



Genetics and Adaptations

Understanding Inherited Traits and Survival



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Introduction

This guide contains background information about genetics, and directions for three activities that will help students better understand how inheritable traits help plants and animals survive in Zion National Park. The activities are most beneficial to students when completed in order. This guide is specifically designed for seventh grade classrooms, but the activities can be modified for students at other levels.

Theme

The variety of plants and animals in Zion National Park are well-adapted to their environment because of their inherited traits passed down from parent to offspring.

Focus

The activities focus on how different plants living in Zion National Park use their inheritable traits to adapt to their environment.

Activities

Crossing Cacti

An activity using beans will model the combination of alleles, representing the hybridization of pricklypear cacti in Zion National Park.

Adaptation Art

Using knowledge of plant adaptations, students will design and draw imaginary plants that will have to adapt to one of the four main habitats in Zion National Park.

Survival Scenarios

Students will explore how a group of aspen trees, which reproduce asexually, will react in different scenarios.

Mendel's Laws of Heredity are still relevant today and help scientists understand why specific traits are passed on. Mendel found that inherited traits are defined by a gene pairs: an offspring gains one allele from each parent, forming a gene pair. In these genes, there are always dominant and recessive alleles, which will determine how the trait will manifest itself in the offspring. Genes from different traits are decided independently, so the inheritance of one trait is not dependent on the inheritance on another.

The basics of genetics and heredity allow certain plants and animals to become specially adapted, depending on which traits help them best survive in their habitat. In Zion National Park, a diverse array of plants and animals inhabit the varying environments in the park. The variety of environments, from the river and springs, to dry grasslands, to steep cliffs, is a result of the wide range of elevations in the park and the fact that Zion is located on the edge of three major ecoregions: the Mojave Desert, the Colorado Plateau, and the Great Basin. While some organisms, such as mountain lions, can survive in all of Zion's habitats, others like cacti, frogs, and pinyon pine trees, thrive in only one or two of Zion's environments.

Activity Materials

Corresponding materials which may include images, worksheets, and answer keys are provided for each activity. Materials can be downloaded from the lesson plan webpage, found [here](#).

Core Connections

Utah Core Curriculum
Seventh Grade Science

Standard 4: Students will understand that offspring inherit traits that make them more or less suitable to survive in the environment.

Objective 1: Compare how sexual and asexual reproduction passes genetic information from parent to offspring.

Objective 2: Relate the adaptability of organisms in an environment to their inherited traits and structures.

Background

Little was known about why offspring looked like their parents until the mid-1800s, when a monk named Gregor Mendel started experimenting with cross-breeding pea plants. He is now known as the "Father of Genetics," and his research with plants gave birth to the ideas of heredity and the passing on of genetic material in all organisms.

Crossing Cacti

Duration

60 Minutes

Location

Inside

Key Vocabulary

allele, DNA, genes, genetics, inherited trait, offspring, organism, sexual reproduction

Objectives

Students will be able to explain how sexual reproduction can produce diversity in plants.

Method

An activity using beans will model the combination of alleles, representing the hybridization of pricklypear cacti in Zion National Park.

Background

In sexual reproduction, the way cacti reproduce, an offspring inherits its traits from both parents. Each parent gives the offspring an allele, which controls some trait, and the two alleles combine to form a gene pair.

These alleles can be dominant or recessive, and how they combine (with the other dominant or recessive allele) will determine how the trait will show itself in the offspring.

Two dominant alleles or a dominant and a recessive will allow the dominant trait to express itself, while two recessive alleles will form a gene where the recessive trait will manifest itself. Even when not revealed, recessive genes remain in the genetic code of an individual organism. The recessive gene will be passed to offspring, where again, it may or may not show based on the allele pairing.

There are many different species of pricklypear cacti that live in Zion National Park. The original species were differentiated by the color of their bloom and size of pads. Some cacti had yellow blooms with larger pads and others had pink blossoms with smaller pads. However, the species have hybridized through cross-pollination to the point where distinguishing different species is very difficult. The hybrid cacti have blossoms that are yellow, pink, or peach (a combination of yellow and pink), and have pads of varying sizes.

Materials

- One container per student
- Package of red beans, or similar (50 beans per student)
- Package of white beans, or similar (50 beans per student)
- Crossing Cacti Worksheet
- Crossing Cacti Answer Key
- Cacti of Zion Images



Insects pollinate the bloom of a pricklypear, *Opuntia spp.*, cactus.

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Suggested Procedure

1. Review the process of how some plants use sexual reproduction, and different types of pollination (animal or wind).
2. Review or introduce ideas of how genes, and alleles, get passed from parent to offspring, and what dominant and recessive genes are. Remind students that a dominant allele does not mean it is a trait that is “better” and that recessive alleles can stay stored in genes even if they are not expressed on the organism itself.
3. Explain that some plants will hybridize, or cross-breed between species. The pricklypear cacti in Zion, for example, used to be separate species, but have cross-bred so the genes are mixed and it is hard to distinguish between different species. Use the images of cacti to illustrate the different varieties of cacti that can be found in Zion.
4. Put students in pairs. Each student will get a container holding 100 beans, 50 of each color, and a worksheet for each student. Each student in the pair will pull a random bean from the container and pair it up with their partners. This represents one of four outcomes of combinations for colors, or genes. Students will record their findings on their worksheet, and continue to pair beans until all the beans are gone. Have students answer the questions on the worksheet with their partners. In this activity, the white beans represent yellow cactus flowers and red beans represent pink cactus flowers. When these colors are combined (red-white or white-red), this represents the hybrid peach cactus flowers.
5. After students have completed the worksheet, discuss the class’ findings. Why do students think these plants can cross-breed? What advantageous adaptations might it provide to the cacti? Do the different colors of blooms attract different pollinators?



Pink, yellow, and peach blooms of pricklypear cacti in Zion National Park.



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A tarantula hawk feeds exclusively on milkweed, helping with pollination.

Leaves of the manzanita are coated in wax to limit evaporation.

Quaking aspen prepare for winter by changing color and losing leaves.

Adaptation Art

Duration

60 to 120 Minutes

Location

Inside

Key Vocabulary

acquired trait, allele, DNA, genes, genetics, inherited trait, offspring, organism, sexual reproduction

Objectives

Students will identify how certain traits provide advantages for the survival of an organism in some habitats and not others, and how passing down advantageous traits can help a plant survive in their habitat.

Method

Using knowledge of plant adaptations, students will design and draw imaginary plants that will have to adapt to one of the four main habitats in Zion National Park.

Background

Zion has four distinct habitats that vary according to elevation. The lowest and hottest parts of the park are the desert grasslands. Also low in elevation but cooler are the riparian areas right around the Virgin River and other smaller streams and springs. Higher up is the pinyon-juniper woodland, and higher still the habitat changes again to a plateau environment. Each environment is described in more detail in the Habitats of Zion Chart in the activity materials.

Different species of plants have physical adaptations which help them to live or to reproduce in their environment and the specific habitat.

A common adaptation of many plants is to produce tasty fruit, such as the berries on Oregon grape, the fruits of yucca, or the pinyon pine nuts on pinyon trees. This helps the seeds spread away from the original plant when eaten or hidden by animals. Other plants spread their seeds by other methods, such as cottonwood trees which encase their seeds inside light and fluffy “cotton,” which is easily blown around and distributed by the wind.

The shape of a flower can be perfectly adapted to its pollinator. Sacred datura flowers are large, white, and only open at night to attract the nocturnal sphinx moth. Pricklypear cacti, like many flowers, have bright pink or yellow flowers to attract bees. Penstemons have a trumpet-shaped bloom to accommodate the long, narrow beak of hummingbirds.

In the desert, many plants have adaptations to help prevent water loss, such as small leaves with reduced surface area (cactus spines are an extreme example of this), or a waxy surface, such as on cactus pads or manzanita leaves, which also helps minimize evaporation.

Other plants have adaptations to help them soak up as much scarce water as possible. Cottonwood trees have long taproots to search out deeper water sources, while pricklypear cacti have shallow roots that spread out far from the main plant to try and soak up as much water as possible when it does rain.

Almost all of these traits and adaptations have evolved over time to help the plants adapt to their specific environments. These traits are thus inherited traits, passed on through generations, not acquired traits, which are learned and do not involve genetic material.

Materials

- Paper
- Art supplies for creating plants (i.e. colored pencils, paint, clay, papier mâché, etc.)
- Habitats of Zion Chart
- Plant Adaptation Images

Suggested Procedure

1. Discuss with the students the various habitats of Zion described in the Habitats of Zion Chart, displaying the chart for the students.
2. Have the students brainstorm types of traits or adaptations that certain plants living in Zion have to help them survive in the different habitats. Have students describe the advantage of the adaptation represented by the trait. Review different types of adaptations plants have to help them survive in different habitats (i.e. how they prevent water loss in the desert, or that they have bright colored-flowers to attract pollinators).

3. Tell the students they will each have a chance to design their own original plant which is adapted to its habitat. Brainstorm as a class on the board what an invented plant might need or look like.
4. Have students brainstorm a list of the adaptations that will help their plant survive in their chosen habitat. Each student should decide:
 - What kind of plant is it: flower, cactus, or tree?
 - Where will the plant live: desert grassland, pinyon-juniper woodlands, riparian, or plateau?
 - How does the plant get water?
 - How is it pollinated (animal or wind) and what parts of the plant are designed specifically for reproduction? Do they attract specific pollinators?
 - How do the seeds disperse?
 - What other special adaptations does the plant have to help it survive in its environment? (be creative and silly; they don't have to be real adaptations of real plants)
5. Using their list of adaptations, have students create their own original plant by drawing it, or by creating a model in another artistic medium such as clay or papier mâché.
6. Along with each creation, have each student write a report that describes the name of the plant and each of the traits or characteristics listed in step four. Have the students include their lists of adaptations, the reasons for the adaptations, and the advantages they provide for living in the habitat. Have students name a different habitat from the one their plant lives in and explain what would happen to the plant in that foreign habitat. What difficulties would it encounter? Would it survive, and why or why not? Students can create plants and write their descriptions during class time or be assigned material as a long-term project.
7. Once student projects are complete, have students pair up with another student that has a similar plant to them (both flowers, or cacti, etc.). Randomly assign each pair one of the four habitats where their plants will live. Have each pair create a third plant that is the offspring of each of their original plants. Remind students that while the plant can't create any new traits to help it adapt to its habitat, the offspring plant should try and utilize the best traits from each parent to help it survive in its new habitat.
8. Have students present their plant to the class either individually or in pairs.

Extension

Collect pictures of plants from Zion National Park or the local area around your school to create a bulletin board or slideshow showing some of the adaptations discussed. Look for pictures showing plant traits compatible with the invented plants. Display images of actual plants alongside the students' plants, and compare traits or adaptations they share.

Survival Scenarios

Duration

45 Minutes

Location

Inside

Key Vocabulary

asexual reproduction, genetics, inherited trait, offspring, organism, sexual reproduction

Objectives

Students will be able to articulate in writing advantages and one disadvantage of asexual reproduction in plants.

Method

Students will explore how a group of aspen trees, which reproduce asexually, will react in different scenarios.

Background

Aspens can reproduce both sexually and asexually. In sexual reproduction, pollination occurs between male and female trees in early spring. The cotton-like seeds are dispersed via the wind, but are only viable for a short time. Germination only occurs if the seed reaches moist soil in favorable conditions.

Due to the low success rate of sexual reproduction in aspen trees, aspens more

commonly reproduce asexually. Aspens send up shoots from their root systems that eventually grow into new aspen trees. This results in groves of aspen clones that can spread out over acres (described further in the worksheet).

Materials

- Survival Scenarios Worksheet
- Survival Scenarios Answer Key

Suggested Procedure

1. Introduce aspens through the video about the Pando Forest, in central Utah: <http://www.fs.fed.us/wildflowers/beauty/aspen/grow.shtml>
2. Discuss the regeneration of aspen groves and trees and why aspens tend to favor asexual reproduction, through root sprouts, over sexual reproduction. Each tree is genetically identical to all the other trees in that particular clone. Discuss advantages and disadvantages to this adaptation. What if a disease attacks that the DNA cannot fight off? Does root sprouting provide an advantage for quick recovery?
3. Give each student a Survival Scenarios Worksheet. Have them read through each scenario and answer the questions. Allow 30 minutes for students to complete the worksheet. Discuss answers as a class.



Aspen grove near Lava Point in Zion National Park.

Glossary

acquired trait: traits or characteristics that are not passed down through genes. For instance, learning how to hide from predators, or humans becoming stronger through exercise are both acquired traits. Contrast with inherited traits.

allele: a member of gene pair that controls a specific trait. Alleles are either dominant or recessive.

asexual reproduction: a way of making more offspring or more of itself that does not involve fertilization or the exchange of genetic information. The offspring from asexual reproduction are all clones, or exactly the same as the parent. Many plants, almost all microorganisms, and a few animals practice asexual reproduction.

DNA (deoxyribonucleic acid): a two-stranded structure inside the nucleus of a cell that contains all the genetic information for an organism.

genes: the fundamental physical part of DNA that is responsible for the inheritable traits of an organism.

genetics: the study of the inheritance of traits, or heredity.

inherited trait: a characteristic, usually physical, that is inherited or passed on from parent to offspring. Contrast with acquired traits.

offspring: the children, or the next generation, of a parent.

organism: any living thing, large or small. All organisms need air, water, and energy and can grow and reproduce.

sexual reproduction: a way of making more offspring or more of itself that involves two parents, fertilization, and the exchange of genetic information. The offspring of two parents will resemble the parents, but are genetically different. Some plants and almost all animals practice sexual reproduction.

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