Biology Magnets Module 9: Food Chains, Food Webs, Cladograms - Teacher and Student Guides

Teacher Information

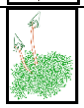
This module uses magnets designed for teacher and student interaction to guide learning about food chains, food webs, and cladograms. Contained in this guide are outlines for lessons that can last from 10 minutes to approximately 80 minutes depending upon teacher preference. The lessons have both teacher-centered and student-centered activities. The student-centered activities are most effective if students are in small groups. It may be necessary to have multiple magnet sets for large classes. Student handouts are provided which can be printed out and given to each student group to help guide their progress as they work with the magnets. If budget or white board space is limited, groups can alternate between using a set of magnets and doing other activities. Teachers can refer to the videos posted at the Biology Magnet web site at Biologymagnets.com for further teaching instructions.

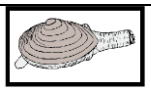
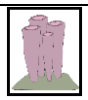
Magnet Care and Maintenance

Biology magnets are made to last for years. Periodically magnets will fall off or are knocked off the plastic. A piece of magnetic tape is included with each module, which should be able to replace around 10-12 magnets if necessary. Simply cut a new magnet and peel off the back to replace. Magnetic tape can be purchased from a hobby store to replace magnets lost over time. Laminate may peel off, especially on small pieces. Use transparent tape to re-attach laminate that comes loose, curling the tape over the back of the magnet. The machines used to cut Biology magnets are not perfectly accurate. Sometimes a bit of white or black outline on the edges occurs or a cut might be slightly off center. Use scissors to remove extra outline that is unnecessary if desired. Store magnets in the clasp envelopes in which they arrived for easy organization.

Copyright Information – Module 9 – Food Chains and Food Webs

Module 9 – Food Chains and Food Webs – Materials List

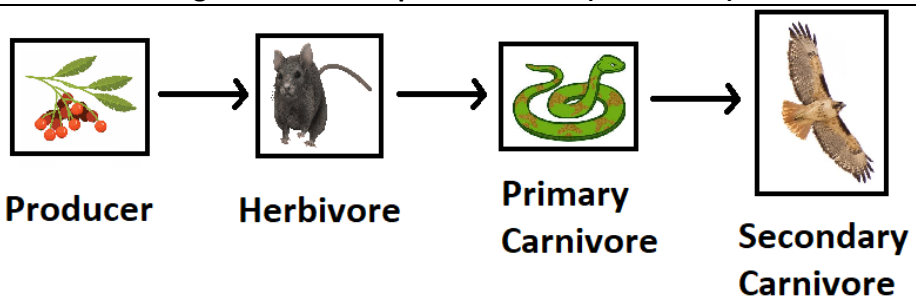
Name	#	Picture	Trophic Level	Consumes	Consumed by
Flower	6		1 – producer	n/a	Cricket, butterfly, deer, fly, mouse
Tree	1		1 - producer	n/a	Cricket, deer, squirrel, mouse, fly
Grass	1		1 - producer	n/a	Cricket, deer, mouse, fly
Berries	1		1 – producer	n/a	Cricket, butterfly, deer, fly, mouse, bear
Algae	1		1 – producer	n/a	Shrimp, Crabs
Conifer	1		1 – Producer	n/a	Cricket, deer, squirrel, mouse, fly
Moss	1		1 – Producer	n/a	Cricket, deer, squirrel, mouse
Fern	1		1 – Producer	n/a	Cricket, deer, squirrel, mouse
Cricket	1		2 – herbivore	Flower, tree, grass, berries	Mouse, frog, spider, songbird, snake. fish
Fly	1		2 – herbivore or detritivore	Flower, berries, tree, grass – Eats dead organic matter	Spider, songbird, frog
Squirrel	1		2 – herbivore	Tree, flower, berries	Snake, fox, hawk
Butterfly	1		2 – herbivore	Flower, berries	Songbird, spider, frog
Deer	1		2 – herbivore	Flower, berries, tree, grass	Bear
Mouse	4		2,3 – herbivore, omnivore	Flower, berries, tree, grass, cricket, butterfly	Prokaryotic and Eukaryotic – Plant and Animal
Shrimp	1		2 – herbivore	Algae	Crab, fish
Earthworm	1		2 – herbivore, detritivore	Fungi, bacteria, eats dead organic matter	Songbird, mouse, snake, worm
Songbird	1		2,3 – herbivore, carnivore	Fly, butterfly, spider, earthworm, grasshopper, berries, flower, tree, grass	Fox, hawk, snake

Frog	1		2,3 – herbivore, carnivore	Fly, cricket, algae, shrimp, butterfly, spider	Snake. Hawk
Clam	1		2,3 – Omnivore	Plankton, algae	Fish, starfish, birds
Jellyfish	1		2,3 - Omnivore	Fish, shrimp, crabs, algae	Sharks, fish, birds
Sponge	1		2,3 – Omnivores, decomposer	Plankton, bacteria, dead organic matter	Fish, starfish
Planarian	1		3 – Carnivore, decomposer	Bacteria , dead organic matter	Fish, shrimp
Snake	2		3,4 – carnivore	Mouse, frog, squirrel, songbird	Bear, hawk, fox
Spider	1		3,4 – carnivore	Fly, butterfly, cricket	Frog, songbird, snake, mouse
Hawk	1		3,4,5 – Carnivore	Fish, mouse, snake, songbird, frog, squirrel	Fox, snake, bear (eggs, fledglings)
Bear	1		2,3,4,5 – Carnivore, Omnivore	Fish, snake, mouse, berries, deer, crab	n/a
Fox	1		3,4,5 – Carnivore	Songbird, mouse, hawk, squirrel, snake, fish. frog	bear
Fish	1		2,3,4 – Carnivore, omnivore	Shrimp, crab, cricket, algae	Bear, shark, hawk
Shark	1		3,4,5 – Carnivore	Crab, fish	n/a
Bacteria	1		Decomposer	Absorbs organic molecules from dead organisms	n/a
Fungi	1		Decomposer	Absorbs organic molecules from dead organisms	n/a
Sun	1		Source of energy for trophic level 1	n/a	n/a
DDT	6		Poison involved in biomagnification	n/a	n/a
3” Magnetic Tape Strip	1		Used to replace lost magnets	n/a	n/a
Total Pieces	**50**				

Lesson 9A – Food Chains and Food Webs (10-80 minutes)

Teacher-Centered Activity (10-30 minutes): This lesson reviews food chains and food webs using the Biology Magnets from Module 9 as shown in the table above. For this lesson, remove duplicate magnets of the berries, mouse, and snake. These will be used in lesson 9B. Start the lesson by going over simple food chains. Use magnets to show a food chain, drawing arrows between magnets to demonstrate movement of biomass or energy (**Figure 9.A.1**). Use different magnets to show how several examples of food chains can be made with the module. It may be helpful to label and discuss the food chain with words such as producer, herbivore, primary carnivore, and secondary carnivore.

Figure 9.A.1 – Simple Food Chain (with labels)



To start building a food web, place trophic level one organisms (producers) near the bottom of the board **(figure 9.A.2)**. Place trophic level two above them, and draw arrows showing movement of biomass or energy between levels **(figure 9.A.3)**.

Figure 9.A.2 – Producers

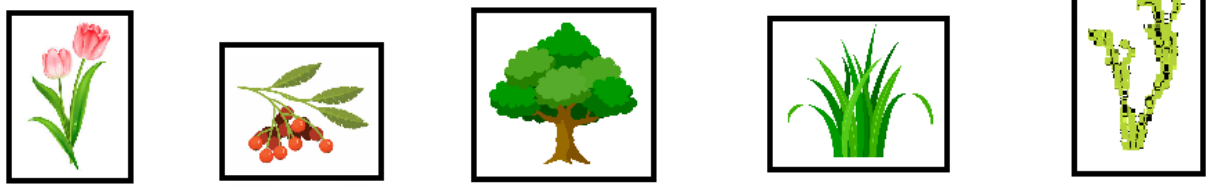
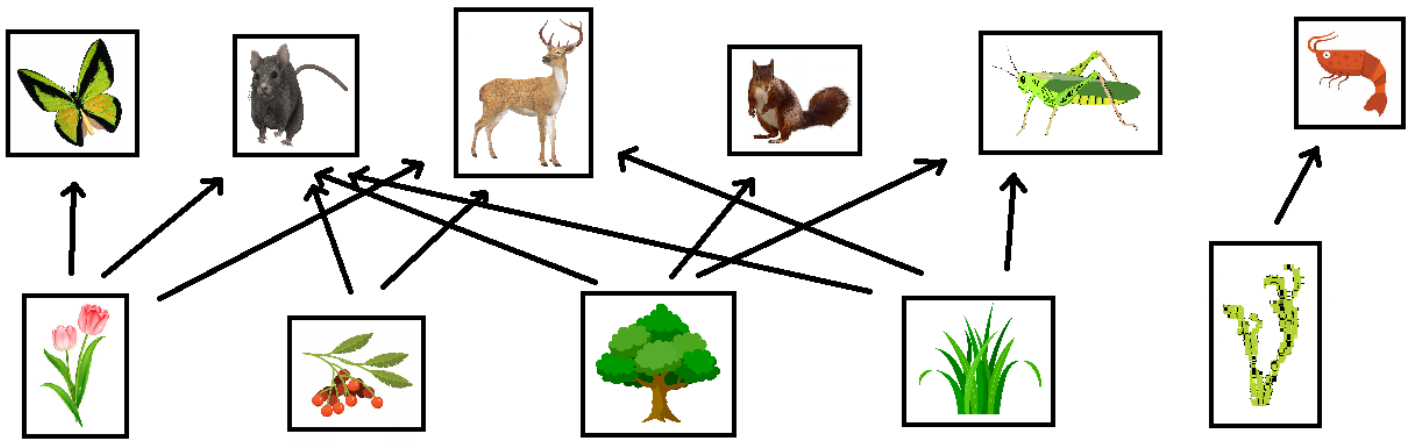


Figure 9.A.3 – Trophic Level Two Placement



Next, place trophic level three organisms with appropriate arrows. Note that some organisms on trophic level three may also feed on trophic level one organisms, making them omnivores. Include some of those arrows as well **(figure 9.A.4)**. Place the trophic level four organisms next with the appropriate arrows **(figure 9.A.5)**.

Figure 9.A.4 – Trophic Level Three Placement

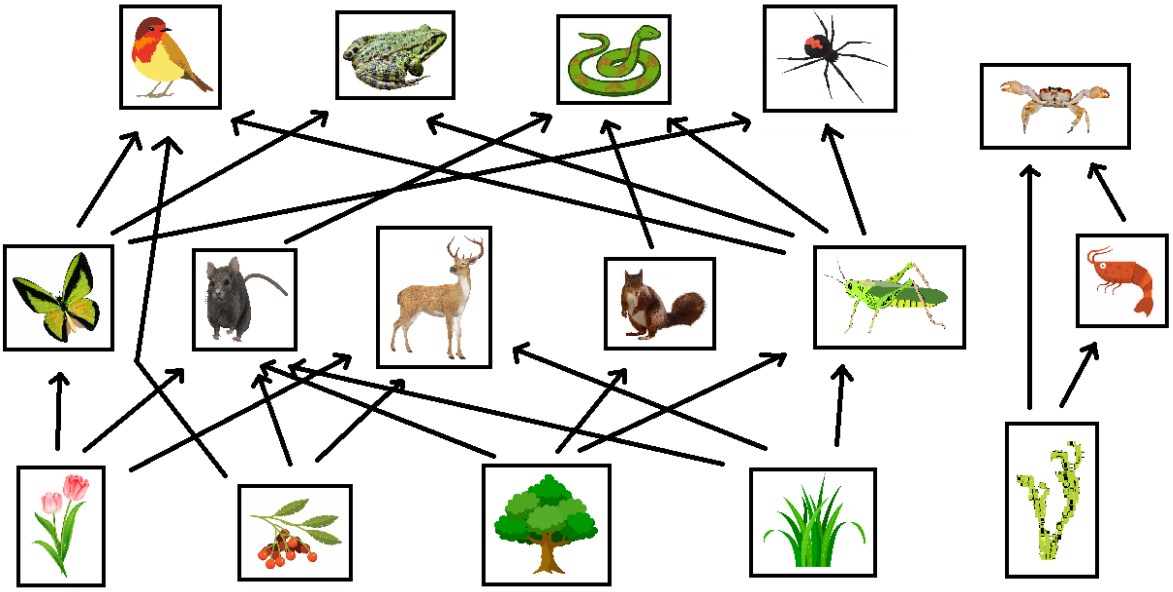
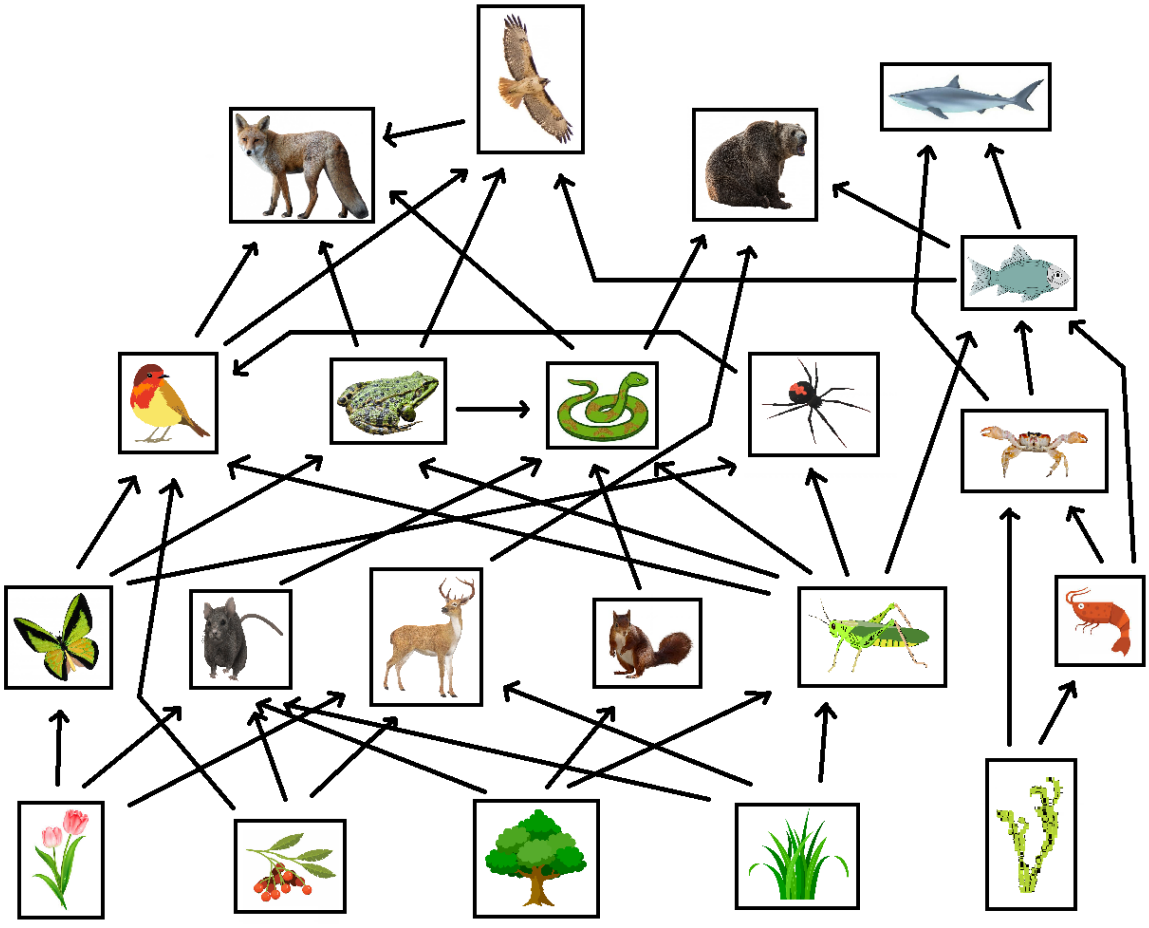
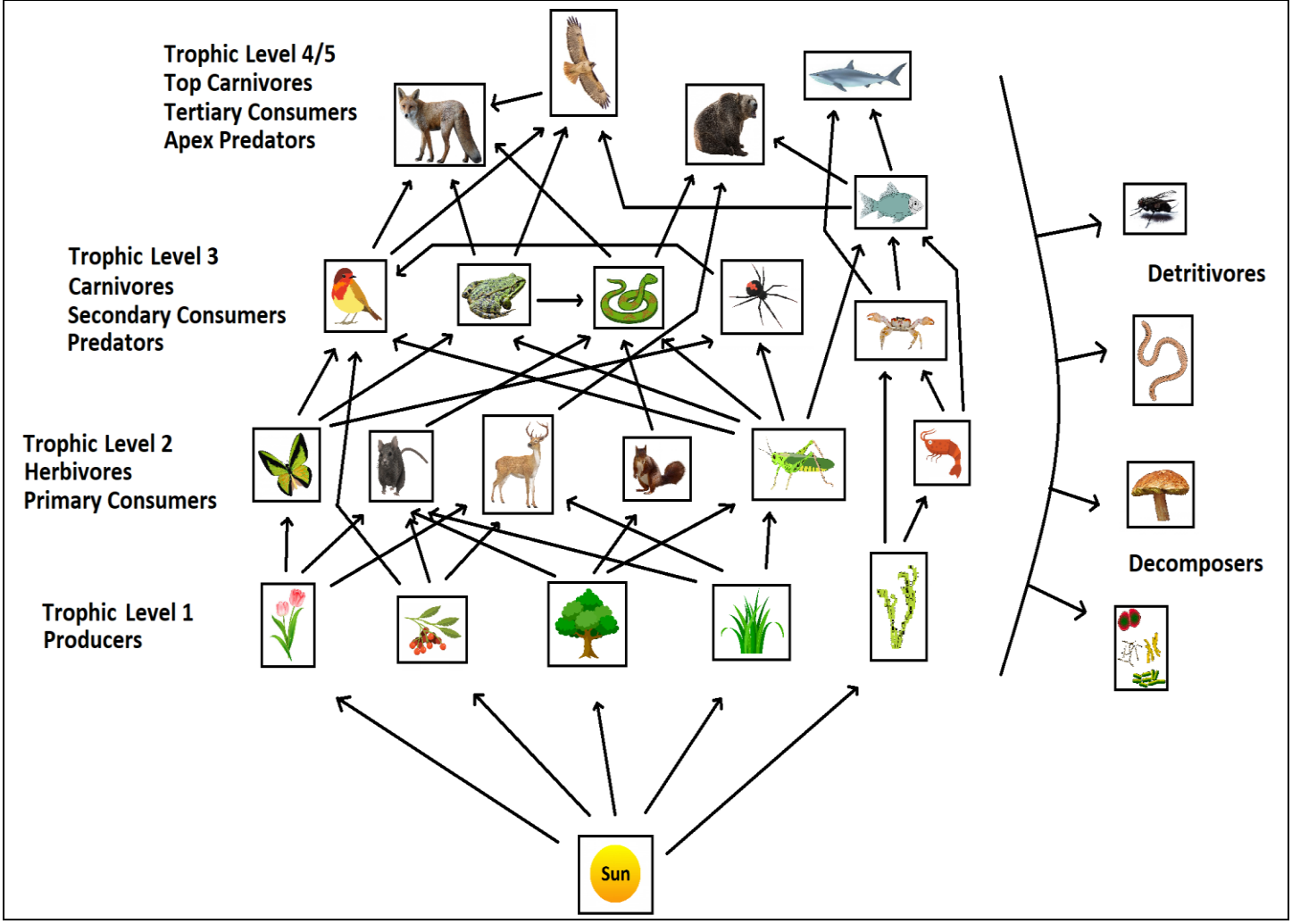


Figure 9.A.5 – Trophic Level Four Placement



If it is appropriate for grade level, place magnets and discuss the role of the sun (which sustains the entire food web), and of detritivores and decomposers (which break down dead organic matter). Add written labels to complete the lesson **(figure 9.A.6).**

Figure 9.A.6 – The Sun, Detritivores, Decomposers, and Labels



Student Centered Activity (20-50 minutes): After teaching food chains and food webs, put students into small groups and have them take turns building food chains and then food webs. Allow the students to help one another. Students can use the student guide to help build the web. The alternate student handout can also be used to have students research each organism and figure out what the various organisms eat (see extra exercises). Note that student webs will look different from the examples and from one another according to the placement each group uses and the number of arrows drawn. It is probably a good idea to limit any organism to 3 or 4 arrows either going from it or going to it, to reduce the clutter on the board.

Extra exercises:

Research Organisms: Instead of giving student groups the completed student handout, provide the alternate student handout and have students go online and find out what organisms eat. Have them complete the student handout as they build the web.

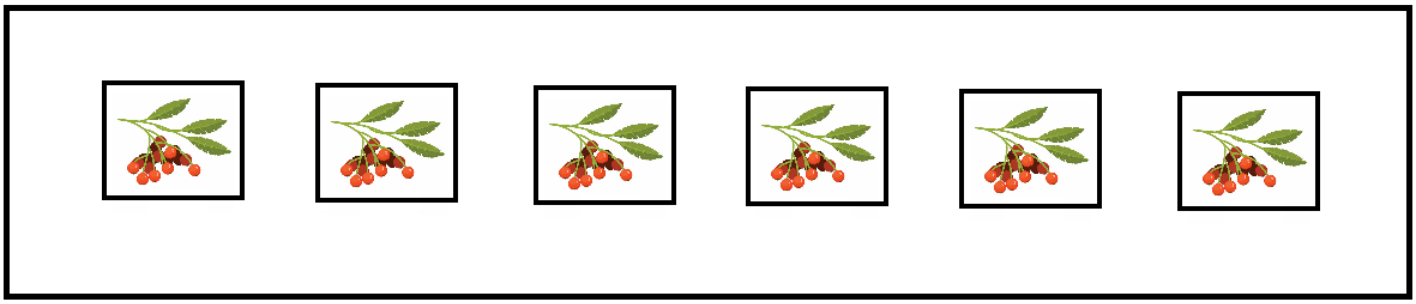
Food Web Disruptions: Have the students investigate what would happen if a certain organism is suddenly eliminated from the food web, the bear for example. Have them figure out how this would affect the rest of the food web. What organisms would be most greatly affected? What organisms would be unaffected? What organisms would increase? What organisms would decrease?

Making magnets: Have the students use index cards, colored pencils, and magnetic tape to make their own magnets of organisms and add them to the food web. For instance, a student might draw a cactus on a card, place magnets on the back, and add it to the board. The students can research where it would fit on the board and what would eat it. Make a human magnet. Where would it fit in?

Lesson 9B – Ecological Pyramids and Biomagnification – (10-70 Minutes)

Teacher-Centered Activity (10-30 minutes): This lesson reviews ecological pyramids and biomagnification using the Biology Magnets from Module 9 as shown in the table above. For this lesson, use the magnets representing the berries, mice, snakes and hawk. Start the lesson by placing the six magnets representing berries near the bottom of the board and drawing a large box around them. This represents trophic level 1, the producers, which use the sun's energy to make biomass by photosynthesis (**Figure 9.A.1**).

Figure 9.B.1 – Trophic Level 1 - Producers



Next, add the four mice magnets above the berries and draw a box around them. This represents trophic level 2. Explain that there are fewer mice than berries because approximately 90% of energy at each level is lost as heat, passing along only 10% of the energy to the next level (**Figure 9.B.2**). Continue to add trophic levels until reaching the top of the pyramid. Add labels to show the names of each level (**Figure 9.B.3**).

Figure 9.B.2 – Trophic Level 2 - Herbivores

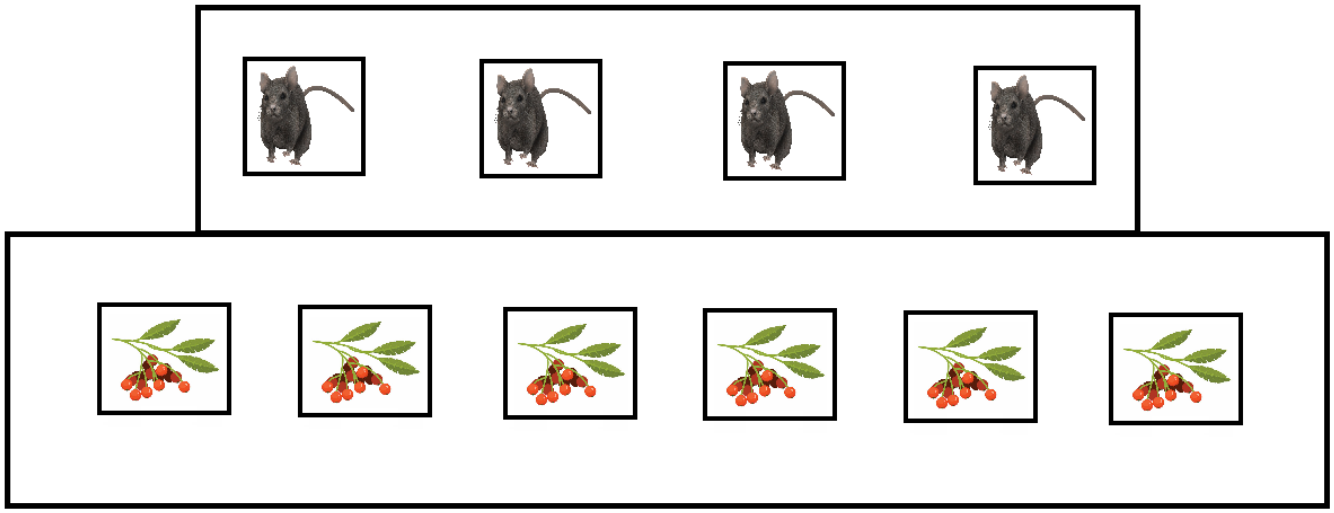
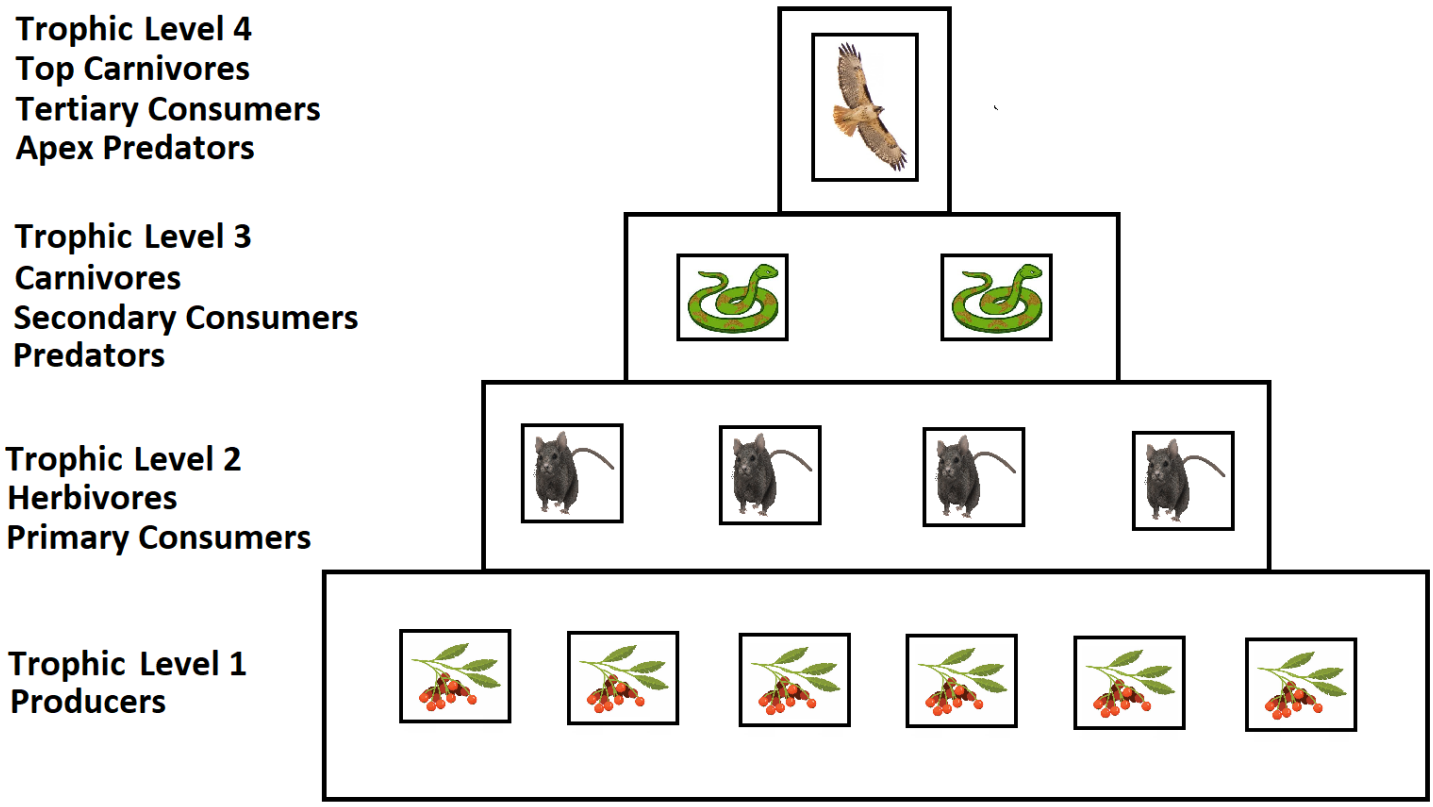
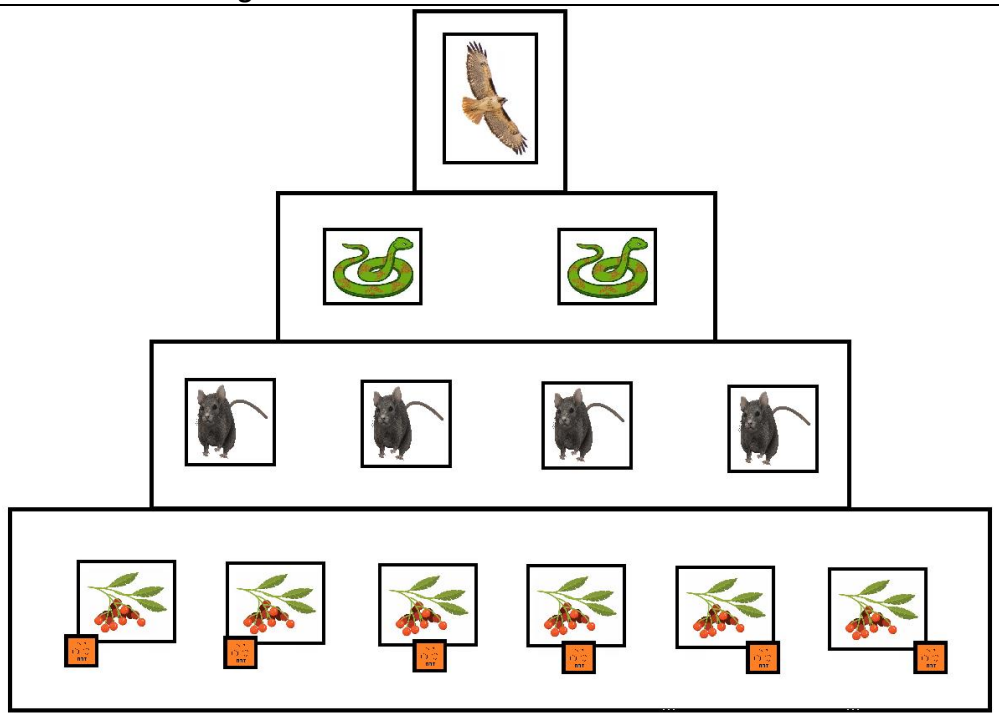


Figure 9.B.3 – Trophic Level 3/4 – Carnivores – With Labels



Biomagnification: To demonstrate biomagnification, use the six DDT magnets by placing one next to each plant magnet at the bottom of the pyramid. This represents a low concentration of insecticide sprayed on crops to protect them from pests (**Figure 9.B.4**).

Figure 9.B.4 – Initial Insecticide Concentration



Next, move the DDT magnets up to the mice, representing the fact that most of the DDT remains dissolved in the fats of the consumers (**Figure 9.B.5**). Continue to move the magnets up to the snakes, then finally to the hawk at the top of the pyramid. In nature, biomagnification can raise levels of poisons over one million times the level at which they were originally present in the environment, damaging or killing organisms at the top of the pyramid (**Figure 9.B.6**).

Figure 9.B.5 – Insecticide concentration increases as it moves up the food chain

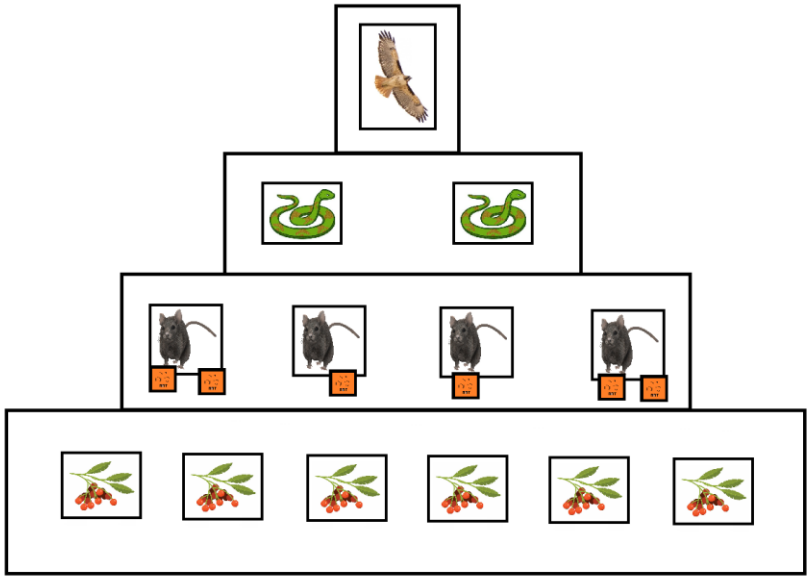
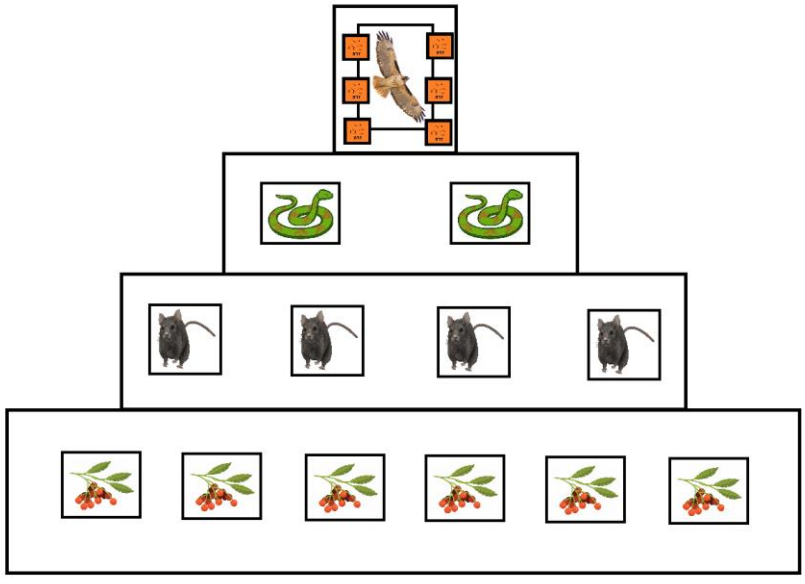


Figure 9.B.6 – Insecticide concentrates in higher trophic levels

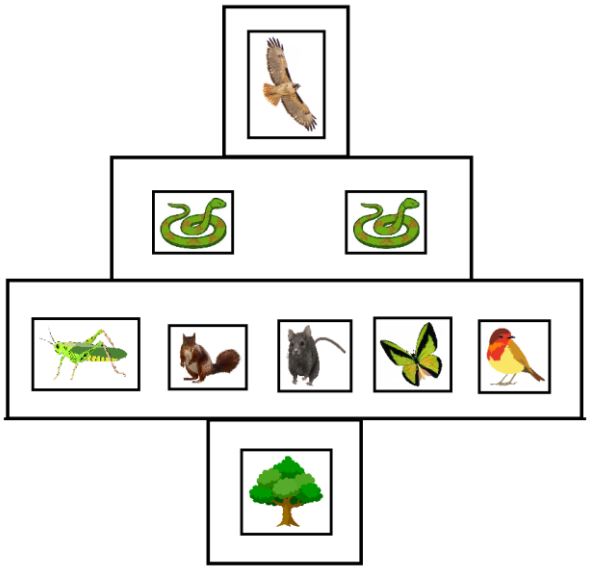


Student Centered Activity (10-40 minutes): After teaching ecological pyramids and biological magnification, put students into small groups and have them take turns building ecological pyramids and demonstrating biological magnification. Allow the students to help one another. Students can use the same magnets shown in **Figures 9.B.1-6** or they could build pyramids using other magnets, as long as the organisms at each trophic level are correct. Have the students write down the appropriate names of each level next to their pyramid. They can also use the blank diagram on the student handout to write the names for each level.

Extra Exercises:

Pyramid types: Have students investigate and differentiate between pyramids of biomass, numbers, and energy. Students can build an inverted pyramid of numbers by having a single tree on the bottom of the pyramid with numerous herbivores in trophic level two above it (**Figure 9.B.7)**. Because a tree is so large, a single tree can feed many herbivores, but if the pyramid were converted to a pyramid of biomass the bottom would still be significantly larger. To simulate a pyramid of energy, students can use the sun magnet and arrows to the side of the pyramid that show loss of heat to the environment.

Figure 9.B.7 – Sample inverted pyramid of numbers



Problems:

Energy problem: If the biomass of the producers in the ecological pyramid in **Figure 9.B.3** had an energy content of 50,000 kcal, how many kcal of energy would be contained in the biomass of the tertiary consumers at the top? Assume that 90% of energy is lost in transition to each level (10% is conserved).

Answer: *50,000 kcal in producers x 0.10 = 5,000 kcal in primary consumers (herbivores)*
5,000 kcal in herbivores x 0.10 = 500 kcal in secondary consumers (primary carnivores)
*500 kcal in primary carnivores x 0.10 = **50 kcal** in tertiary consumers (secondary carnivores)*

Biomass problem: If the mice in **Figure 9.B.3** had a biomass of 22.6 kg and the snakes had a mass of 3.2 kg, what would be the efficiency of the biomass transfer between the two trophic levels?

Answer: *3.2/22.6 x 100% = 14% efficiency*

Simpson's Diversity Index Problems: Have the students use the magnets from the pyramid in **Figure 9.B.3** to calculate the Simpson's diversity index for the community. The Simpson's diversity index formula is: $D = 1 - \sum (n / N)^2$. Have students add or remove magnets from the group and mathematically determine how the diversity index would change. Different sets of magnets can be given to student groups to determine the Simpson's diversity index.

Answer $= 1 - \sum ((6/13)^2 + (4/13)^2 + (2/13)^2 + (1/13)^2)$
$= 1 - \sum (0.213 + 0.0946 + 0.0237 + 0.006)$
$= 1 - 0.337$
$= \mathbf{0.663}$

Lesson 9C – Cladograms – (10 - 50 Minutes)

Teacher-Centered Activity (10-30 minutes): This lesson involves setting up and describing cladograms using some of the Biology Magnets from Module 9. Three sample cladograms that could be constructed are shown below. The first is the evolution of plants, the next is the evolution of animals and the third is the evolution of vertebrates. Using the tables and the magnets, show students how to set up a cladogram while drawing the lines and labeling them with the appropriate shared derived characters (**Figure 9.C.1-6**).

Figure 9.C.1 – Character Table 1 – Plant Evolution

	Taxa				
Characters	Algae	Moss	Ferns	Conifers	Flowering Plant
Cloroplasts	✓	✓	✓	✓	✓
Embryo Protection		✓	✓	✓	✓
Cuticle		✓	✓	✓	✓
Vascular Tissue			✓	✓	✓
Seeds				✓	✓
Flowers and Fruit					✓

Figure 9.C.2 – Cladogram 1 – Plant Evolution

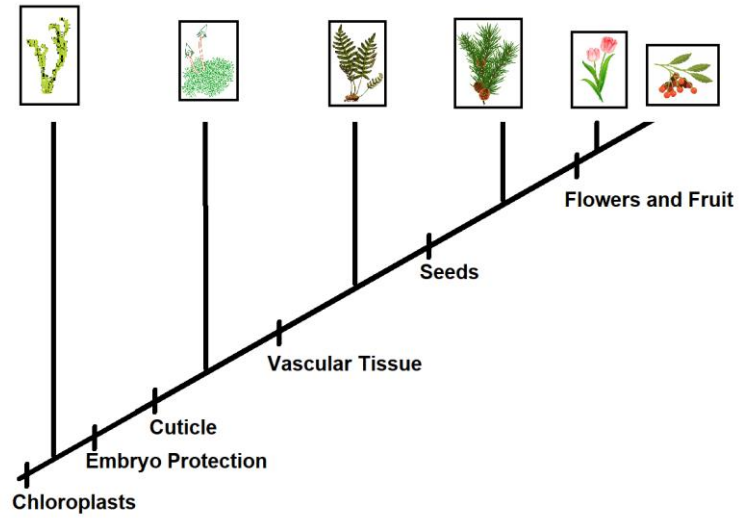


Figure 9.C.3 – Character Table 2 – Vertebrate evolution

	Taxa						
Characters	Shark	Fish	Frog	Snake	Bird	Fox	Deer
Dorsal Nerve Cord	✓	✓	✓	✓	✓	✓	✓
Bony Skeleton		✓	✓	✓	✓	✓	✓
Lungs			✓	✓	✓	✓	✓
Amniote				✓	✓	✓	✓
Feathers					✓		
Hair, Mammary						✓	✓
Antlers							✓

Figure 9.C.4 – Cladogram 2 – Vertebrate evolution

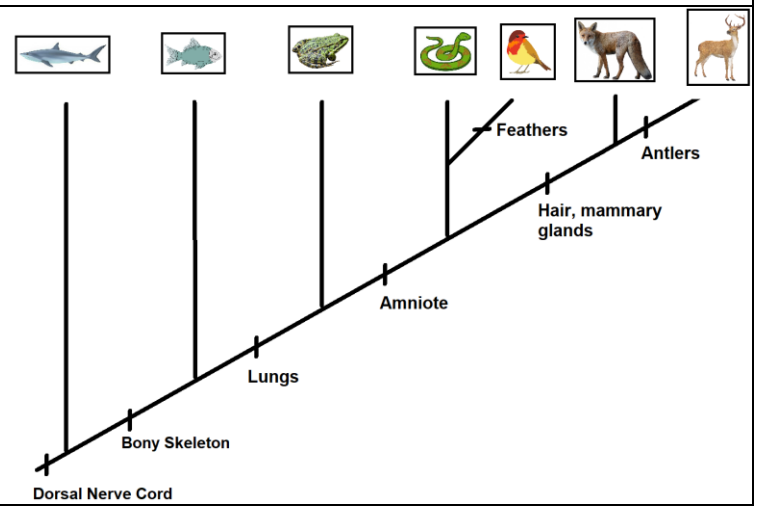
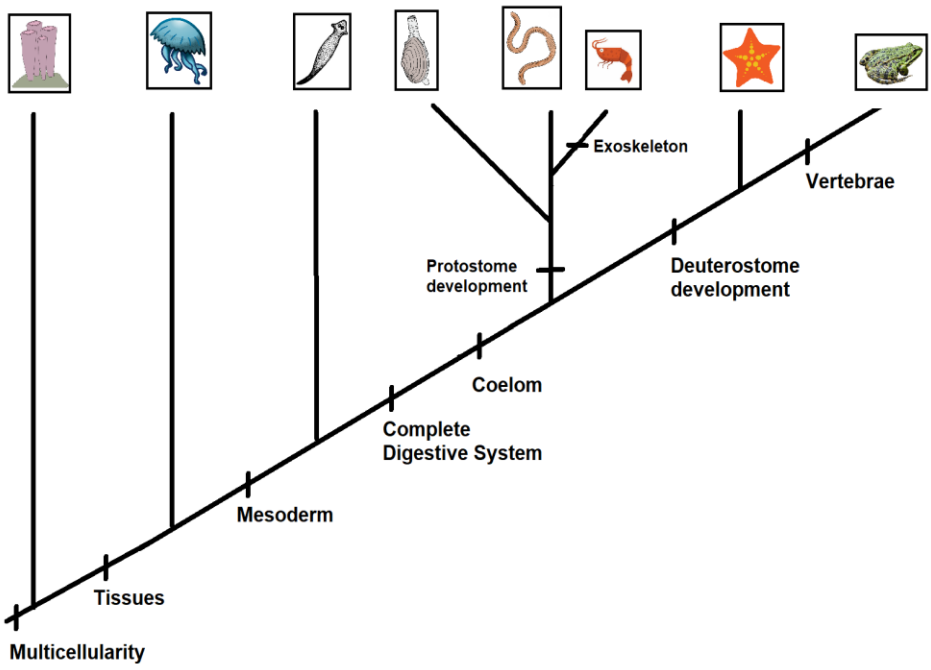


Figure 9.C.5 – Character Table 3 – Animal Evolution

Taxa

Characters	Sponge	Jellyfish	Flatworm	Clam	Earthworm	Shrimp	Starfish	Frog
Multicellularity	✓	✓	✓	✓	✓	✓	✓	✓
Tissues		✓	✓	✓	✓	✓	✓	✓
Mesoderm			✓	✓	✓	✓	✓	✓
Complete Digestive System				✓	✓	✓	✓	✓
Coelom				✓	✓	✓	✓	✓
Protostome Development				✓	✓	✓		
Exoskeleton						✓		
Deuterostome Development							✓	✓
Vertebrae								✓

Figure 9.C.6 – Cladogram 3 – Animal Evolution



Student Centered Activity (10-40 minutes): There are several ways to teach the students to make a cladogram, which can vary based on proficiency. You can give the students the tables (which are larger in the student handout) and have students build the cladograms on the board using the magnets. Alternatively, for higher-level students, hand out an empty trait table and have them fill it out by looking up the traits of each organism online. After filling out the tables, students can then build the cladogram using the magnets and drawing the lines with a marker.

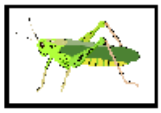
Extra Exercises:

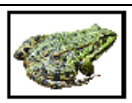
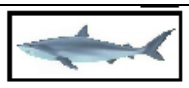
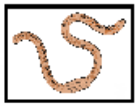
Add Organisms: Have students add animals or plants from the other magnets in the set to their existing cladograms and then research the characters that evolved to differentiate the species.

New Cladograms: Have students make new cladograms for other organisms in the magnet set. If a set of magnetic tape is available, have the students use index cards to draw organisms not included in the set for a new cladogram.

Lesson 9A – Food Chains and Food Webs – Student Handout

Student Centered Activity: After studying food chains and food webs, try to build a food web using the Biology Magnets. If you have the completed student handout, use the information on the chart to help build the web. If you have the student handout with blanks, use the internet or other means to research the organisms and fill in the chart. It may be a good idea to limit any organism to 3 or 4 arrows either going from it or going to it, to reduce the clutter of the board.

Magnet Name	Picture	Trophic Level	Consumes	Consumed by
Flower		1 – producer	n/a	Cricket, butterfly, deer, fly, mouse
Tree		1 - producer	n/a	Cricket, deer, squirrel, mouse, fly
Grass		1 - producer	n/a	Cricket, deer, mouse, fly
Berries		1 – producer	n/a	Cricket, butterfly, deer, fly, mouse, bear
Algae		1 – producer	n/a	Shrimp, Crabs
Cricket		2 – herbivore	Flower, tree, grass, berries	Mouse, frog, spider, songbird, snake. fish
Fly		2 – herbivore or detritivore	Flower, berries, tree, grass – Eats dead organic matter	Spider, songbird, frog
Squirrel		2 – herbivore	Tree, flower, berries	Snake, fox, hawk
Butterfly		2 – herbivore	Flower, berries	Songbird, spider, frog
Deer		2 – herbivore	Flower, berries, tree, grass	Bear
Mouse		2,3 – herbivore, omnivore	Flower, berries, tree, grass, cricket, butterfly	Prokaryotic and Eukaryotic – Plant and Animal

Magnet Name	Picture	Trophic Level	Consumes	Consumed by
Shrimp		2 – herbivore	Algae	Crab, fish
Songbird		2,3 – herbivore, carnivore	Fly, butterfly, spider, earthworm, grasshopper, berries, flower, tree, grass	Fox, hawk, snake
Frog		2,3 – herbivore, carnivore	Fly, cricket, algae, shrimp, butterfly, spider	Snake. Hawk
Snake		3,4 – carnivore	Mouse, frog, squirrel, songbird	Bear, hawk, fox
Spider		3,4 – carnivore	Fly, butterfly, cricket	Frog, songbird, snake, mouse
Crab		2,3 – herbivore, carnivore	Algae, shrimp	Fish, hawk, bear, fox
Hawk		3,4,5 – Carnivore	Fish, mouse, snake, songbird, frog, squirrel	Fox, snake, bear (eggs, fledglings)
Bear		2,3,4,5 – Carnivore, Omnivore	Fish, snake, mouse, berries, deer, crab	n/a
Fox		3,4,5 – Carnivore	Songbird, mouse, hawk, squirrel, snake, fish. frog	bear
Fish		2,3,4 – Carnivore, omnivore	Shrimp, crab, cricket, algae	Bear, shark, hawk
Shark		3,4,5 – Carnivore	Crab, fish	n/a
Bacteria		Decomposer	Absorbs organic molecules from dead organisms	n/a
Fungi		Decomposer	Absorbs organic molecules from dead organisms	n/a
Earthworm		2 – herbivore, detritivore	Fungi, bacteria, eats dead organic matter	Songbird, mouse, snake, worm

Lesson 9A – Food Chains and Food Webs – Alternate Student Handout

Magnet Name	Picture	Trophic Level	Consumes	Consumed by
Flower				
Tree				
Grass				
Berries				
Algae				
Cricket				
Fly				
Squirrel				
Butterfly				
Deer				
Mouse				
Shrimp				
Songbird				
Frog				

Magnet Name	Picture	Trophic Level	Consumes	Consumed by
Snake				
Spider				
Crab				
Hawk				
Bear				
Fox				
Fish				
Shark				
Bacteria				
Fungi				
Earthworm				

Extra exercises:

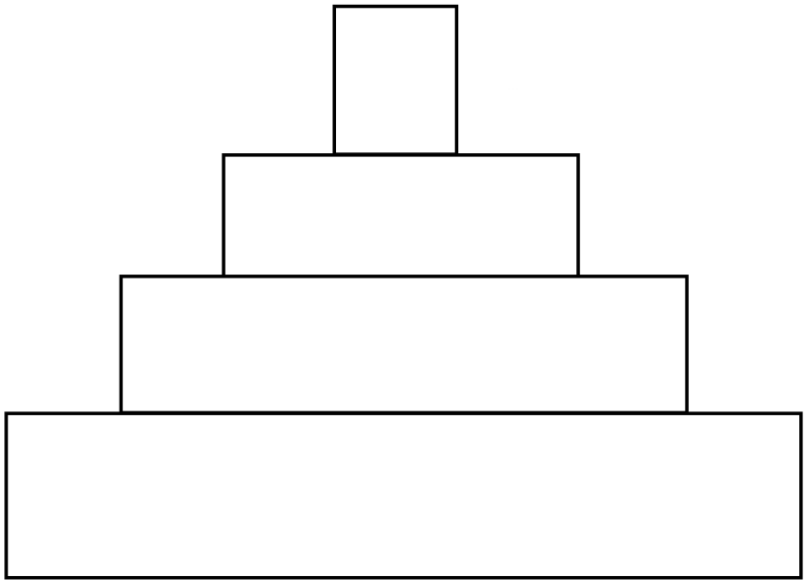
Food Web Disruptions: Investigate what would happen if a certain organism is suddenly eliminated from the food web, the bear for example. Figure out how this would affect the rest of the food web. What organisms would be the most greatly affected? What organisms would be unaffected? What organisms would increase? What organisms would decrease? Write down your results and show or tell your teacher or other groups.

Making magnets: Use index cards, colored pencils, and magnetic tape to make your own magnets of organisms and add them to the food web. For instance, you might draw a cactus on a card, place magnets on the back, and add it to the board. Research where it would fit on the board and what would eat it. Make a human magnet. Where would it fit in? Choose any animal or plant and put it in the appropriate spot on the food web you constructed. Show your teacher or other groups when you are finished.

Lesson 9B – Ecological Pyramids and Biomagnification – Student Handout

Student Centered Activity: After studying ecological pyramids and biological magnification, try to build a food web using the Biology Magnets. Start with the Biology Magnets for berries, mice, snakes, and the hawk. Build a pyramid with the producers at the bottom, then the herbivores, then the primary carnivores, then the apex predators. Note how the size of the pyramid decreases as you move up the pyramid. Next to each level, write terms that describe names given to the organisms that exist at that level. Fill in the chart below with the appropriate terms. To demonstrate biological magnification, use the DDT magnets provided. Show your teacher or other groups. Use different Biology Magnets to build different pyramids.

Student Handout - Blank Ecological Pyramid – Write names for each level in the spaces provided



Extra Exercises:

Pyramid types: Investigate and differentiate between pyramids of numbers, pyramids of energy, and pyramids of biomass. Build an inverted pyramid of numbers by having a single tree on the bottom of the pyramid with numerous herbivores in trophic level two above it. Show the inverted pyramid to your teacher or other groups. If the inverted pyramid of numbers were converted to a pyramid of biomass, what would it look like?

Problems:

Energy problem: If the biomass of the producers in the ecological pyramid in **Figure 9.B.3** had an energy content of 50,000 kcal, how many kcal of energy would be contained in the biomass of the tertiary consumers at the top? Assume that 90% of energy is lost in transition to each level (10% is conserved).

Biomass problem: If the mice in **Figure 9.B.3** had a biomass of 22.6 kg and the snakes had a mass of 3.2 kg, what would be the efficiency of the biomass transfer between the two trophic levels?

Simpson's Diversity Index Problems: Use the magnets from the pyramid in **Figure 9.B.3** to calculate the Simpson's diversity index for the community. The Simpson's diversity index formula is: $D = 1 - \sum (n / N)^2$. Add or remove magnets from the group and mathematically determine how the diversity index would change.

Lesson 9C – Cladograms – Student Handout

Student-Centered Activity (10-30 minutes): This lesson involves setting up cladograms using some of the Biology Magnets from Module 9. Three sample cladograms can be constructed from the tables below. The first is the evolution of plants, the next is the evolution of vertebrates, and the third is the evolution of animals. Use the tables and the magnets to set up a cladogram according to the shared derived characters in the table. Draw the appropriate lines on the board and label them with the characters at the base of the cladogram. Place the magnets accordingly. A sample start to the first cladogram is shown in figure 9.C.2 (**Figure 9.C.1-4**).

Figure 9.C.1 – Character Table 1 – Plant Evolution

Taxa

Characters	Algae	Moss	Ferns	Conifers	Flowering Plant
Cloroplasts	✓	✓	✓	✓	✓
Embryo Protection		✓	✓	✓	✓
Cuticle		✓	✓	✓	✓
Vascular Tissue			✓	✓	✓
Seeds				✓	✓
Flowers and Fruit					✓

9.C.2 – Start of Cladogram

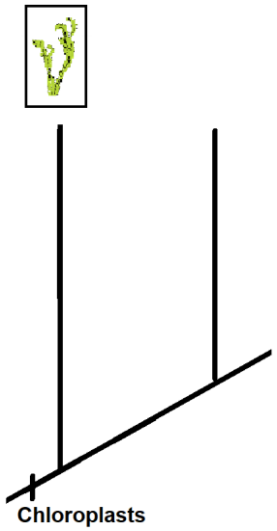


Figure 9.C.3 – Character Table 2 – Vertebrate evolution

Taxa

Characters	Shark	Fish	Frog	Snake	Bird	Fox	Deer
Dorsal Nerve Cord	✓	✓	✓	✓	✓	✓	✓
Bony Skeleton		✓	✓	✓	✓	✓	✓
Lungs			✓	✓	✓	✓	✓
Amniote				✓	✓	✓	✓
Feathers					✓		
Hair, Mammary						✓	✓
Antlers							✓

Figure 9.C.4 – Character Table 3 – Animal Evolution

Taxa

Characters	Sponge	Jellyfish	Flatworm	Clam	Earthworm	Shrimp	Starfish	Frog
Multicellularity	✓	✓	✓	✓	✓	✓	✓	✓
Tissues		✓	✓	✓	✓	✓	✓	✓
Mesoderm			✓	✓	✓	✓	✓	✓
Complete Digestive System				✓	✓	✓	✓	✓
Coelom				✓	✓	✓	✓	✓
Protostome Development				✓	✓	✓		
Exoskeleton						✓		
Deuterostome Development							✓	✓
Vertebrae								✓

Extra Exercises:

Add Organisms: Add animals or plants from the other magnets in the set to their existing cladograms and then research the characters that evolved to differentiate the species.

New Cladograms: Make new cladograms for other organisms in the magnet set. If a set of magnetic tape is available, use index cards to draw organisms not included in the set for a new cladogram.