by taxonomists when classifying butterflies.

Abdomen: Contains the digestive system, breathing apparatus, a long tubular heart and sexual organs.

Spiracles: On the sides of each segment are microscopic holes called spiracles, through which air enters and leaves the body. Slight rhythmic movements of the body, coordinated with the opening and closing of the spiracles, causes air to be drawn into tiny lung-like sacs, and later expelled.

Thorax: Consists of three body segments, which are fused together, forming a chitinous cage, which contains the flight muscles, and acts as an anchor point for the legs.

Legs: Butterflies have three pairs of legs.

Proboscis: A tube, much like a drinking straw. This tube can be coiled up like a spring for storage, or extended to enable the butterfly to reach deep into flowers to suck up nectar.

Head: Contains the eyes, antennae and proboscis.

Eye: Butterflies have compound eyes that produce an image that looks like a mosaic.

Procedure

Students will build butterfly models out of the following items:

- Gum drops (head)
- Small marshmallows (thorax)
- Orange candy slices (abdomen)
- Black shoelace licorice (legs)
- Red shoelace licorice (proboscis)
- Mini M&M's (compound eyes)
- Large pretzel twists (wings)
- White frosting (glue for candy)
- Toothpicks (holds head, thorax and abdomen together)

Constructing Pollinators

Objective: Students will use their knowledge of pollinators to construct a fictional pollinator.

Materials: Drawing paper, pencil, markers, crayons, paints, and art supplies. Materials to build a pollinator such as foam, yarn, felt and pipe cleaners.

Background

Animals or insects that transfer pollen from plant to plant are called “pollinators.” Pollinators visit flowers for many reasons, including food and shelter. Although some plant species rely on wind or water to transfer pollen from one flower to the next, the vast majority, almost 90 percent, of all plant species need the help of animals to accomplish this task. Of the approximately 200,000 different species of animals around the world that act as pollinators, the vast majority are invertebrates, including bees, butterflies, wasps and flies.

Among pollinators, bees are the superstars, as they are the only group of insects that actively collect pollen and, in the process, transfer large amounts of pollen from flower to flower. Bees also exhibit a behavior called floral constancy, which means that they visit flowers of one species repeatedly over a period of time. North America alone boasts more than 5,000 species of native bees, 90 percent of which lead solitary lives. The remaining 10 percent are social bees, live in colonies and share the work of preparing and provisioning the same nest. Whether solitary or social, many species of bees pollinate effectively, with the European honey bee, the bumble bee, and the sweat bee among the most prolific.

Butterflies have excellent vision and are thus drawn to bright colors, including reds and oranges like sunflower, coneflower, artichoke, thistles, and dandelions. Lavender, mint and other herbs are naturally appealing to these fluttering insects. Attracting butterflies involves incorporating plants that serve the needs of all their life stages, places to lay eggs and form chrysalides, as well as food plants for larvae (caterpillars) and nectar sources for adults. The wing colors and patterns of butterflies are one of their most visible adaptations. Some butterflies have wing patterns that allow them to blend into their surroundings, while others have colorings that make predators believe they are poisonous. Still other butterflies have wing patterns that look like eyes, making them appear larger and scarier to enemies.

Flies can transport large amounts of pollen, which they often pick up from nectar-producing flowers. They prefer shallow, open flowers with readily accessible nectar droplets. Flies generally have tubular, sucking mouthparts, which vary in length and limit which flowers different species will visit. They are drawn to carrots, celery/celeriac, parsnip, parsley, mustards, greens, strawberry, raspberry, blackberry and onions, many of which also happen to be unattractive to bees.

Procedure

Before students begin, review what they learned about pollinators and their role in a healthy garden. Take a look at the physical attributes of actual pollinators. Include images of body types, wings, legs and mouthparts. After students have background information on pollinators, introduce the concept of building or drawing a fictional pollinator. Explain that their pollinator can be a bee, fly or butterfly. When students are building their pollinator, they must explain the reasoning behind coloration (what function does it serve, protection, mating, etc.) mouth parts, legs and other body parts. Use the following questions for a basis to build the pollinator:

- What does your pollinator eat?
- How does it eat?
- What colors is it attracted to?
- How large is your pollinator?
- Where does it live? Describe the habitat?
- What are its predators?

Once the students have built their pollinator, have them write a narrative about the insect. Students may use the writing prompts on the *student page*.

Student Page

My Pollinator

The name of my pollinator is:

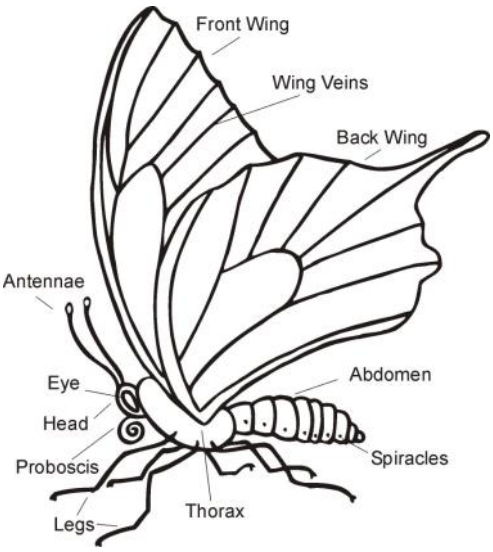
I eat:

I live in:

I help the garden:

I like to:

Student Page



Wings

One pair of wings - flies

Two pair of transparent wings - wasps, bees and ants

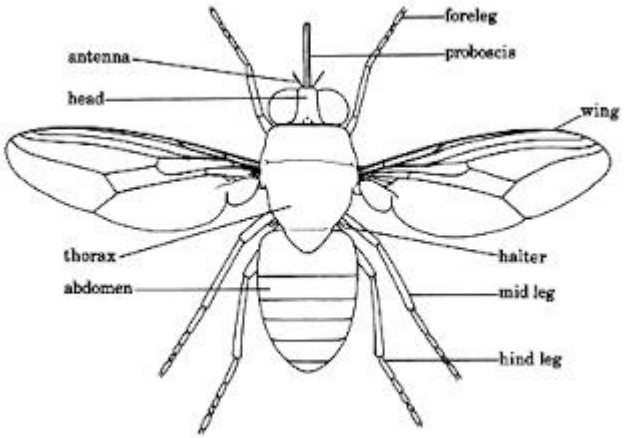
Two pair of wings with powdery scales - butterflies and moths

Wings with covers meeting straight down the back - beetles

Legs:

Six legs - all insect pollinators

Mouth Parts



Chewing mouth parts - beetles

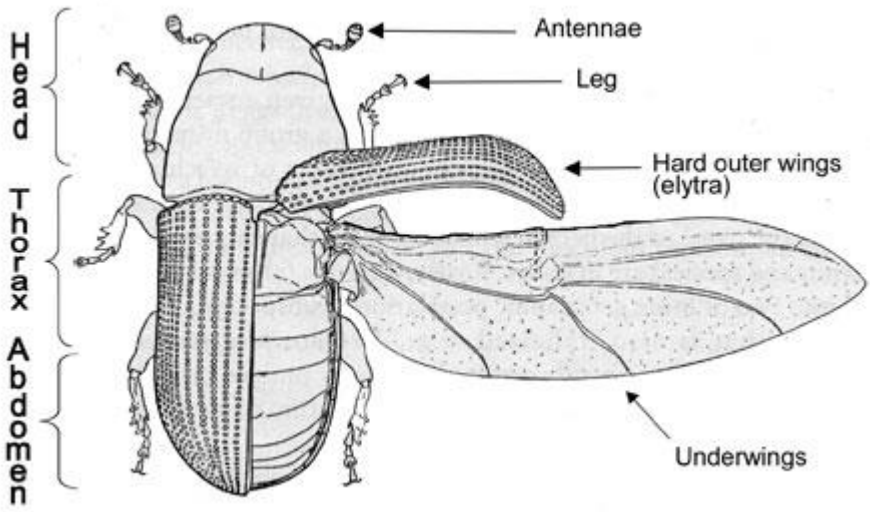
Sucking mouth parts, long and coiled - butterflies and moths

Sucking mouth parts - flies

Antennae

Conspicuous antennae - flies, wasps, bees and ants

Knobbed or plume-like - butterflies and moths



Pollinator Garden Quest: *Pollinators*

Directions: Have students observe plants and pollinators only to complete the pollinator garden quest. Be sure to set a time. Students can work individually or in small groups.

Describe a pollinator. Identify it. Draw:	Describe something a pollinator likes to eat. Draw:
Find something that should not be in the garden. Will it harm the pollinators? How did it get in the garden? Draw:	Something that is living. How can you tell it is alive? Draw:

Scientific Drawing

Objective: Students will learn to observe physical details of moths and butterflies and commit them to paper.

Materials: Watercolor paper, watercolor pencils, watercolor crayons, pencil, paper cups, Q-tips or paint brush and clip board.

Background: When drawing animals outdoors, plan to have students spend time observing the animals, in this case butterflies or moths. In some cases, you can observe your objective for two-thirds of your time and draw for one-third of the time.

Scientific drawings are an important part of the science of biology and all biologists must be able to produce good quality scientific drawings regardless of your artistic ability.

Drawings not only allow you to record an image of the specimen observed, but more importantly, they help you to remember the specimen as well as the important features of the specimen. Drawing a specimen requires you to pay attention to detail so that you can re-create it on the paper. While doing this, your brain is recording these same features in such a way that you can recall them if necessary. Simply observing pictures of specimens in a book, or on a computer screen, is less effective when it comes to remembering and understanding what you observed.

Procedure: Find the pollinator you wish to draw. Observe the pollinator. Look at color, form and shape as if it were an outline in the sky. Think in terms of simple shapes like triangles, squares, rectangles, ovals, etc. Close your eyes and try to reconstruct the plant/animal in your mind. See its color, body shape and texture. Using your drawing materials, draw the shape of the pollinator. Drawing the outline as you would see it if it were surrounded by sky. Once the body is outlined, concentrate on filling in the details. When your pollinator is completed, fill in the details of the surroundings or habitat. Fill in as many details as you can and fill your entire page. Add color with watercolor crayons or colored pencil.

To make the pencils and/or crayons come alive, wet a Q-tip or paint brush and apply water to the picture, going from color to color. You can add texture by stippling or applying the brush in different directions.

Once students have completed their observation and drawing, have them identify their pollinator. Students can use the *student page* to assist them with their drawing and identification.

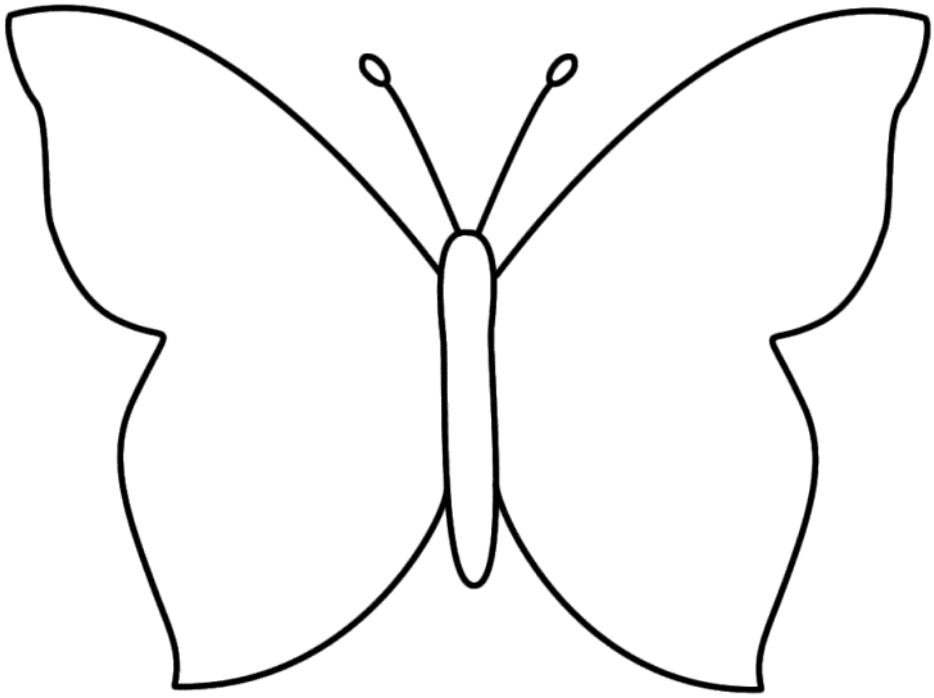
Monarch Butterfly Diagram

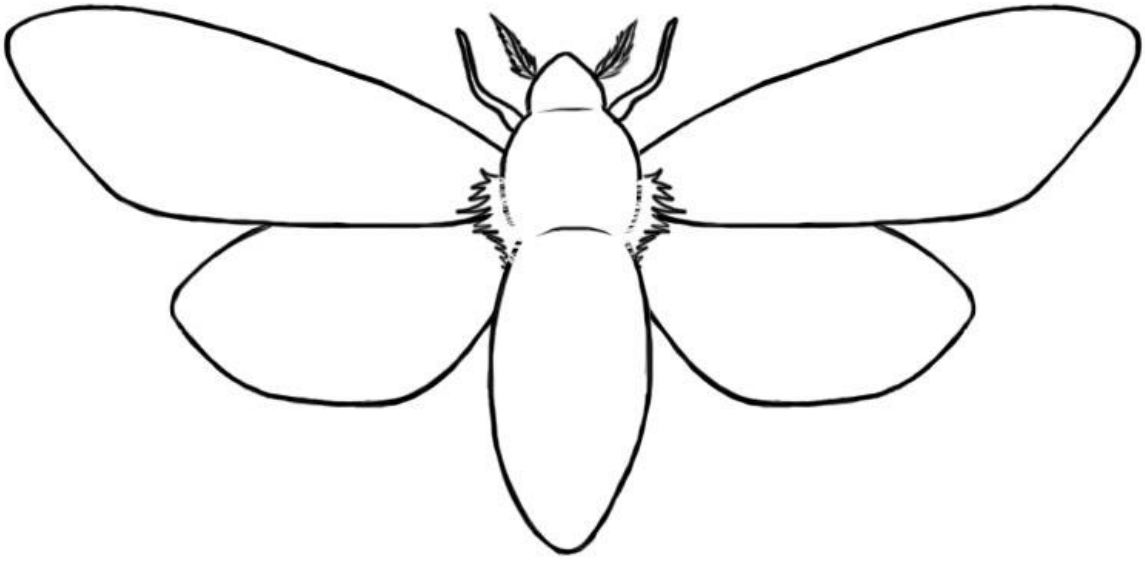
Student Page

While closely observing a butterfly or moth, make a sketch using the outlines below. You can reshape the wings or body as needed. Make sure to get as many details as you can.

Select: **Moth** or **Butterfly**

Name of Pollinator: _____





Writing for Science

Objectives:

- Develop an understanding of technical writing.
- Use observational skills to identify pollinator species.

Materials: Paper, writing utensil, clip board and *Butterflies, Moths, Dragonflies and Damselflies* field guide

Background: Technical writing is an explicit form of writing used to provide instructional information to its readers. Researchers use technical writing to communicate information and relay research findings.

When carrying out a technical writing assignment, you must remember to follow what is known as the three "Cs" and ask yourself the following questions:

- Is it clear?
- Is it concise?
- Is it complete?

Procedure:

Have students visit the pollinator garden and allow them to observe different pollinator insects for a few minutes. Next have students select a pollinator insect and tell them they have 10 minutes to write a technical writing piece. This piece should fully describe the insect using only facts that are observed by the student. After 10 minutes, have students pull out their *Butterflies, Moths, Dragonflies and Damselflies* field guide. Pair students in groups of two or three and have them read their partner's technical writing piece and identify the insect.

Now that students have a feeling for the facts of writing technically, have them return to their pollinator insect and list 10 adjectives or adverbs describing the pollinator and its relationship to the garden. Once the students have made their list, have them write a paragraph using the 10 words. Use the *student page* for this part of the activity. Have students share their paragraphs with the class.

Once this is done, have students compare the two writing styles. Which style do they like best? Why? When would you use the technical writing style? When would you use the creative writing style?

Extension:

Have students exchange technical writing pieces with their partner without first identifying the insect. Have students draw and color the insect based on the technical writing. How close was the drawing to what their partner saw in the pollinator garden?

Student Page

Write 10 different words that describe your pollinator insect.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Write a paragraph about your pollinator insect using the 10 words you wrote above.

Mimicry or Camouflage?

Objective: Students will learn the difference between mimicry and camouflage, be able to define it and identify the two terms in animals.

Background: Camouflage and mimicry are adaptations adopted by animals to increase their chances of survival. To survive, some animals use camouflage so they can better blend in with their surroundings. Camouflage is a set of colorings or markings on an animal that help it to blend in with its surroundings, or habitat, and prevent it from being recognized as potential prey. Mimicry is the close external resemblance of an organism to a different organism to mimic the benefits from mistaken identity.

Procedure: Define camouflage and mimicry for your students and provide several examples of both. Next provide images of animals exhibiting either camouflage or mimicry and have students write the names of the animals in the provided *student page: Mimicry or Camouflage?* For example, a white-tailed deer fawn with spots would be written into the camouflage column. Images can be given to each group of students or projected to the front of the classroom

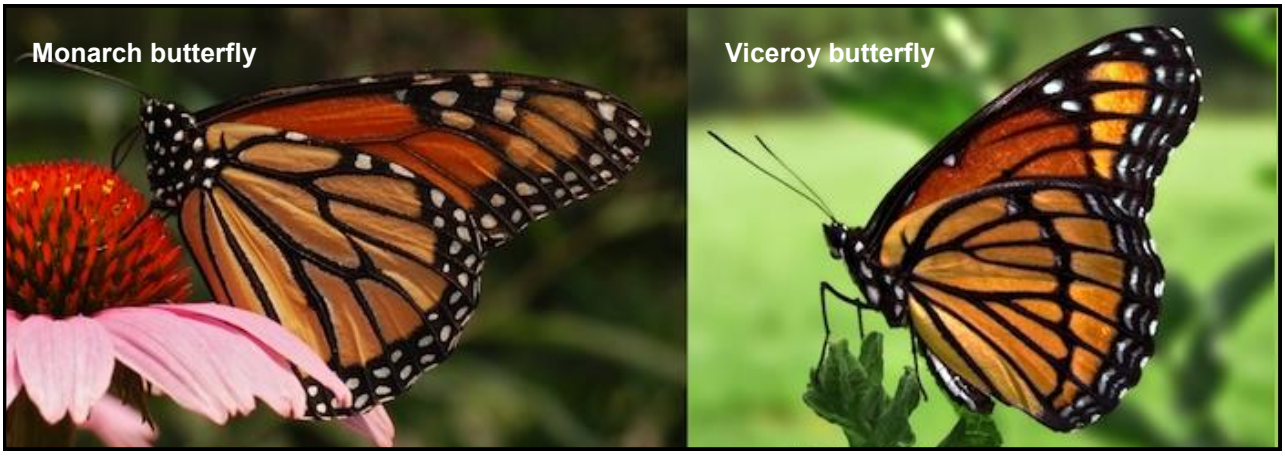
Images that can be used for camouflage are:

- Polar bear (white blends or camouflages in snow)
- Sharp-tailed grouse (color blends in with prairie habitat)
- Perch (vertical stripes blend in with aquatic vegetation)

Mimicry images:

- Drone fly and wasp
- Coral snake and red milk snake
- Monarch butterfly and Viceroy butterfly
- Walking sticks and vegetation
- Bullsnake and prairie rattlesnake

Next, select two animals that mimic each other and compare them on *student page: How are Mimicking Animals Different?*



Student Page: Mimicry or Camouflage?

Mimicry	Camouflage

Student Page: How are Mimicking Animals Different?

Animal 1:	Animal 2:

Mimicry Game

Objective: Students will learn value and consequences of animals that exhibit mimicry.

Background: Camouflage and mimicry are adaptations adopted by animals to increase their chances of survival. What can an animal do to keep from being a predator's dinner? To survive, some animals use camouflage so they can better blend in with their surroundings. Camouflage is a set of colorings or markings on an animal that help it blend in with its surroundings, or habitat, and prevent it from being recognized as potential prey. Mimicry is the close external resemblance of an organism to a different organism to mimic the benefits from mistaken identity.

Materials: Ziploc plastic bags, Plain M&Ms (at least 10 of each color), Skittles, metal pie tin or other deep plate, cups for collecting candies during the hunt (one cup per predator), timer and data chart.

Preparation:

1. Place 10 M&Ms of each color (yellow, blue, green, brown, red, orange) into one plastic bag.
2. Place 60 Skittles into five separate plastic bags. This means you will have five separate bags of Skittles.
3. Explain the game to your student predators. Predators are hungry M&Ms-feasting birds. Predators hunt with their beak (make a beak with thumb and pointer finger) or a tweezers for older students. M&Ms are the prey. Skittles are an organism mimicking the M&M's and make the birds sick. Skittles should be avoided. Players will have 20 seconds to hunt during each round of the game.

Procedure:

In this science activity, students will become the hungry predators and hunt for different colored candies. But it may not be as easy as it sounds, some of your prey will be mimicked by Skittles and undesirable food choice that may be poisonous. Divide students into groups of two to three.

1. Have predators sit in a circle. Each predator should have a cup.
2. Place the pie plate in the center of the circle where everyone can reach.
3. Pour the plastic bag of M&Ms and one plastic bag of Skittles containing a single color into the pie plate and mix the candies together.
4. Set the timer for 20 seconds.
5. When you say "Go," predators should begin hunting. Candies should be placed into the cup during the hunt. Players should stop when the timer beeps.
6. Each player should count the number of each M&M's color they collected and record their numbers on the data sheet. If a player collected any Skittles, record the number in the bottom row of their column (labeled "Skittles"). Remember that Skittles make the predators sick and should be avoided.
7. Record the number of M&M's and Skittles collected. Once data has been recorded, put all the M&M's back in the plastic bag. This includes the M&M's people picked, as well as the M&M's still in the pie plate. The plastic bag of M&Ms should now be like you prepared it in preparation Step 1.
8. Remove the Skittles you used for the habitat (these can be saved for eating after the activity).
9. This procedure can be repeated to compare results. Make sure to record the results.

Student Page

Data Sheet	**Trial 1**	**Trial 2**
Orange M&M's		
Yellow M&M's		
Red M&M's		
Brown M&M's		
Green M&M's		
Blue M&M's		
Skittles		

Sustaining Pollinators

Food Web

Objective: Students will begin to understand the nature of biodiversity by building a food web. They will observe how all living things are connected within an ecosystem.

Materials: Large open area in which to build the web, animal and plant cards (one card per student, pictures and facts included, glue these to index cards), one to two large balls of yarn or other string.

Background: A food web is a group of interlinked food chains. In addition to herbivores, omnivores and carnivores, the food web also contains scavengers and decomposers, so that no available source of energy is ever allowed to go to waste. Food chains give us a clear-cut picture of who eats whom. However, some problems come up when we try and use them to describe whole ecological communities.

For instance, an organism can sometimes eat multiple types of prey or be eaten by multiple predators, including ones at different trophic levels. This is what happens when you eat a hamburger patty! The cow is a primary consumer, and the lettuce leaf on the patty is a primary producer.

To represent these relationships more accurately, we can use a *food web*, a graph that shows all the trophic, eating-related interactions between various species in an ecosystem.

Procedure: Introduce the idea of ecosystem and biodiversity. All living things are connected within an ecosystem. Ask for examples of predator/prey relationships in an ecosystem (bird/spider, spider/ladybug, ladybug/aphid, aphid/flower). Talk about how some things in the ecosystem eat the waste products of other things (worms and millipedes eat rotting vegetable matter, scavengers eat dead animals), which in turn ends up back in the soil in the form of nutrients for plants.

Give each student an animal or plant card. The card will say what this organism eats or needs to survive and what eats or preys upon the organism.

Review the rules of the game with the students.

- Do not pull on the string.
- Do not let go of the string unless directed by the teacher.
- Hold onto your own card.
- Hold the card so everyone can see the organism.

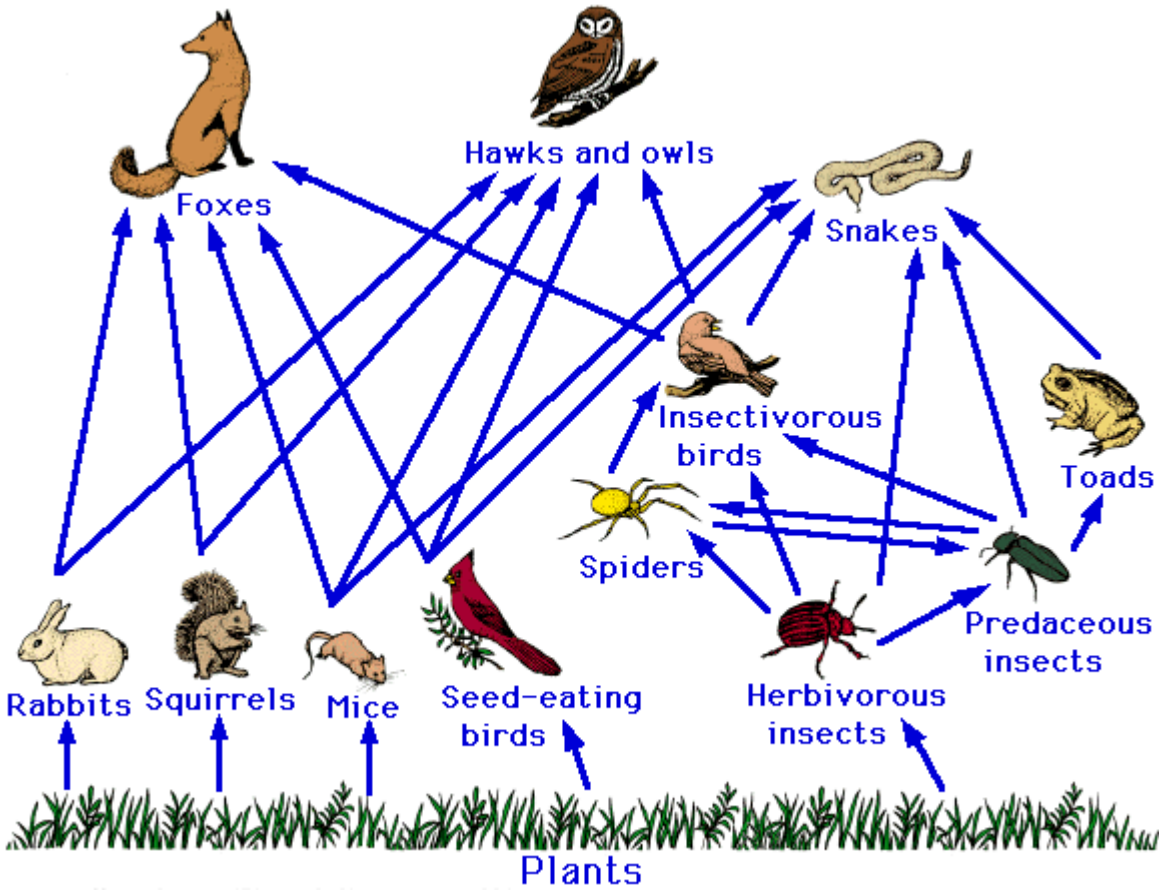
Choose one student to start. She will read her card, saying what organism she is, and what she eats. Holding onto the end of the string, she will pass the remaining string to one of her “prey” (an organism she eats).

The next student (the “prey”) will do the same: read their card, hold the string and pass the remaining string onto a “prey.” There are now three students connected by the string.

Students will continue in this manner until all students are connected to at least three other students with string, creating the pollinator garden food web.

Continue to pass the string until all students are connected by the “food web,” many will be connected more than once. Discuss what the students see as they look at the web.

Food Web Example



Extension 1:
1. Demonstrate how all living things are connected in the ecosystem, and what happens if an organism is endangered or goes extinct. Read an ecosystem scenario (included, or make up your own), about one organism that dies out (ex. grasshopper).
2. The “grasshopper” student will let go of the string at their point. Animals that eat the grasshopper will lose a food source. If this is their only food, they will die. They drop the string. Continue with the chain of reactions.
3. What does the web look like without some of these organisms? Discuss how organisms are connected within the ecosystem.

Extension 2:
Have students write about or draw a food web. Students can demonstrate creative writing skills by writing from the perspective of one of the animals in the food web. When drawing or illustrating the food web, have students use art supplies and large art paper.

Monarch Butterfly

Eats:

Milkweed flower

Juneberry nectar

Milkweed

Needs:

Nutrients from the soil

Water

Earth Worm

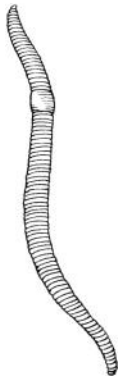
Eats:

Native grass

Fruit

Produces:

Compost



Coyote

Eats:

Pheasants

Juneberries

Grasshoppers

Cottontail rabbit

Mosquito

Feeds on blood from:

Coyote

Deer

Raccoon

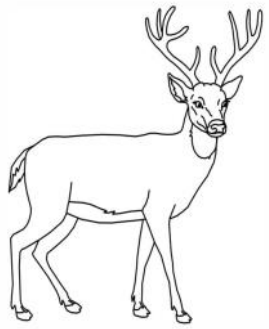
Cottontail rabbit

White-tailed Deer

Eats:

Grass

Juneberries



Wild Prairie Rose

Needs:

Nutrients from the soil

Water

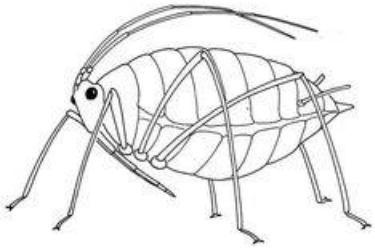
Aphid

Eats:

Wild rose leaves

Juneberry leaves

Milkweed leaves



Bee

Eats nectar from:

Wild Rose

Juneberry bush

Milkweed

Produces:

Honey

Raccoon

Eats:

Butterfly

Earthworm

Juneberries

Grasshopper

Native grass

Pheasant eggs

Ring-necked Pheasant

Eats:

Juneberries

Wild rose

Grasshoppers

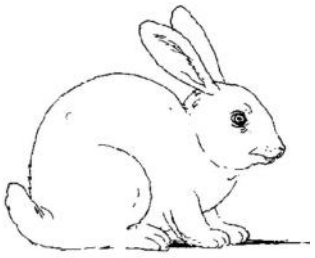
Native grass

Cottontail Rabbit

Eats:

Native grass

Juneberries



Juneberry

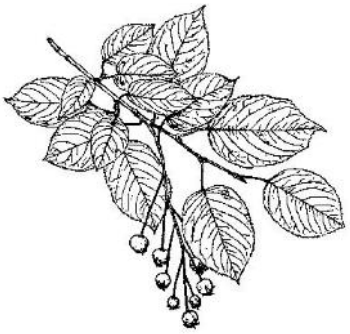
Needs:

Water

Compost

Produces:

Juneberries



Bobcat

Eats:

Pheasant

Cottontail rabbit

Grasshoppers

Coyote

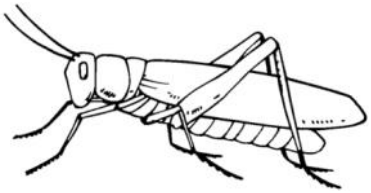
Grasshopper

Eats:

Juneberry

Wild rose

Native grass



Native Grass

Needs:

Compost

Water

Ladybug

Eats:

Aphids

Water

All animals and plants require water for their survival:

Insects: Monarch butterflies, grasshoppers, ladybugs, aphids, mosquitos

Plants: Milkweed, juneberry, wild rose, native grass

Animals: Earthworm, white-tailed deer, coyote, bobcat, raccoon, pheasant, cottontail rabbit

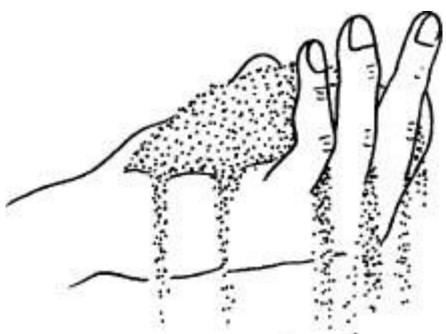
Compost (Soil)

When these die, they feed the soil:

Insects: Monarch butterflies, grasshoppers, ladybugs, aphids, mosquitos

Plants: Milkweed, juneberry, wild rose, native grass

Animals: Earthworm, white-tailed deer, coyote, bobcat, raccoon, pheasant, cottontail rabbit



Compost (Soil)

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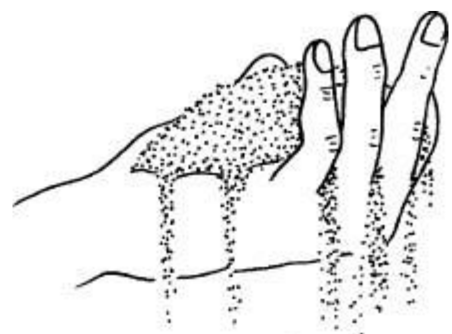
Insects: Monarch butterflies, grasshoppers, ladybugs, aphids, mosquitos

Plants: Milkweed, juneberry, wild rose, native grass

Animals: Earthworm, white-tailed deer, coyote, bobcat, raccoon, pheasant, cottontail rabbit



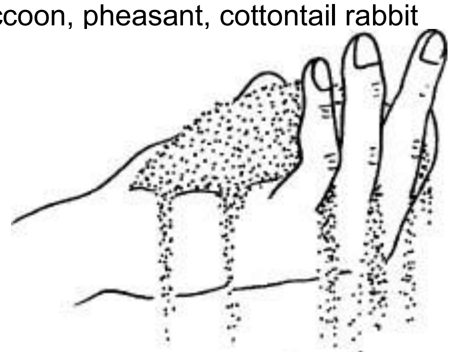
Compost (Soil)

When these die, they feed the soil:

Insects: Monarch butterflies, grasshoppers, ladybugs, aphids, mosquitos

Plants: Milkweed, juneberry, wild rose, native grass

Animals: Earthworm, white-tailed deer, coyote, bobcat, raccoon, pheasant, cottontail rabbit



Compost (Soil)

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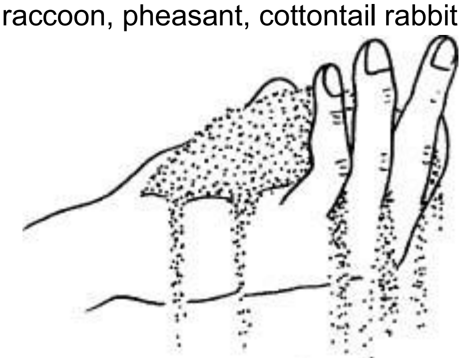
Animals: Earthworm, white-tailed deer, coyote, bobcat, raccoon, pheasant, cottontail rabbit



Pollinator Plants in Your Community

Objective: Students will learn about local plant diversity in their community, plant communities in their region, and they will demonstrate an understanding of the difference between a native and a nonnative plant.

Background: The habitat affects the type of plant communities that dominate a region. As habitat changes, plant communities will change. Many factors such as competition from nonnative plant species, natural disturbances (fire), changes in climate, and human disturbances (urbanization and agriculture) can affect plant communities in a habitat. These result in changes in the environment, available wildlife habitat and soil conditions.

However, there are things that we can do to protect these habitats. Conservation biologists protect and conserve natural areas where native plant communities exist. They work to remove and prevent the spread of nonnative plants that can negatively impact local native plant communities. Once they remove the invasive plants, conservation biologists replant native plants to boost existing populations and increase wildlife habitat.

Plant communities are areas where similar plant species live together in the same habitat. The types of plant communities that grow in a particular habitat are related to factors such as geography, climate and soil type. Many conservation biologists are working with students just like you to protect and conserve natural areas. In this activity, students will investigate a native plant community in the neighborhood.

Materials: Books, computers, list of regional native plants, *Habitats of North Dakota Student Guides, Woodlands, Riparian, Wetlands, Prairie and Badlands.*

Procedure: Divide the class into groups. Each group should have at least four students. Assign habitats (woodlands, riparian, wetlands, prairie and badlands*)* to each group. Using the *Habitats* guides, have each group make a list of plants associated with their habitats using the *student page*. Once each group has completed their list, have the class make a master list of native plants by type (forb, grass, shrub, tree).

Once a master list has been compiled, have groups investigate the school neighborhood or a natural area during a field trip. Provide *student page* and plant field guides so students can record the native plants observed. Assign a specific location to each group to investigate and a time frame to complete the observations.

After all groups have completed their observations, compile the group's list of plants onto a master list:
Which plants are the most common?
Which plants are the least common?
Discuss why native plants are important?
How does agriculture practices and urbanization effect native plants?

Extensions: Younger students can simply go on a walk as a group in the school neighborhood to inventory the amount and types of native or wild flowers found.

Older students can make recommendations to the school neighborhood on how they can increase the number of native plants in the area and benefits to the community.

Student Page

Habitat: _____

Grasses	**Forbs**
Trees	**Bushes**

Student Page

Field Trip Group # _____

Grasses	Forbs
Trees	**Bushes**

Your Pollinator Garden

Objective: Students will understand the importance of land use planning as it affects people, wildlife and the environment. Students will observe butterflies in their natural environment. Students will discover the correlation between butterflies and plants as it relates to attracting wildlife.

Materials: Graph paper for planning, seed catalogues, seeds or seedlings, gardening supplies (soils, fertilizer, shovels, rake, hoe) and containers to start seeds.

Background: Butterflies and other pollinator insects need gardens to survive. Planning and planting a pollinator garden is a positive action for pollinators. Students will work together on a long-term project, planning where and when to plant their garden, deciding on equipment and supplies they will need.

Different species of butterflies have different preferences of nectar, in both color and taste. When trying to attract the greatest diversity of butterflies it is important to plant a wide variety of food plants. Select plants that bloom at different times of the season, providing a constant food source. Keep in mind that groups of the same plants are easier for butterflies to see.

Consider a butterfly friendly site for your garden. Butterflies like sunny areas that are sheltered from high winds. These sights are most needed in the spring and fall. Be sure to provide rocks or bricks to give butterflies a place to soak up the warm sun.

Butterfly gardens are a good way to expand students' interest in nature. By providing an area with native inhabitants, students will have the opportunity to explore and observe the local environment around them. Pollinator gardens also play an important role in conserving butterfly habitats, which are diminished by urban development.

Procedure:

Step 1: Planning

Discuss how butterflies and other insects use plants and how they need special plants at different times in their life cycles. Discuss the work involved in a garden, including the maintenance of the garden during summer months. Brainstorm the benefits of a garden (decreased noise and air pollution from reduced mowing, reduced soil erosion, a beautiful garden, food and shelter for many organisms.)

As a class, you should decide on the criteria you will use to judge a site. Important considerations include available sunlight, foot traffic, visibility to school and others, and vulnerability to vandalism. Choose the plants that you want in your garden. Encourage students to choose plants that bloom at different times. Perennials are good since they only have to be planted once. You can include an area for annual plants also. Plants should vary in height, color and length of blooming time. Using the chart, decide which butterflies you would like to attract, then choose the correlating plant.
Once the class has decided which plants they want in the garden, consider printing pictures of the plants and using them to plan the garden. Use the graph paper to draw out a plan for planting.
(Older students can work individually or in small groups with younger students with the teacher as a recorder.)

Step 2: Start seeds

Buy seeds or plan where to purchase plants. Remember to purchase plants when it is time to plant your garden.
Plant seeds: Fill trays with planting medium and plant seeds according to instructions on seed packets. Keep seedlings in a sunny window or under grow lights.

Have students keep track of the seedling's growth in a journal, recording days to sprouting, height and leaf stage. After 6-12 weeks, seedlings will be ready to plant outside.

Step 3: *Planting the garden*
Prepare the soil by tilling and turning it over so it is loose for planting. This is also a good time to add fertilizer. When planting the seedlings, make sure the chance of frost is past. Apply mulch to prevent soil erosion, maintain soil moisture and slow weed growth. Once the garden is planted, set a class schedule for garden maintenance. This includes watering, weeding and replacing mulch. Make sure to leave time to observe the garden at least once a week. Keep track of the blooming plants and insects seen in the garden.

Summer Care
Make a plan for caring for the garden over the summer months. Involve parents, local garden clubs or other school staff and faculty. You can add a number of butterfly accessories to your garden. Students can build butterfly houses with small slots. You can also consider providing additional nectar source to supplement your flowers.

Common butterflies in North Dakota and their host and nectar plants:

Butterfly	**Host Plants**	**Nectar Plants**
Spreadwing skippers	False indigo	The following nectar plants are a good start for a pollinator garden. Using a combination of annuals and perennials will allow you to provide flowers in bloom throughout the season. • Sedum • Asters • Bee balm • Blackeyed Susan • Blanket flower • Butterfly bush • Butterfly weed • Clover • Coneflower • Cosmos • Daisy fleabane • Dame's rocket • Dandelion • Day lily • Gayfeather • Goldenrod • Lavender • Liatris • Lilac • Marigold • Petunia • Phlox • Verbena • Yarrow • Zinnia
Grass skippers	Little bluestem, switch grass	
Yellow swallowtail	Willow	
Black swallowtail	Dill ,fennel, parsley, celery, carrot, Queen Anne's Lace, prairie parsley, water parsnip, water hemlock, wild chervil, water parsnip	
White or cabbage butterfly	Spider flower , radish, mustards, cabbage, broccoli	
Yellow or sulphur butterfly	Alfalfa, clover, vetch, legumes	
Bronze copper butterfly	Docks and smartweed	
Hairstreak butterfly	Mallow, legumes	
Melissa blue butterfly	Wild licorice and alfalfa	
Mormon metalmark butterfly	Rabbit brush	
Frittillaries	Violets	
Crescents and checkspots	Asters	
Angelwings and tortoiseshells	Currents, gooseberry, stinging nettle	
Monarch	Milkweeds	
Painted lady	Thistle, mallow	

Pollinator Garden Observations

Date______________________ Name______________________________________

Time______________________

Weather Conditions: Sunny Cloudy Raining Windy Calm Other___________

Temperature__________

Species of Insect/Butterfly____

Life Cycle State____________________ Caterpillar size _____________ Inches/Centimeters

Type of plant observed on ____

Date______________________ Name______________________________________

Time______________________

Weather Conditions: Sunny Cloudy Raining Windy Calm Other___________

Temperature__________

Species of Insect/Butterfly____

Life Cycle State____________________ Caterpillar size _____________ Inches/Centimeters

Type of plant observed on ____

Date______________________ Name______________________________________

Time______________________

Weather Conditions: Sunny Cloudy Raining Windy Calm Other___________

Temperature__________

Species of Insect/Butterfly____

Life Cycle State____________________ Caterpillar size _____________ Inches/Centimeters

Type of plant observed on ____

Pollinators: The Source of Food

Objective: Students will learn the impact of pollinators on their meals.

Background: Pollinators are known to be responsible for one out of every three bites of food we eat daily. This makes pollinators essential to food production. Unfortunately, many species of active pollinators are declining in population very quickly.

Procedure: Have students record their meals and snacks for one day. The purpose of this is to examine how dependent their diets are on pollinators.

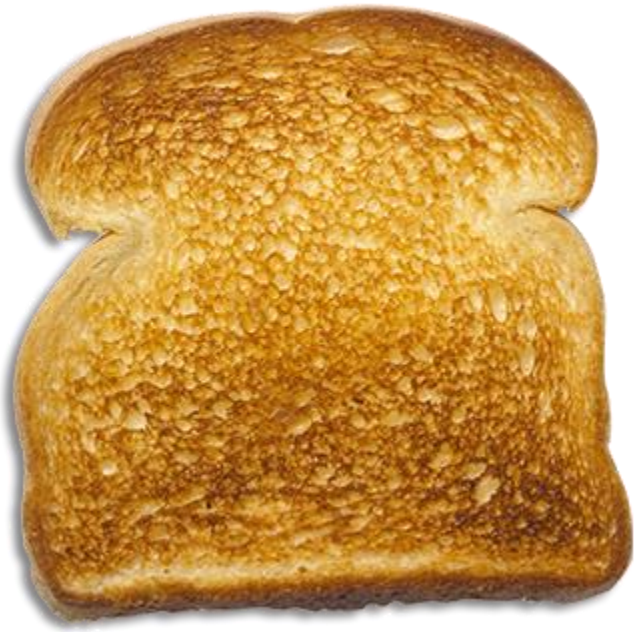
Sample Diet

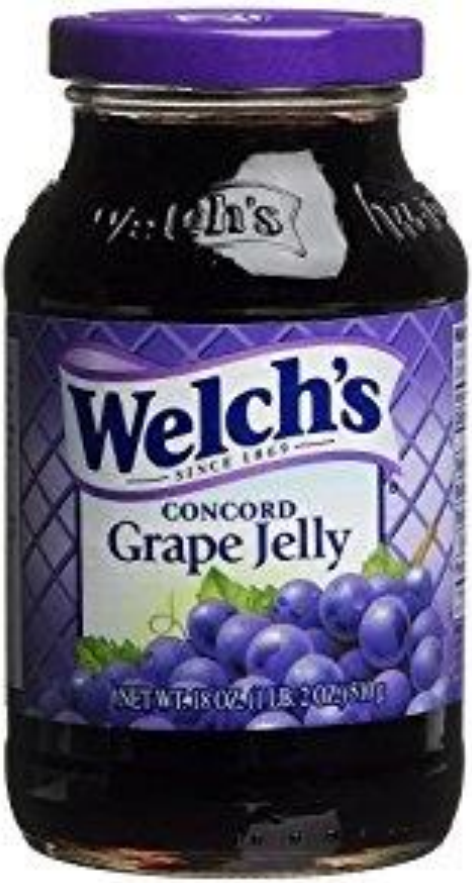
Breakfast	Lunch	Dinner	Snacks
Toast	Vegetable soup	Chicken breast	Pretzels
Jelly	Crackers	Mashed potatoes	Grapes
Orange juice	Banana	Gravy	Crackers
	Oatmeal cookie	Sliced tomatoes	Cheese
		Green beans	
		Ice cream	

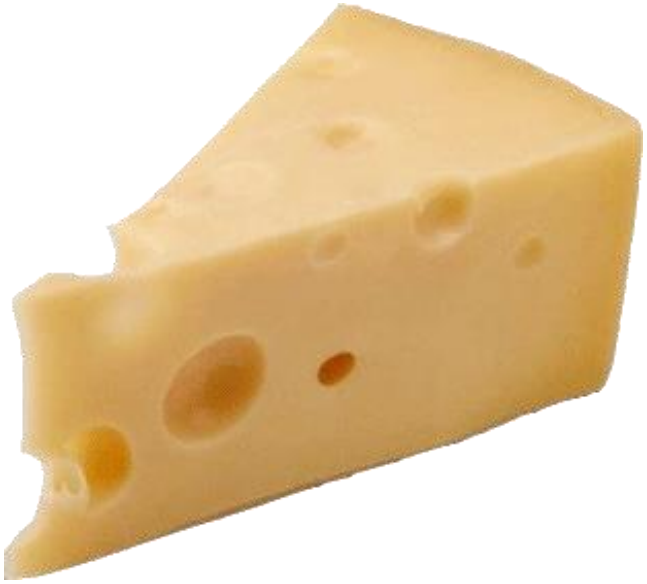
Once everyone has recorded their food, have them go through each food item and cross off the items are made possible by pollinators. This includes anything that is plant-based. Once this is done, explain to the students the remaining items would be the only ones available for consumption in the world without pollinators. You can also have students think about the remaining items such as beef or pork and decide if they would be reliant on pollinators because they also eat plants. What can you eat now?

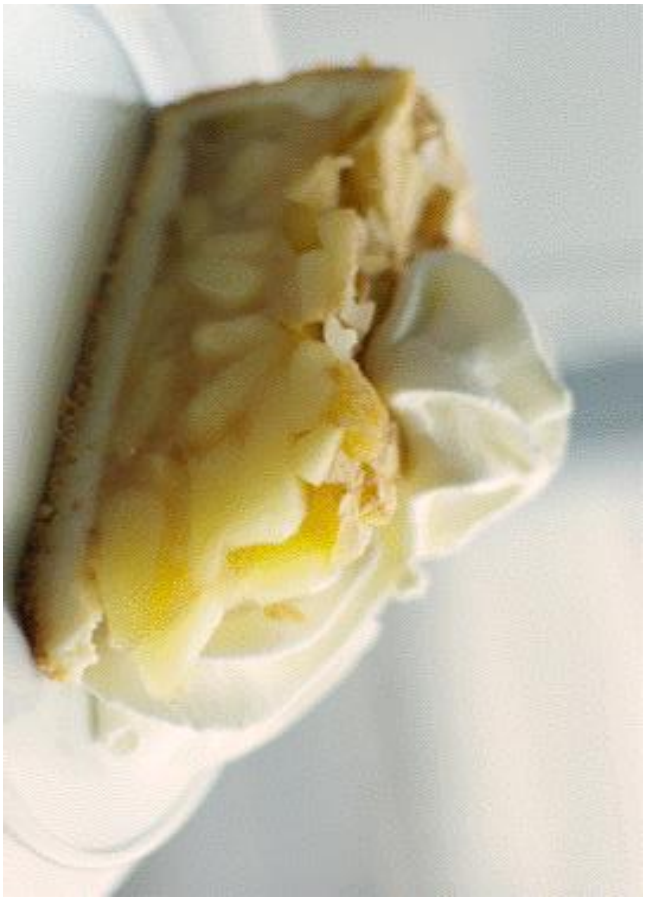
For younger students:

Using the picture templates, have students build the meal of their choice. Once they have gathered pictures that represent a meal, remove pictures that are made possible by pollinators. Explain the remaining items are the only foods that would be available to eat without pollinators.




Welch's
CONCORD
Grape Jelly





Plant Community Benefits

Objectives: Students will learn the dominant plants in a North Dakota habitat.
Students will identify the wildlife found in a North Dakota habitat.
Students will identify threats to the habitat and conservation efforts in the habitat.

Materials: *Habitats of North Dakota Student Guides*, graphic organizer, poster paper, markers and drawing equipment.

Background: Plant communities are areas where similar plant species live together in the same habitat. The types of plant communities found in a habitat are related to geography, climate and soil type.

Factors like competition from nonnative plant species, natural disturbances (fire or flood), changes in climate, and human disturbance (urban and energy development) can affect plant communities in a habitat. These result in changes in the environment, usable habitat and soil condition.

Conservation biologists protect and conserve natural areas where native plant communities exist. They work to remove and prevent the spread of nonnative plants that can negatively impact local native plant communities. Once they remove the invasive plants, conservation biologist plant native plants to boost existing populations and increase wildlife habitat.

Procedure: Divide the class into groups that represent habitats in North Dakota (riparian, prairie, wetlands, woodlands, badlands).

Using the graphic organizer, have each group investigate their assigned habitat. Within each group, students will research a different aspect of the assigned habitat using the *Habitats* guides.

- Plants found in that habitat.
- Types of wildlife.
- Components (wildlife habitat, water, climate and food resources).
- Changes that have occurred over time.
- How the changes have affected the habitat.
- Conservation efforts.

Once the group members have completed their research, they should compile and share their information.

Groups will construct a mural that represents their habitats and the areas on the graphic organizer. Once murals are completed, each group will display their mural and present their findings to the rest of the class.

Extensions: 1. Have students prepare a PowerPoint presentation on their habitat.

2. Have students come up with a plan to conserve, or restore, plant communities that have been disturbed by development, and present the plan to the city council citing the benefits to the community, wildlife populations and pollinators.

Habitat:

Plants found in that habitat

Types of wildlife

Components

Changes that have occurred over time

How the changes affected the habitat

Conservation efforts

Vocabulary

Abdomen – The most posterior portion of the three segments of an insect.

Antennae – Specialized, segmented, receptive, sensory organs found on the head of all insects.

Biodiversity - Diversity among and within plant and animal species in an environment.

Binomial nomenclature – The system of assigning scientific names of organisms.

Butterfly – Any member of the Lepidoptera order within the following families: swallowtails, brush-footed butterflies, whites and sulphurs, gossamer-winged butterflies, metalmarks and skippers. They generally have brightly colored wings and are diurnal.

Caterpillar – Larva stage of butterfly or moth.

Chrysalis – The hard-shelled or cased in form of some pupas, when going through metamorphosis.

Citizen science – The practice of volunteers or other lay people conducting scientific research.

Classification – Method used by biologists to categorize and group organisms.

Compound eye – An eye that is made up of many, separate visual units that allow the user to have a wider field of vision, better detect movement and see a wide range of colors.

Cotyledon - Part of the seed that contains stored food used for initial growth.

Cross-pollination – The transfer of pollen from the flower to one plant to another.

Decomposers - An organism, usually a bacterium or fungus, that breaks down the cells of dead plants and animals into simpler substances.

Dichotomous key – A key used to identify organisms. The user goes through a series of descriptions that narrow down possible species until the organism is identified.

Distribution – The frequency and natural geographic range of where something can be found.

Diversity – The state of being different.

Embryo - Developing plant still inside the seed.

Endangered - A plant or animal species existing in such small numbers that it is in danger of becoming extinct, especially such a species placed in jeopardy as a result of human activity. One of the principal factors in the endangerment or extinction of a species is the destruction or degredation of its native habitat.

Ecosystem - A community of living organisms in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system. These biotic and abiotic components are regarded as linked together through nutrient cycles and energy flows.

Extinct - No longer in existence; that has ended or died out.

Family – The major subdivision of an order when classifying organisms, which usually contain several genera.

Food web - A series of organisms related by predator-prey in an ecological community.

Habitat – The natural environment of an organism or the type of location where it is generally found. Includes, food, water, shelter, space and the proper arrangement of previous components.

Head – The most superior segment of an insect, containing the antennae and other cranial organs.

Hilum - The scar on a seed coat at the location where it was attached to the plant's stalk during development .

Host plant – The specific plant that the larvae of an insect may use as a food source rearing site.

Insect – Any member of class Insecta, which has six segmented legs, three body parts and one or two pairs of wings.

Larva - The immature, wingless, feeding stage of an insect that undergoes complete metamorphosis.

Lepidopterist – A person who studies butterflies and/or moths.

Life cycle – The developmental changes that an organism goes through from its time of conception to its point of death. Each step in the cycle is often marked by obvious, physiological changes.

Metamorphosis – A very profound change in physical form from one state of some organisms' life cycle to the next. Examples include the change from a caterpillar to a butterfly.

Micropyle - The small pore in a seed that that allows water absorption

Mimicry – The similarity of one species to another, which increases the fitness and/or protection of one or both species.

Moth – Any member of the Lepidoptera order within the following families: Sphinx or hawk moths, giant silkworm and royal moths, tiger moths, or geometer or inchworm moths. They generally have dull-colored wings and are nocturnal.

Natural selection – The overall process by which traits become more or less common in a population due to the survival and reproduction of organisms that possess those traits.

Native plant - Plants that occur naturally in an area ,or that have existed for many years in an area. Native plants form a plant community where several species, or environments, have developed to support them.

Nectar – The sugary fluid produced by some plants that helps attract pollinating insects and other animals.

Nectar source – A flowering plant that produces nectar (a sugary liquid that often attracts pollinating insects and other animals).

Nonnative plant - Plants that are introduced to a new area where they did not previously exist.

Nutrients - Chemicals necessary in any ecosystems for organisms to effectively grow, survive and decompose.

Pistil – The female organ of a flower, which is made up of a stigma, style and ovary.

Pollen – Microscopic grains produced by the male reproductive organs (anthers) of some plants that are used to carry male reproductive cells (sperm) to fertilize the female reproductive organs (pistils) of plants of the same species.

Pollinate – The depositing of pollen in order to allow for fertilization.

Pollinator - Animals that move pollen within flowers, or carried from flower to flower, by pollinating animals such as birds, bees, bats, butterflies, moths and beetles, or by the wind.

Population - A group of individuals of a single species that live in a particular area and interact with one another.

Predator – An organism that hunts for food (prey).

Prey – An organism that is hunted for food (by a predator).

Proboscis – An elongated, straw-like, flexible mouth part of some invertebrates, which allows them to suck nectar.

Protocol – The established procedure of an activity, group, or situation.

Plumule - Leaf-like growth that appears during the seed's development into the plant.

Seed coat - The outer, protective skin covering the seed .

Self-pollination – The transfer of pollen from the flower of one plant to either the same flower or another flower on the same host plant.

Stamen – The male fertilizing organ of a flower, typically consisting of a pollen-containing anther and a filament.

Stigma – The receptacle for pollen, found at the top of most pistils.

Style – The portion of the pistil that transfers pollen from the stigma to the ovary.

Symmetry – The characteristic of an object with exact, mirrored halves across an axis.

Taxonomy – Process of classifying animals into larger categories based on shared features and genetics.

Technical writing – A formal form of communication and writing practiced on the job in various scientific fields. It often includes unique jargon and lingo specific to the field.

Thorax – The middle portion of the three segments of an insect.

Transect – To cut across or make a line or section through an object.

Urbanization - The process of changing the landscape to support a population.

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