TOP DESIGN (1-2 HOURS)

In this activity students will examine the relationships between the organisms within an ecosystem and how changes that affect one affect the others.



Overview

Topic: Ecosystems

Real World Science Topics:

- An exploration of the relationship between people and their environment.
- An exploration of how populations adapt to their environments.
- An exploration of specific adaptations that benefit organisms in certain climates.

Objective

Students will gain an understanding of the complexity of an ecosystem, and the nature of adaptations by natural selection.

Materials Needed for Each Student:

several sheets of paper pencil

Preparation

- 1. Before class, design enough different climates so that each group will have one. You can do this by finding existing climate zones (desert, temperate forest, tundra) and noting their basic characteristics.
- 2. Write the names of the following organisms on an index card: the Sun, grass, pine tree, oak tree, blueberry bush, grasshopper, mouse, chipmunk, robin, worm, fox, bear, eagle, rabbit, snake.

Standards Met

National Science Standards Addressed Content Standard A: Science as Inquiry Students: Develop descriptions, explanations, predictions, and models using evidence.

Content Standard C; Life Science Students:

• Will understand that biological evolution accounts for the diversity of species developed through gradual processes over many generations. Species acquire many of their unique characteristics through biological adaptation, which involves the selection of naturally occurring variations in populations.

• Will understand that extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival.

National Technology Standards Addressed Use models and simulations to explore complex systems and issues.

Sources:

National Science Teachers Association http://books.nap.edu/html/nses/overview.html#content National Educational Technology Standards http://cnets.iste.org/currstands/cstands-netss.html

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STEPS FOR TOP DESIGN!



1. Warm-up Activity: Show your students pictures of different climate zones such as a desert, a rain forest, or a tundra. Ask them to list some of the major characteristics of each one. For example, for a desert they would likely say that it is hot and dry. Ask them what kind of adaptations a plant would need to live in a desert. This can be a complicated question, since students might not know much about what a plant needs to survive. If they need help, guide them towards the questions by listing the two biggest needs of plants – water and sunshine.

i.e. This desert is very hot for much of the year, and receives little rain.

i.e. The tundra is so cold that ice mounds can form that last through the entire summer.

2. Divide students into groups of 4-5 and assign each group a climate zone to develop organisms for. Distribute the *Top Design* handout.

3. Students will be developing a small *food web* or *food chain* based on their climate zone. Groups can do this by either assigning each student an organism (plant, primary consumer, secondary consumer) or the group can work together to make each organism in the food web.

4. Tell students that their food chains must have at a minimum a plant, a primary consumer and a secondary consumer, but it can include more organisms if they have time. *Primary consumers* eat plants and *secondary consumers* eat other animals. Each organism must be adapted to the environment in some way. Tell students that the organisms should not be organisms that exist in nature, but can be based on organisms that they know about.

5. Students will likely have the most trouble creating the plants that live in the ecosystem. If students spend some time on this problem and can not design a unique plant then suggest that they use plants that they know live there. For example – a moist, but temperate ecosystem would likely have some type of deciduous tree.

6. If students are having trouble creating an organism, tell them to design an organism first, without thinking about adaptations, and then think about what adaptations that organism would need to evolve if the climate changed to the one which they were assigned. For example, they could design a creature that was a wolf with a shell. If they were assigned a polar climate they might make the shell white to blend in with snow, and the fur very thick to survive the cold. Tell students that the creatures also have to be adapted to the organisms that they eat. So if they create plants that are very hardy, then it is likely that the primary consumers will have to have very strong beaks or jaws in order to eat the plant.

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7. When students are done designing the creatures have the groups come to the front of the class and present their *ecosystems*. Their presentations should describe each organism, and should include what type of organism it is, as well as the specific adaptations that each organism has to its environment and to the creatures around it.

8. Wrap-Up Activity: Give each student one of the index cards that you prepared before class. If there are not enough cards have the students suggest other animals that live in a forest. Have the student stand in the circle and hand one of them the ball of yarn. This student should pass the ball to a student with a card that represents something that it eats until the string gets back to the sun. For example, if the fox gets the string, he could pass it to the rabbit, who could pass it to the grass, who could pass it to the sun. After the sun gets it you should cut the string and start with someone else. Once the food web is complex enough, ask students to imagine a scenario where some kind of disturbance killed off all of the individuals of one their organisms. What would be the effect on the other organisms in the food chain? For example, what if an herbicide killed off all of the individuals of the plant in their ecosystem? How would the consumers be affected? Model this situation by removing one of the students, and adjusting the string accordingly.

Top Design Extension Activity

There are many possible extensions of this type of activity. One would be for students to imagine that their climate changes in some way, for example it gets warmer. What kind of adaptations might the organisms develop through time that would allow them to survive? Are there other creatures from other ecosystems that other groups created that might be able to move into this new climate and compete for food and other resources?

TOP DESIGN BACKGROUND INFORMATION



What are climate zones?

Climate zones are areas with similar seasonal temperature and precipitation profiles. These zones frequently have organisms with similar characteristics. For example, trees can only grow when there is a certain amount of precipitation, warmth, and sunlight. Forests of certain types generally support a certain type of creature. Temperate forests throughout the world have bears and deer, both of which thrive under the trees.

What are ecosystems?

Ecosystems are systems or related organisms that depend on each other for survival. All ecosystems consist of producers, which are plants that get their energy from the Sun, and consumers, who get their energy from eating plants or other consumers. Ecosystems also have decomposers, who obtain energy mostly by consuming dead organisms and waste.

How do populations of organisms adapt to their environment?

A common misconception is that individual organisms adapt to a changing environment during their lifetime. Individuals are born with certain traits that will help them or hurt them during their lifetime. If a trait helps that individual survive in a changing environment then they are more likely to pass that trait on to their offspring. Over time a larger percentage of the population will have that helpful trait. If the environment remains at a relatively steady state then the characteristics of the population of animals will also in general remain steady. The assumption in this activity is that the organisms that the students create are at this point.

How does changing one part of an ecosystem affect other parts?

Ecosystems are frequently related as food chains or food webs. A food chain is a linear depiction of the relationship between consumers and their food. In a food chain it is assumed that each organism above the producer eats only one type of organism, and that each is in turn eaten by only one type of organism. In this case removing one piece would mean that the organisms higher on the food chain would die off as well, while those lower would have an exploding population. This is generally not the case however. In reality most plants are the source of food for many types of animals, and most animals have several sources of food. A diagram depicting this is called a food web. The multiple connections within the web make predictions more complex. In general taking away one species will change the balance for all of the other species. Populations of organisms will then adapt to this change in their environment. Some may not have the necessary traits and will die off, whereas others may become more successful.

Key Vocabulary:

Ecosystem: a complete community of living organisms and non-living things

Climate zone: areas that have similar seasonal temperature and precipitation patterns

Adaptations: changes in a population of organisms that evolve in response to a change in their environment

Primary consumer: an organism that eats plants

Secondary consumer: an organism that eats other consumers

Food web: a graphic organizer that shows which organisms eat other organisms

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STUDENT HANDOUT FOR TOP DESIGN



Name ____

Date

What are the characteristics of the climate that you were assigned?

Sketch your organisms below. Remember to include a plant, a primary consumer, and a secondary consumer.

How are each of these organisms adapted to their specific environment?

What would happen to the consumers if the plant population were to die off?

