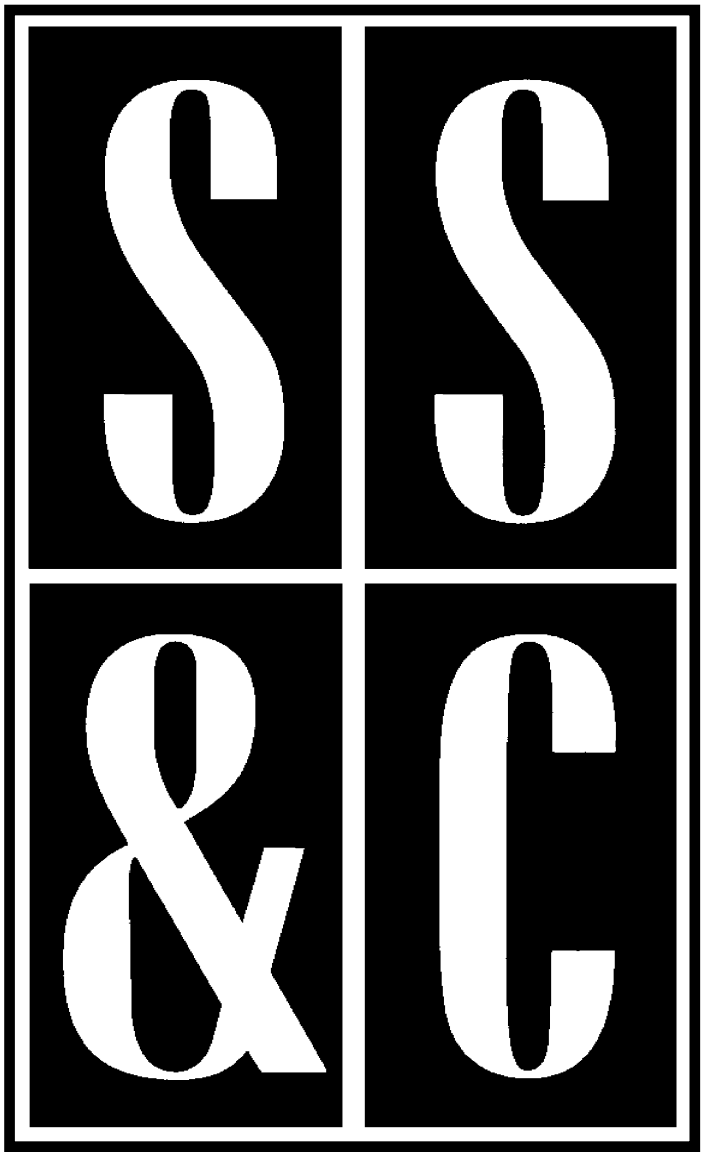
Scope, Sequence & Coordination

A National Curriculum Development and Evaluation Project for High School Science Education



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National Science Education Standard—Life Science

Matter, Energy, and Organization in Living Systems

As matter and energy flow through different levels of organization of living systems—cells, organs, organisms, communities—and between living systems and the physical environment, chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy into the environment as heat. Matter and energy are conserved in each change.

All matter tends toward more disorganized states. Living systems require a continuous input of energy to maintain their chemical and physical organizations. With death and the cessation of energy input, living systems rapidly disintegrate.

The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organism.

Teacher Materials

Learning Sequence Item:

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Construction of Food Chains and Tracing Energy Changes

March 1996
Adapted by: Bill George

Energy Flow Within and Between Living Systems. Students should demonstrate that they understand the concepts of food chain and food web and how they relate to energy transference in an ecosystem. (*Biology, A Framework for High School Science Education, p. 25.*)

Contents

This micro-unit was adapted by **Bill George** (Georgetown Day School, Washington, D.C.)

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Learning Sequence

Energy Flow Within and Between Living Systems. Students should demonstrate that they understand the concepts of food chain and food web and how they relate to energy transference in an ecosystem. (*Biology, A Framework for High School Science Education, p. 25.*)

Science as Inquiry	*Science and Technology*	*Science in Personal and Social Perspectives*	*History and Nature of Science*
Nibbles and Bits (1) **Activity 1** Nibbles and Bits (2) **Activity 2** Nibbles and Bits (3) **Activity 3** Energy Flow **Assessment 1** Food Webs **Assessment 2**		Food Chains **Assessment 3** Meat Demand **Assessment 4** Being a Vegetarian Is Cheaper **Assessment 5**	

Suggested Sequence of Events

Event #1

Lab Activity

1. Nibbles and Bits (1)

Event #2

Lab Activity

2. Nibbles and Bits (2)

Event #3

Lab Activity

3. Nibbles and Bits (3)

Assessment items are at the back of this volume.

Assessment Recommendations

This teacher materials packet contains a few items suggested for classroom assessment. Often, three types of items are included. Some have been tested and reviewed, but not all.

1. Multiple choice questions accompanied by short essays, called justification, that allow teachers to find out if students really understand their selections on the multiple choice.

2. Open-ended questions asking for essay reponses.

3. Suggestions for performance tasks, usually including laboratory work, questions to be answered, data to be graphed and processed, and inferences to be made. Some tasks include proposals for student design of such tasks. These may sometimes closely resemble a good laboratory task, since the best types of laboratories are assessing student skills and performance at all times. Special assessment tasks will not be needed if measures such as questions, tabulations, graphs, calculations, etc., are incorporated into regular lab activities.

Teachers are encouraged to make changes in these items to suit their own classroom situations and to develop further items of their own, hopefully finding inspiration in the models we have provided. We hope you may consider adding your best items to our pool. We also will be very pleased to hear of proposed revisions to our items when you think they are needed.

Teacher Sheet

Science as Inquiry

Nibbles and Bits (1)

Materials:

3 ∞ 5 index cards (enough for class)
dark marking pencil or crayon (enough for class)
colored string or yarn tape

Procedure:

Have students identify the names of plants and animals represented in a particular ecosystem (home area would enhance students' learning). List these names on the chalkboard. There should be a variety of names from which several food chains and food webs can be developed. Have each student select one of the names from the chalkboard and print that name on his/her index card. Tape the name of the producer or consumer onto the student. Using the colored string guide the students in connecting food chains. Once the chains have been determined, list these on the chalkboard in the order of primary producer, herbivore, carnivore, and top carnivore.

Develop a food web by connecting producers from one chain to animals that eat them from another chain. Continue this step with consumers. Use the same colored string from producers to consumers and from consumers to top consumers (predators). Reinforce these connections on the chalkboard. Have students copy their food chains and webs from the chalkboard.

Further Variations:

Have students eliminate a member of the food chain to show the effect on the entire food web.

Adapted from Kutscher, E. *Hands on Environmental Science Activities*, 1992.

Teacher Sheet

Science as Inquiry

Nibbles and Bits (2)

Materials:

photocopied food chain cards
(student teams of 4 or 5)

Procedure:

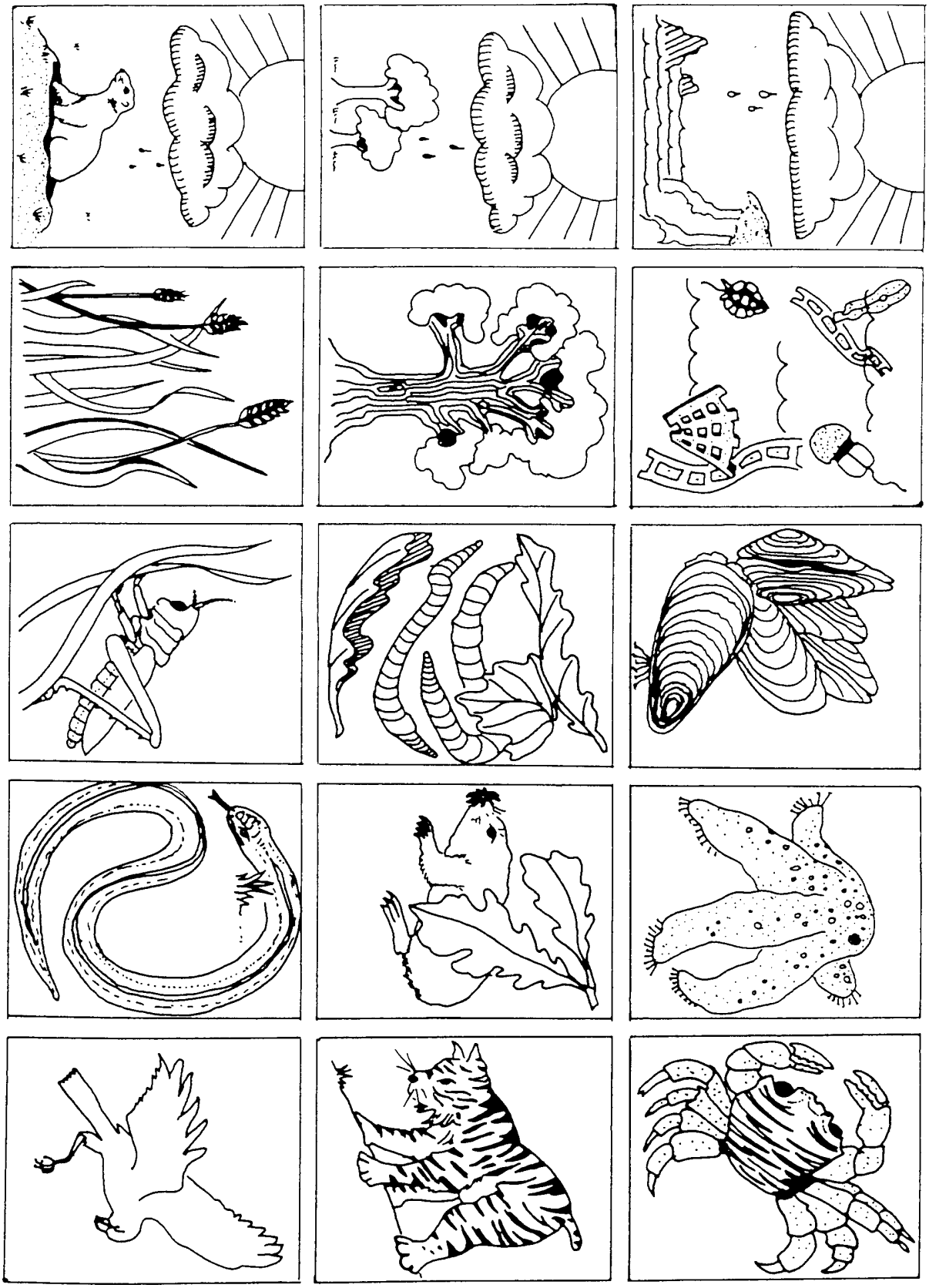
Prepare food chain cards, either from the drawings on the following pages or from pictures cut from magazines, calendars, and so forth. You might consider having students color the drawings before laminating. Consider simplifying the students' task of forming chains by color coding the cards, either by coloring the margins differently or by mounting each chain on a different color of paper or tagboard. Abiotic factor cards can be left out depending on your focus. You might also add organisms to one or more chains (humans can be added to many chains).

Divide the class into teams of four or five students each. Explain that their team task is to arrange themselves into a logical food chain by lining up in order, from the abiotic to the last member of a food chain. Issue the food chain cards to the students. When all students have formed food chains, each student explains why he or she placed himself/herself in a certain position in the food chain.

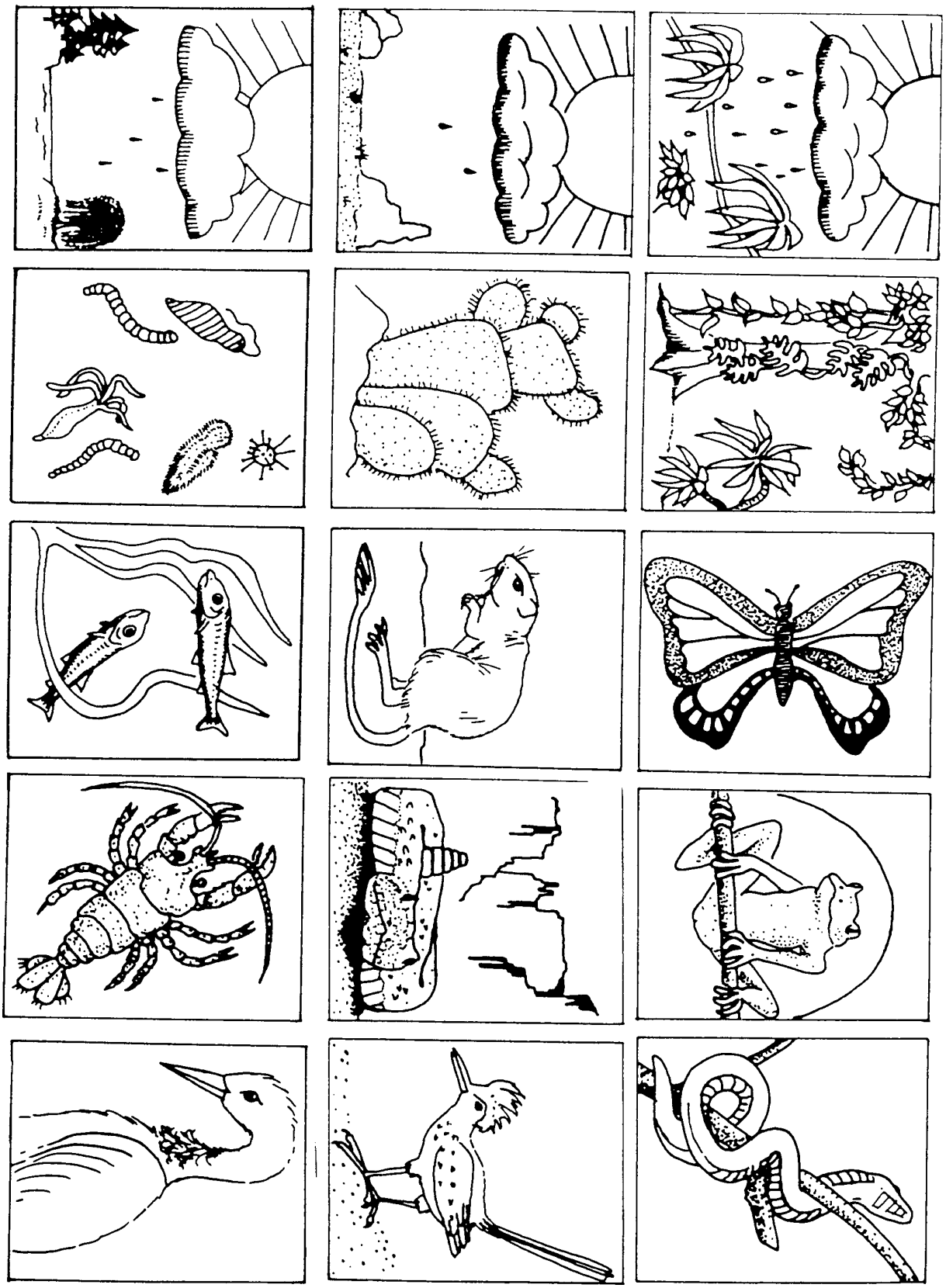
Further Variations:

Have students determine if any webs can be formed with food chains formed by other teams. Have students investigate and report on other food chains and make bulletin boards illustrating food chains, food webs, or pyramids of numbers.

Adapted from Roa, M.L. *Environmental Science Activities Kit*. Cen. for App. Res. in Ed. N.Y., 1993.



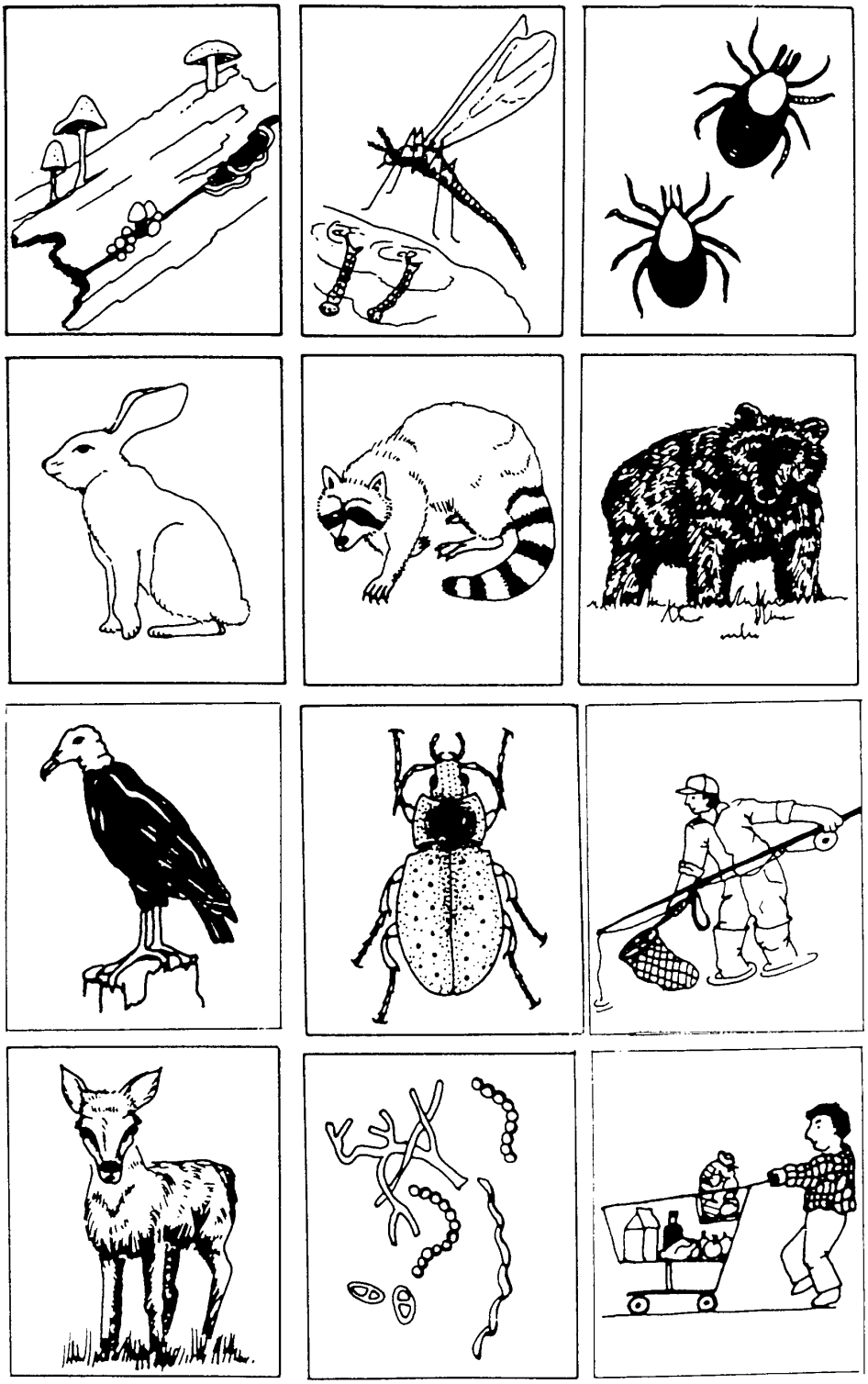
Food Chain Cards



Food Chain Cards

Supplemental Food Chain Cards

(Use these to alter the food chains provided or to adjust them according to the number of students doing the activity.)



Teacher Sheet

Science as Inquiry

Nibbles and Bits (3)

Materials:

metric rulers

Procedure:

Distribute student sheets and rulers. Students can work in pairs or individually. Provide time for them to read the background information. The data on the background of this mythical planet can be expanded.

On a blank sheet of paper have students list the members of this food chain by placing them in order with the members at the bottom of the food chain near the bottom of the page and spacing them 5 cm apart. For each member, beginning with the bottom one, have students draw a horizontal block around it to represent the numbers of each member inside the block following the guidelines presented in the student sheet.

Have students label the organisms in each level according to what they are eating.

Adapted from Bellamy, M. *Biology Discovery Activities Kit.*, 1986.

Science as Inquiry

Energy Flow

Item:

Which of the following biological processes requires a separate external input of energy in addition to having food and water available?

A. a plant growing an extra leaf
B. a child growing a half-inch taller
C. a mother cat giving birth to kittens
D. a lizard growing a new tail

Justification:

Make a list of the things plants need for successful growth. Is the list the same for animals? Why or why not?

Answer:

(A) is the only process in which the energy doesn't come only from chemical reactions that have products with lower total energy than reactants. Sunlight is the extra source of energy for plant growth and no animal can use this energy directly. Thus all living things depend eventually on one process to capture energy and store it in chemical bonds. Animals technically do not need any outside energy in the form of heat or light.

Science as Inquiry

Food Webs

Item:

A food web is a complex arrangement of “who eats whom." When X eats Y, material and energy are transferred from Y to X. All direct transfers are parts of a long chain of energy transformations. Which of the following pairs represents the initial and final outputs of energy from all food webs?

A. Input cow, output human.
B. Input human, output vegetable.
C. Input sunlight, output heat.
D. Input algae, output whale.

Answer:

C. The only true input/output in a food web is: to autotrophs from sunlight and out the food web as heat along every portion of the web.

Science in Personal and
Social Perspectives

Food Chains

Item:

Food chains describe the sequences of dependency of one organism on another organism for food. The progressions are called trophic levels, and the levels are usually named producers, primary consumers, secondary consumers, and tertiary consumers, respectively. Humans are normally considered tertiary consumers. However, if overpopulation by humans, and overall shortage of food is a major problem for the earth, and we wish to sustain the largest possible human population without major hunger, which of the following would have to be the major source of food for humans?

A. producers
B. primary consumers
C. secondary producers
D. decomposers

Justification:

Draw a flow diagram to show what happens to all the mass and energy as one trophic level consumes the one below it.

Answer:

(A) At each stage of the food pyramid, much energy is lost to heat and materials lost to decomposition cycles. Thus, as much direct consumption of autotrophic species (plants) as possible is the most efficient way to feed people.

Science in Personal and
Social Perspectives

Meat Demand

Item:

When people have wanted to buy more meat at the market, farmers have had to respond by growing much more grain, in terms of mass (tons) than the increase in meat demand would indicate. Why is a much larger mass of grain needed to produce a certain mass of meat? What happens to all the additional mass and the additional energy stored in the grain?

What would be an alternative plan for people to have enough food? Why?

Answer:

Science in Personal and
Social Perspectives

Being a Vegetarian Is Cheaper

Item:
At the market, the price of one pound of meat is generally much higher than that of one pound of a vegetable. In terms of energy and mass flow through the food chain from grain to animal to humans, explain why you might expect this price difference.

Answer: