Tallgrass Prairie Storyline

Notes to Educator:

- We use different colors to specify information we are providing to you.
- **Red** is used to connote scientific terms with their definitions. We encourage you to ask your students what they think the terms means before providing the definitions.
- **Purple** is used to designate notes from us to you. **Purple** may also indicate questions you can ask your students. Answers aren't always provided because there may not be definitive answers available.
- **Blue** are the Driving Questions – the overarching questions that drive the flow of the material

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Lesson 2: Prairie Food Chains and Food Webs

Driving question: **How do ecosystems maintain their health?**

Lesson 2 question: **What lives in/on a Tallgrass Prairie?**

Terminology & Concepts

- *10% Rule* = The rule explaining the inefficient transfer of energy in an energy pyramid. E.g., Only 10% of the total available energy is transferred when primary consumers eat producers. The same occurs when secondary consumers eat primary consumers. The majority of energy is lost as heat during transfers.
- *Abiotic component* = the non-living components of an ecosystem – e.g., atmosphere, water, soil, rocks.
- *Biotic component* = the living components of an ecosystem – e.g., plants, animals, bacteria, fungi, and protists.
- *Consumer* = organisms that eat other organisms for their food. They may eat producers (= herbivores) or they may eat other consumers (= carnivores) or they may each both (= omnivores).
  - The Consumer that eats the producers is also called the Primary Consumer (e.g.,mouse).
  - The Consumer that eats the Primary Consumer is called the Secondary Consumer (e.g., snake).
  - The Consumer that eats the Secondary Consumer is called the Tertiary Consumer, or the Top Level/Apex Consumer (e.g., hawk).
- *Decomposer* = A specialized type of consumer that gets its food energy from the breakdown of a dead organism (e.g., bacteria and fungi).

- *Energy Pyramid* = An image that stacks the trophic levels in order with the Producers at the bottom and the top-level Consumers at the top. Because energy isn't efficiently transferred between the levels (lost as heat), the rows become narrower to show that energy loss.
- *Food Chain* = A simple chain image of a natural system that shows the connection between food and who is consuming the food.
- *Food Web* = A more complex, and realistic image, of a natural system that shows more of the components of a system and what/who they eat.
- *Producer* = a trophic level for organisms that use the sun's energy to make their own food. Photosynthesizers.
- *Trophic Level* = Troph = "feeding" in Latin. The Trophic Level describes an organisms' form of feeding in a natural system. E.g. – a "Producer" is a trophic level containing photosynthetic organisms that makes their own food using the energy of the sun. First level Consumers eat the Producers.

1. Designing Food Chains and Energy Pyramids

Provide the students with a set of **Plant and Animal Cards** (linked to bottom of document). You may want to laminate them for future re-use.

ACTIVITY: You will receive a set of cards that depict some common animals and plants of the prairie ecosystem. Use the cards to build models and answer the questions below:

TASK A: Using the Plant and Animal Cards – sort them into two piles that represent Producers and Consumers.

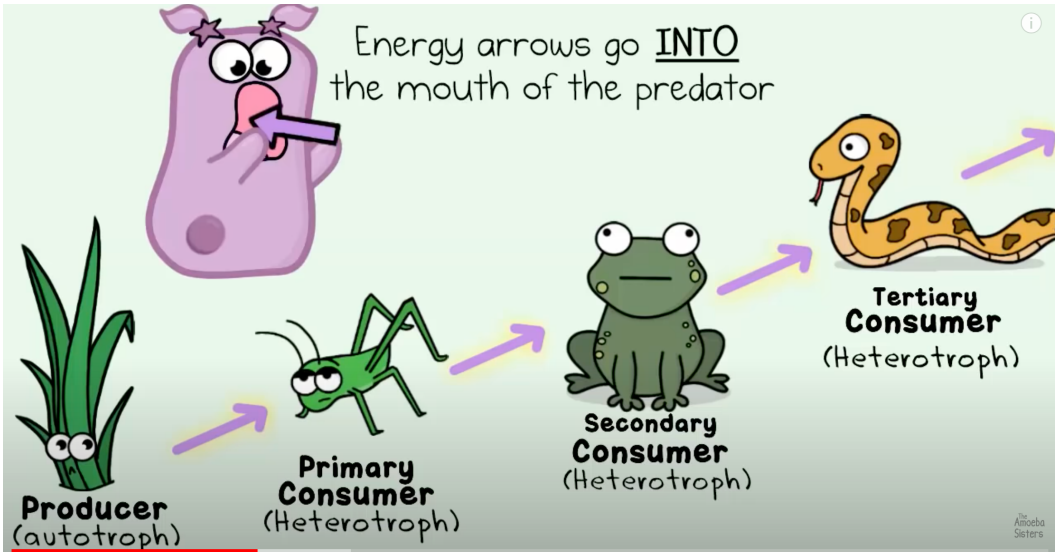
1. How many producers do you have?
2. How many consumers do you have?

TASK B: Construct a food chain and draw the model.

1. Remove the Big Bluestem, Grasshopper, Wild Turkey, and Coyote species cards from the pile and arrange them into a Food Chain.
2. Draw your food chain in your notebook. Label the trophic level of each organism in your food chain as follows:
   - **Producer**
   - **Primary consumer**
   - **Secondary consumer**
   - **Tertiary consumer**
3. Use species scientific names and add arrows to the model to show the flow of energy between food and consumer.

TASK C: Draw an energy pyramid with the same components as your food chain (4 levels), with the producer at the bottom and the tertiary consumer at the top.

Video explaining Energy Pyramids and the 10% Rule (PowerPoint)



ACTIVITY: Simulating the 10% Rule – **The Bucket Brigade Activity**

Preparation: To be done outdoors – put students into groups of 4 with each team getting a bucket of water, Styrofoam cups for everyone. Put 1 hole (punch a pencil through the bottom) in the cups of the Primary Consumers and Secondary Consumers. No holes in the Producers or Tertiary Consumers.

Step 1: In each group of 4, select who will be:

- Producer – cup with no holes
- Primary Consumer – cup with 1 hole
- Secondary Consumer – cup with 2 holes
- Tertiary Consumer – cup with no holes

Step 2: The producers will stand next to the "sun" = bucket of water. The Primary Consumers will be 10 yds. away from the Producers. The Secondary Consumers will be 10 yds. away from the Primary Consumers, and the Tertiary Consumers will be 10 yds. away from the Secondary Consumers. The GOAL: Transfer energy (water) from the bucket to the cups – passing it between the trophic levels. You want to fill the cup held by the Tertiary Consumer if you can.

This is a race! The first group to completely fill the Tertiary Consumer's cup wins!

QUESTIONS – answer these questions in your notebook:

1. What do the holes in the bottom of the Styrofoam cups represent?
2. What role does the sun play in the flow of energy through an ecosystem?
3. Use what you experienced in this activity to explain how energy can limit the number of trophic levels.
4. Using the rule of 10% in energy transfer, record the scientific names for the organisms in each tropic level in your energy pyramid and the amount of energy available at that level if your producer level starts with 3,500,000 kilocalories of energy/area.
5. In one or two complete sentences, describe how the available energy might change between the summer season and the winter season on the prairie.

DISCUSSION – to be done in class

- The Bucket Brigade was a model. What was it modelling?
- Did you think it was an effective model? Did it make it's point?
- Was it a perfect model? Are scientific models perfect?
- What do you think the purpose of a scientific model is?

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2. Designing Food Webs

ACTIVITY: Go back to your groups and get your Plant and Animal cards.

Provide each table with a large sheet of butcher paper to place their species cards and draw arrows to show relationships and energy flow.

TASK A:

- Organize all of your species cards into a food web that represents the flow of energy in the Konza Prairie ecosystem.
- Be sure to include arrows that represent the proper flow of energy through each of the feeding levels. (draw on butcher paper)

TASK B:

- Now research other organisms that live in the Konza Prairie ecosystem using their website's resources: https://keep.konza.k-state.edu/prairieecology/index.html
- Your goal is to add AT LEAST 2 more producers and 5 more consumers to your list of species of the prairie, to construct a more accurate food web that illustrates

how energy flows from producers through primary consumers, secondary consumers, and tertiary consumers. Feel free to add more as you wish.

TASK C:

- In your notebook, draw a version of the food web you made with your cards. Then, answer the following:
  1. What happens to the available energy within each level when

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3. Limiting Factors in an Ecosystem

The presence (or absence), abundance, and growth if individual species within an ecosystem is determined by the amount of materials needed for its life to exist. Many of these materials are “abiotic” or not alive.

TASK A:

- In your notebook, make a list of some abiotic materials in an ecosystem that living organisms need to survive = “Necessary Abiotic Materials”
- Make a second list of some abiotic materials that you think play no role in any organisms’ survival = “Unnecessary Abiotic Materials”

Watch each of the following videos:

Energy in the atmosphere over the prairie (PowerPoint)

https://www.youtube.com/watch?v=uH9A-7Y3lL0

Prescribed fire of the tallgrass prairie – via drone footage (PowerPoint)

https://www.youtube.com/watch?v=t0mUzXk940E

TASK B:

- Copy the following table in your notebook: (PowerPoint)

Species	Abiotic (non-living) Factors	Biotic (living) Factors
Bluestem		
Grasshopper		
Turkey		
Coyote		

- Record all of the potential biotic and abiotic factors that could positively or negatively impact the species listed in the table.
- Discuss with your table – did you all come up with the same things?

4. MODEL TRACKER

As we try to understand more about healthy environments, it is going to be very important to keep track of our discoveries and ideas. We will be figuring out a LOT of different things. Some things might be important in our models and others may be less important.

TASK A:

- Refer to your Incremental Model Tracker (IMT) that was introduced in Lesson 1 (PowerPoint)

- What have we figured out during this lesson (Lesson 2)?
- What can we add to our model – “What lives in a tallgrass prairie?”

LESSON QUESTION (What Question Are We Trying to Answer?) **&** **LESSON NICKNAME**	**WHAT DID WE FIGURE OUT?** Which parts of what we figured out (if any) can help us with our model? (Highlight them!)	**BASED ON OUR PROGRESS THIS LESSON, HOW CAN WE ADD TO OR REVISE OUR MODEL?** How should we represent our ideas in our model? (Use pictures, words, or symbols)
Lesson 2 - What lives in a tallgrass prairie?		

Lesson 2 Exit Assignment – Understanding Food Webs and Energy Pyramids

Product submitted by student: A completed worksheet
Points: 4

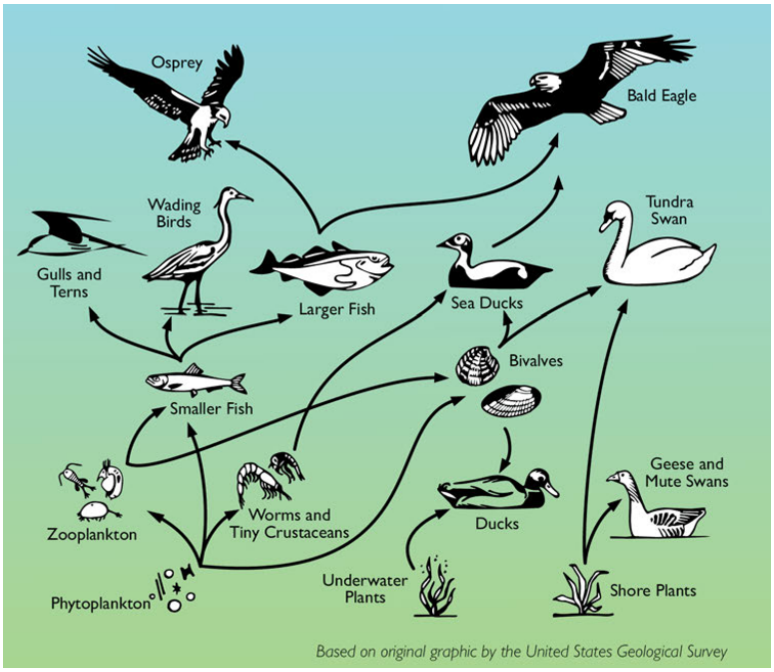
Name:_____
Section:_____
Date:_____

1. Circle the answer that is FALSE:

    a. Food webs include every possible organism that lives in a particular ecosystem.
    b. Food webs model the flow of energy in an ecosystem.
    c. Food webs display feeding relationships in an ecosystem.
    d. Food webs provide a general idea of the kinds of organisms that live in an ecosystem.
    e. Food webs are really a series of interconnected food chains.

2. From the food web below, indicate the organism (circle choice - from the list of choices) that would be considered a "secondary consumer".

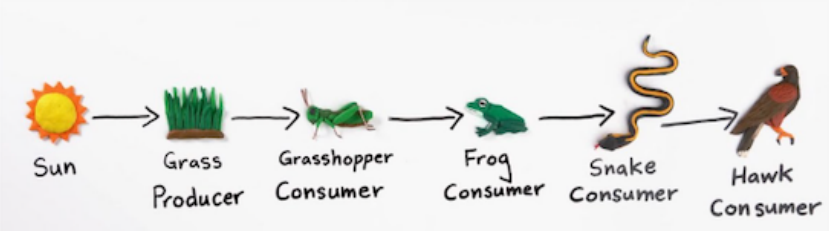
    a. Bald Eagle
    b. Duck
    c. Worms and Tiny Crustaceans
    d. Phytoplankton



3. Which choice below accurately describes why available energy can be a limiting factor in ecosystems?

    a. Almost all available energy makes its way to the next feeding/trophic level.
    b. Top predators always have a maximum amount of energy available to them.
    c. Very little energy is lost as heat and waste from one trophic level to the next.
    d. Organisms retain about 90% of the energy they consume.
    e. On average, only about 10% of the energy available flows to the next feeding/trophic level.

4. A basic food chain is displayed below. If the sun provided 4,000,000 kcal of energy to the grass, then how much energy would be available to the remaining trophic levels in the food chain? (circle your choice)



    a. Grasshoppers – 2,000 kcal
       Frogs – 200 kcal
       Snakes – 200,000 kcal
       Hawks – 2,000,000 kcal

    b. Grasshoppers – 400,000 kcal
       Frogs – 40,000 kcal
       Snakes – 4,000 kcal
       Hawks – 400 kcal

    c. Grasshoppers – 400 kcal
       Frogs – 4,000 kcal
       Snakes – 40,000 kcal
       Hawks – 400,000 kcal

    d. All 4,000,000 kcal would be available to each level of the food chain.

Plant and Animal Cards

Species: *Bison bison* Males 900 kg, Females 450 kg	 American bison
Habitat: American bison like open plains, savannas, and grasslands.	
Diet: They prefer low growing grasses and sedges.	
Predators: Wolves and Grizzly Bears	
Social Groups: Bison occur in groups - coming all together into one group during the late summer breeding season ("the rut"). Throughout the year cow/calf groups typically remain separate from the group of adult bulls.	

Species: *Lynx rufus* Males 18 kg, Females 15 kg	 Bobcat
Habitat: The bobcat is an adaptable species. It prefers woodlands, deciduous, coniferous, or mixed—but does not depend exclusively on deep forest.	
Diet: They are predators. The bobcat prefers rabbits, but will hunt insects, chickens, other birds, small rodents, and deer.	
Predators: The adult bobcat has relatively few predators. Mountain lions and gray wolves can kill a bobcat, but it is rare.	
Social Groups: Like most felines, the bobcat is generally solitary.	

Species: Canis latrans Males 20 kg, Females 18 kg	 Coyote
Habitat: Highly varied. They will live just about anywhere including the plains, mountains, deserts, and cities of North America.	
Diet: They are omnivores and will eat just about anything. However, they favor meat and prefer to hunt for their food. Favorite prey include small mammals, rabbits, and squirrels.	
Predators: The adult coyote has relatively few predators. Mountain lions, gray wolves, black bears, and grizzly bears are able to kill a coyote. Humans are the biggest threat to coyotes.	
Social Groups: Like most felines, the bobcat is generally solitary.	

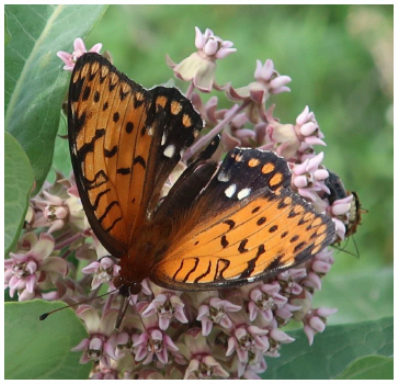
Species: *Cathartes aura* Both genders 2 kg	 Turkey vulture
Habitat: Widely distributed. It is found in open and semi-open areas from Canada to the tip of South America	
Diet: They feed on carrion - roadkill. They prefer animals that are recently deceased. Unlike most birds, they are able to smell, and detect their meals using this sense.	
Predators: They have few natural predators, but foxes, raccoons, and opossums may ravage their nests.	
Social Groups: Vultures are gregarious and will nest together in colonies.	

Species: *Meleagris gallopavo* Males 11 kg, Females 5.5 kg
Habitat: Wild turkeys prefer hardwood and mixed conifer -hardwood forests with scattered openings such as pastures, fields, orchards and seasonal marshes.
Diet: They prefer eating acorns and nuts as well as various seeds, berries, buds, roots, and insects, such as grasshoppers.
Predators: They have a variety of predators. Predators of eggs include raccoons, opossums, skunks, and foxes. Predators of the young (poults) include barred owls and red-tailed hawks. Predators of the adults include coyotes, foxes, great-horned owls, domestic dogs and cats, and bobcats.
Social Groups: Males breed with multiple mates and form all-male flocks outside of the breeding season, leaving the chick-rearing to the females, The chicks travel in a family group with their mother, often combining with other family groups to form large flocks of young turkeys accompanied by two or more adult females.

Wild turkey

Species: *Misumena vatia* Males 5 mm, Females 10 mm
Habitat: Widely distributed in prairies and forests. Typically is found in flowers, changing color to camouflage themselves within the flower.
Diet: They are predators of insects that visit the flowers to access pollen or nectar = bees, flies, butterflies, grasshoppers, and dragonflies. They do not build webs, but hunt (relying on their vision) while on a flower.
Predators: Their biggest threat comes from parasitic wasps who lay their eggs in the nest of the spider. The wasp egg hatches and feeds upon the eggs of the spider. The crab spider female must zealously guard her nest to keep parasitic wasps at bay.
Social Groups: These spiders are generally solitary.

Crab spider

Species: *Speyeria idalia* Males 3.5 cm, Females 5.0 cm	 Regal fritillary
Habitat: Regal fritillaries require relatively non-degraded native tallgrass and mixed-grass prairies.	
Diet: Larva/caterpillars feed exclusively on violets. Adults nectar on milkweed, native thistle, and ironweed blooms.	
Predators: Their biggest threat to regal fritillaries is habitat loss. They require prairie habitats and as the prairie goes, so goes the regal fritillary. They are a species of concern due to steep population drops that correlate with the loss of prairie habitat.	
Social Groups: Regals are generally solitary; they live for 2 - 8 weeks, mating during this time and laying eggs on violets.	

Species: *Danaus plexippus* Both genders of the same size - 9.0 cm	 Monarch
Habitat: Monarch habitats can be found in agricultural fields, pasture land, prairie remnants, urban and suburban residential areas, gardens, trees, and roadsides – anywhere where there is access to larval host plants.	
Diet: Larva/caterpillars feed exclusively on milkweeds. Adults nectar on milkweed, goldenrod, native thistle, coneflowers, and ironweed blooms.	
Predators: Populations of monarchs have declined precipitously due to habitat loss at their traditional wintering grounds as well as loss of milkweed from mowing and herbicide use and death from direct exposure to insecticides.	
Social Groups: Monarchs are generally solitary except during their annual migration south to Mexico in the autumn and their migration back north in the spring.	

Species: *Melanoplus ponderosus*
Both genders of the same size - 35 - 45 mm

Habitat: Spur-throated grasshoppers are generally found in fields and open meadows. They may travel widely. They are common pests of grassy field crops, like corn and wheat.

Diet: They feed on grass and some forbs (wildflowers).

Predators: Birds, including wild turkey and bobwhites, spiders, and coyotes will all eat these grasshoppers.

Life cycle: Females lay eggs, only about 20, directly into the soil, where they spend the winter. Eggs hatch into miniature versions of the adult, termed “nymphs”. Nymphs go through 5-6 instar stages (growing with each stage) before reaching adulthood - determined visually by the length of their wings. Once wings reach the tip of their abdomen, they’re adults.

Spur-throated grasshopper

Species: *Amorpha canescens*
Small deciduous shrub - reaches 0.3 - 1.0 m tall

Habitat: Prairie - the presence of leadplant usually indicates a high-quality prairie.

Diet: Photosynthetic

Predators: It is very palatable to livestock and wildlife, including cattle, sheep, horses, elk, and deer. Grasshoppers will also
eat leadplant.

Miscellaneous: A single plant may form a clump 3 ft. in diameter. Leadplant is a legume, and as such, may have root nodules with bacteria that are capable of changing atmospheric nitrogen (N_2) into ammonia (NH_3), a form the plant may use to produce proteins.

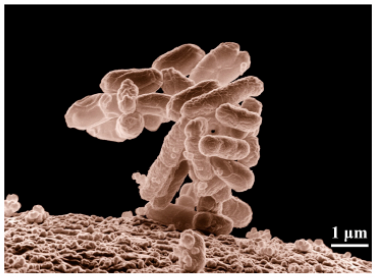
Leadplant

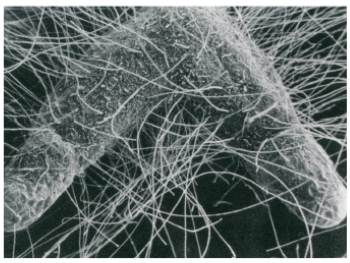
Species: *Asclepias syriaca* Up to 1.5 m tall	 Common milkweed
Habitat: Prairies, grasslands and fields of the central United States. It is quite wide-spread.	
Diet: Photosynthetic	
Predators: The leaves of milkweed contain a white milky latex ("milkweed") - that contains cardiac glycosides, a chemical rendering the plant toxic to livestock and many other animals. Other insects employ ingestion of the toxins to make themselves toxic to predators, e.g. monarch butterflies.	
Miscellaneous: Numerous insects are attracted to the nectar-laden flowers and it is not at all uncommon to see flies, beetles, ants, bees, wasps, and butterflies on the flowers at the same time. Monarch caterpillars commonly feed on the leaves. Adult monarchs feed on the flower nectar.	

Species: *Solidago altissima* 0.6 - 1.2 m tall	 Tall goldenrod
Habitat: Drier soils of grasslands, prairies, and fields of the central United States.	
Diet: Photosynthetic	
Predators: Goldenrod is not palatable to livestock, but many insects visit the flowers for nectar, including migrating monarch butterflies in September.	
Social Groups: Tall goldenrod has an extensive rhizome (underground stem adapted for storage of food and water) And it can facilitate the spread of this plant into neighboring areas. The rhizome also ensures the plants survival after a fire (whether prescribed or wildfire).	

Species: *Panicum virgatum* Can reach heights of 2.5 m	 Switchgrass
Habitat: Prairie, especially moist lowland	
Diet: Photosynthetic	
Predators: Early growth is an excellent pasture grass. Important as a source of fuel for ethanol production.	
Social Groups: Arising from a tough underground rhizome, Switchgrass stems are often clustered in large bunches.	

Species: *Andropogon gerardii* Up to 2.7 m - the tallest of the tallgrasses	 Big bluestem
Habitat: Widespread prairie habitats - it is extremely drought tolerant. It is the most abundant species of grass in the tallgrass prairie.	
Diet: Photosynthetic	
Predators: Big bluestem is high in protein and is a good forage for horses and cattle, and can also be cut and used for hay. It has long been considered a desirable and ecologically important grass by rangeland ecologists. It is often grown for wildlife gardens, natural landscaping, and grassland habitat restoration projects.	
Social Groups: Monarchs are generally solitary except during their annual migration south to Mexico in the autumn and their migration back north in the spring.	

Species: Nitrogen-fixing bacteria *Bradyrhizobium* spp. and *Azospirillum* spp.	 Bacteria
Habitat: *Bradyrhizobium* - lives in root nodules of legume plants like Leadplant. *Azospirillum* lives in prairie soils.	
Diet: Both groups of bacteria feed on organic molecules, like plant sugars to produce energy. They use that energy to take atmospheric nitrogen and turn it into NH_4 - a form of nitrogen that plants can absorb and use to make proteins. .	
Predators: Oxygen and moisture will inhibit the action of these bacteria.	
Social Groups: Bacteria normally occur in large clusters.	

Species: Mycorrhizal fungi *Glomus* spp. and *Archaeosporales* spp.	 Mycorrhizal fungi
Habitat: Mycorrhizal fungi are normal inhabitants of the soil. The fungi grow towards plant roots and will grow into the roots themselves,and act like hair extensions for the roots, dramatically extending the reach of the root network into the soil	
Diet: Fungi feed on the sugars secreted by the plant roots. Plants make the sugars by photosynthesis and then transfer the sugar down to the roots.	
Predators: Plowing, tillage and agricultural chemicals will kill mycorrhizal fungi.	
Social Groups: Mycorrhizal fungi occurs as a fine mesh of hyphae filaments that looks like hair extending from the roots.	