



Spring

High School Lesson Plan

Topic Ecology – Reproduction and heredity

Grade Level 9-11

Overview

The QUEST *Spring* video explores the many responses of plants and animals to the coming of spring. Have you or your students ever examined tree flowers? Searched the forest floor for the earliest signs of green in the spring ephemerals? Or spent a chilly spring night watching the salamanders make their way to their breeding grounds? The migration of birds, the flowering of plants, and the calling of frogs – all triggered by the longer days and warming temperatures of this changing season – are part of wildlife’s preparations for creating the next generation of offspring.

Introduction

QUEST *Spring* addresses the response of organisms to the coming of spring. Each organism times its process of reproduction to give its young the maximum advantage for survival. In this teaching unit, students will identify specific signs of spring as signals of the beginning of the reproductive cycle. They will also investigate the reproductive strategies of various organisms. Each generation inherits characteristics from the parent generation that enable the reproductive cycle to continue. Students will explore how this inheritance is passed along and how variations in its traits can allow certain species to have greater success in raising their population levels. By the end of this unit, students will be able to:

- Correlate various signs of spring with the reproductive strategies of various organisms.
- Describe how organisms inherit traits from generation to generation.
- Describe the difference between sexual and asexual reproduction.
- Identify the advantages and disadvantages of each type of reproduction for the survival of organism populations.

Time Allotment Five 45-minute class periods, or 3 longer blocks of class time.

Accessing Prior Knowledge

Students should have some basic knowledge of sexual and asexual reproduction. They should understand the basics of heredity and the role of genes in transmitting traits between generations.

**QUEST: Investigating Our World is a regional public television series
seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television**



VERMONT
PUBLIC
TELEVISION
PBS



Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network’s Programming.



more connected
more **Maine**
The Campaign For
Maine Public Broadcasting Network’s Programming



Concepts to Clarify

Research indicates that high-school students often have difficulty integrating two distinct concepts about heredity at both the individual and population levels. Students first need to understand that trait changes are caused by chance changes in genetic material in individuals, not by changes in the environment, nor can such changes be willed by the species. Secondly, students should understand that a change becomes predominant in a species' population only because those with the new trait have a higher rate of survival and reproduction. This allows the genetic material to pass to a higher and higher proportion of the population. The change in population is not caused by each individual slowly changing.

Research has also shown that scientific reasoning is an important skill for students to apply in order to better understand these concepts. Because the nonscientific world often conveys the concept that species change because of their need to do so, students may have difficulty in accepting any alternative theory or conflicting evidence. However, studies have shown that, given adequate time and systematic science instruction, students' understanding of such concepts can greatly improve.

CONNECTIONS TO THE STANDARDS

Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards	National Science Education Standards	Benchmarks for Science Literacy
<p>Continuity and Change</p> <p>D2. Describe why the offspring of sexually reproducing species have different survival rates than those of asexually reproducing species under a variety of conditions. Describe the advantages and disadvantages of each.</p>	<p>Life Science</p> <p>3a. Explain how the characteristics of living things depend upon genes.</p> <p>Describe how genetic material is passed from parent to offspring during asexual and sexual reproduction, e.g., mitosis, meiosis.</p>	<p>The Living World: Organisms, Evolution, and Interdependence</p> <p>7.13.ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.</p> <p>The Human Body</p> <p>7.14.aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations).</p>	<p>Content Standards (9-12)</p> <p>C. Life Sciences: Reproduction and Heredity</p> <p>In many species, including humans, females produce eggs and males produce sperm. Plants also reproduce sexually – the egg and sperm are produced in the flowers of flowering plants. An egg and sperm unite to begin development of a new individual. That new individual receives genetic information from its mother (via the egg) and its father (via the sperm). Sexually produced offspring never are identical to either parent.</p>	<p>Chapter 5: The Living Environment</p> <p>5A. The variations of organisms within a species increases the likelihood that at least some members of the species will survive under changed conditions, and a great diversity of species increases the chance that at least some living things will survive in the face of large changes in the environment.</p> <p>5B. The sorting and recombination of genes in sexual reproduction results in a great variety of possible gene combinations from the offspring of any two parents.</p>



Materials Needed

- TV and VCR
- QUEST *Spring* video
- Chart paper and markers.
- Computer(s) with Internet access (for teacher to print materials, or for students to conduct online research or read through a “library” of research materials on genetics)
- Student Handout 1: Springtime – Responding to Changes
- Student Handout 2: Sorting Out the Differences
- Student Handout 3: Fighting an Invasion
- Student Handout 4: *QUEST at Home* – Looking at Spring

1. Introducing the Concepts

This introductory activity will help students make the connection between everyday life and the lesson content on heredity. They will explore their own inherited traits and learned behaviors. The activity can be used to probe and clarify student thinking on the subject prior to adding new knowledge.

Step 1

Explore students' understanding of heredity by asking each of them to write a list of three traits he or she has *inherited*. Students should individually try to identify from which family member each of these traits came from. Then ask each student to list three behaviors he or she has *learned*. Again, students should individually identify the family member from whom each of these traits was learned.

Step 2

Using chart paper and markers, make a class list of inherited traits and learned behaviors. Lead a discussion to clarify the following points:

- Traits are inherited from both parents.
- Traits can be “hidden” in the parents but might have been in the grandparent’s generation.
(Probe to see if students can explain why this is true.)

Also help to clarify students' understanding of the differences between inherited traits and learned behaviors. (**Note:** Some behavioral responses may be genetically inherited; this concept can be confusing to students.)

2. Exploring the Concepts

Students will view a portion of the *QUEST Spring* video for background on wildlife responses to the coming of spring. They will then analyze if these responses are inherited traits or learned behaviors. Students will also identify which activities are related to the beginning of species' reproductive cycles. This activity will help you



determine students' understanding of heredity and their ability to apply this understanding to wildlife in New England.

Step 1

View the first half of the video that depicts the coming of spring and the reproductive response of flowering in plants

Step 2

After viewing the video, use chart paper to create a class list of the changing environmental conditions that spring brings. Then divide the class into teams of 2 to 3 students. Distribute copies of Student Handout 1: *Springtime – Responding to Changes* to each team.

Step 3

Have student teams complete the first three columns of the table in Student Handout 1. Require them to identify three changes in environmental conditions that occur in spring. Next, have them list at least one response of a plant and one of an animal for each environmental condition. Then, recording students' thoughts on chart paper, have each team share one idea until all ideas have been recorded in a class table. (You may also choose to record students' ideas on an overhead.) Allow time for all students to update their individual lists based on the master list you have recorded.

Step 4

Now have teams complete the last two columns of the table on Student Handout 1. They must decide whether each plant and animal response is a learned behavior or a genetically transferred inherited trait. When all teams have finished, discuss the differences between learned behaviors and inherited traits, using the items on the class table as examples. Clarify students' understanding as needed.

3. Developing the Concepts

In the following activity, students will do research on sexual and asexual reproduction. They will also investigate how characteristics are transferred among generations through genetic material. (**Note:** If access to the Web is problematic, visit these sites yourself and make copies of the pertinent data. You may also use any other resources you choose. With these materials, create a classroom “library” for students to use in their research.)

Step 1

Distribute copies of Student Handout 2: *Sorting Out the Differences*. Review the series of questions with the class, and refer them to the list of Web sites at the bottom of the handout. Next, arrange students in pairs to investigate and respond to the questions on the handout. Be sure to have them properly cite each reference they use.

In a round robin, have each team present their findings to the class on one question. Ask other teams if



they have additional information. If time does not allow this format, ask students to submit their information in a “report.” You may want to select the best response to each question and compile it into a “book” for the class.

4. Applying the Concepts

In the following activity, students will work in teams to go through a scenario that allows them to explore the various methods of reproduction used by plants. They will trace the genetic flow of a characteristic in two species. They will also note population variations and percentages with the new trait. Based on their analysis, students will then develop a list of advantages and disadvantages for each type of reproduction.

Step 1

Distribute copies of Student Handout 3: *Fighting an Invasion*. Review the introduction and the scenario on the handout with students. Elicit comments to see how clearly students understand sexual and asexual reproduction from their prior research.

Step 2

Have students complete the activity as specified on the handout. Provide assistance and clarification as needed. When everyone has finished, have students share their results. Lead a class discussion to wrap up the activity. Have each team contribute one part of the report and have others respond or add to their ideas. Encourage students to summarize their thoughts and provide clarification as needed.

5. Extending the Concepts

Quest at Home

Distribute copies of Student Handout 4: *QUEST at Home – Looking at Spring*. Review the handout with students before they take them home. Agree upon a due date for students to return to class with their research findings

Community Connections

With your class, visit a local nature center or forest and take a guided wildflower walk. You might also ask a local nature club member to take the class on a bird walk to see which species nest in your region. Encourage students to learn the distinctive songs of individual species. Another option could be to participate in a vernal pool survey in your area to find out where frogs and salamanders breed.

Career Opportunities

The study of genetics and genealogy pertains to many careers. Review the following options with your students. You might consider asking a professional from one or more of these fields to come in to school to speak with students about his or her chosen career.



INVESTIGATING OUR WORLD

Genetics research: Scientists, technicians, and computer programmers at the Human Genome Project and the National Institutes of Health are mapping the human genome. They are also conducting research to discover how to identify possible medical conditions by examining an individual's chromosomes.

Bioengineering: Scientists, technicians, and computer programmers are working to develop new varieties of plants that survive better under given circumstances. Researchers are also investigating new medicines that can genetically modify cancer cells to prevent them from reproducing.

Field biology: Scientists, foresters, and computer modelers investigate particular species populations. Geographic information system analysts map biodiversity in particular regions of the state, country, and world.

Resources

Genome Projects of the Department of Energy: <http://www.doegenomes.org>
This site includes information about the Human Genome Project.

DNA from the Beginning: <http://www.dnafb.org/dnafb>
This site includes an animated primer on DNA, genetics, and heredity.

DNA: The Instruction Manual for All Life: <http://www.thetech.org/exhibits/online/genome>
This has an on-line exhibit about DNA.

Genetics Science Learning Center: <http://gslc.genetics.utah.edu/units/basics/tour>
A "tour" involving the basics of genetics is included at this site.

The Gene School: http://library.thinkquest.org/19037/general_info.html
This Web site contains animated background on genetics.

Morgan Genetics Tutorial: <http://morgan.rutgers.edu/MorganWebFrames/htmldocs/contents.php>
Background on six levels of genetics can be found here.

National Center for Biotechnology Information: <http://www.ncbi.nlm.nih.gov/genome/guide>
This site includes information about the biomedical applications of genetic engineering.

Maine Wildlife Management Areas: <http://www.state.me.us/ifw/wma/table/index.htm>

Vermont Wildlife Management Areas – Maps: <http://www.anr.state.vt.us/wmamaps/index.html>

The Trust for Public Land: http://www.tpl.org/tier2_rl.cfm?folder_id=209

Maine Land Trust Network: <http://www.mltn.org>

New Hampshire Division of Forests and Lands – State Reservations (public lands):
http://www.nhdfl.org/for_mgt_bureau/fm_dredlands.htm



Sorting Out the Differences

You and your partner will be doing research to find the answers to the questions below. You will write up your answers and should be prepared to share them with your class.

1. How does an organism reproduce asexually?
Respond in writing, then draw a diagram that clearly explains this process.
2. How does an organism reproduce sexually?
Respond in writing, then draw a diagram that clearly explains this process.
3. What happens to the chromosomes in each type of reproduction?
4. What are sex-linked chromosomes?
How do they determine whether an organism will be male or female?
5. What is a Punnett's square?
6. What are some examples of organisms that reproduce asexually?
7. Do all organisms reproduce either sexually or asexually, or can some reproduce both ways?
If no, why not? If yes, what is an example of a species that can reproduce using either method?
8. What are two kingdoms of organisms that reproduce sexually?

You can use the links below as well as other materials provided by your teacher to find the answers to these questions.

Designer Genes: The Punnett Square <http://library.thinkquest.org/18258/noframes/punnettsquares.htm>

This site explains how the Punnett square was developed and how it helped scientists explain heredity.

DNA From the Beginning <http://www.dnafb.org/dnafb>

This is an animated primer on DNA, genetics, and heredity.

DNA: The Instruction Manual for All Life <http://www.thetech.org/exhibits/online/genome>

This site contains an on-line exhibit about DNA.

Genetics Science Learning Center: Tour the Basics <http://gslc.genetics.utah.edu/units/basics/tour>

This site provides background information on the basics of genetics.

The Gene School http://library.thinkquest.org/19037/general_info.html

An explanation of the function of genes is available here.

Morgan Genetics Tutorial <http://morgan.rutgers.edu/MorganWebFrames/html/docs/contents.php>

An introduction to genetics is provided at this site.

Fighting an Invasion

Introduction

In this activity, you will be analyzing the transfer of genetic material between parents and offspring. As you proceed, you will explore the differences in inheritance between sexual reproduction and asexual reproduction.

In the plant kingdom, most trees have flowers and reproduce sexually. In some species, a tree may have both male flowers and female flowers. In other species, one flower may have both male and female sexual parts. Other species may include trees with flowers of only one sex, which must be near another tree with the other sex in order for their fruit to be fertilized. In still other species, the tree may have flowers, but it may also be able to produce offspring by growing sprouts from its root system. This is a type of asexual reproduction. In each case, the method of reproduction has produced an advantage for that particular species.

Scenario

Scientists are investigating forest stands in New England. They have discovered that an insect is affecting the beech and maple trees in these stands. Some of the young maple trees are not being attacked by the insect, while others are. All of the young beech trees are affected. One researcher has proposed that there may be a genetic variation in some of the maple seedlings that is causing them to be resistant to the insects. The scientists would like you to investigate the issue and create a diagram or model of the reproductive processes in the two species of trees (red maple and beech).

One of the scientists has collected the following information about these species.

Life History



Red Maple

Red maple trees flower in the early spring. They are one of the first trees to flower. Red maples flower before their leaves come out. They usually have female flowers on one tree and male flowers on another. On rare occasions, the species can include a tree with both male and female flowers. Red maple flowers are wind-pollinated.



Beech

Beech trees also flower early in the spring. They flower at the same time as their leaves unfurl. Beeches have both male and female flowers on one tree. They are wind-pollinated. They can also sprout new trees from their roots.

Forest Stand Description



Red Maple

The area adjacent to the maples is made up exclusively of hardwoods. When the leaves are down it appears that air circulation is good. An examination of the trees in flower found that there were 13 female and 5 male red maple trees. In addition, there were two trees with both male and female flowers. Only one of the adult female trees did not appear to be attacked by the insects. About 20% of the seedlings did not appear to be affected by the insects.



Beech

The beech trees were upland from the maples in the old growth forest. There were 22 individual trees scattered apart. There were very few beech seedlings. Those that were found were all close to a mature tree. One older beech had fallen in the past few years. The fallen tree had created more randomness in the age and growth of the seedlings in the surrounding area. There were signs of bear in the area; bears commonly feed on beechnuts.

The Question

The researchers assume that the characteristic that is allowing the maple seedlings to resist the invasive insect is caused by a chemical in the leaves. They hypothesize that within the maple trees, a mutation on the DNA of the female sex-linked gene has occurred. It appears that this may be a dominant trait. These scientists would like a report that analyzes the varied methods of reproduction within the two species of trees. They would also like a diagram and/or model of the genetic variability within the population of the two species, assuming that the characteristic is dominant on the female sex-linked gene.

From the data gathered so far, you should analyze the reproduction strategies for these two species of trees. Follow the steps below.

1. Make a chart with three columns and four rows. At the top of the second column, write *Beech*. At the top of the third column, write *Maple*. In the second row, write *Asexual*. In the third row, write *Sexual, Self-pollinating*. In the fourth row, write *Sexual, Cross-pollinating*. Mark an X in each box of the table that applies to each species.
2. Explain your opinion about whether one species has a higher chance of survival because of greater genetic variation than the other.
3. Suggest how the researchers might investigate this question further.
4. For each method of reproduction for each species, create a diagram, a Punnett square, and/or a model that shows the genetic variation of offspring. Indicate the parents' genetic makeup, the reproductive process, and the offsprings' genetic makeup.



INVESTIGATING OUR WORLD

5. Determine the percentage of the first generation of offspring that might have the new trait if it is a dominant characteristic on the female sex-linked chromosome.
6. For each reproductive strategy, make a list of advantages and disadvantages for the species.
7. If there were many types of stresses on this forest community, explain which method of reproduction might produce a population of species with the best chance of survival.
8. Summarize your findings in a report to the scientists. Your report should be in the form of a letter that includes:
 - a. Your statement of the problem,
 - b. Your opinion on whether one species has a higher likelihood of survival because of broader genetic variation and how the researchers might investigate this question further;
 - c. Support your ideas with the results of your Punnett's Square diagram. and a summary of the advantages and disadvantages of each type of reproduction and,
 - d. Extend your ideas by explaining why the species with a given type of reproduction strategy would best be able to survive if the forest came under many stresses over a short period of time.



Looking at Spring

You're on a Quest!

Spring means the blooming of flowers, the return of birds, and the greening of the countryside. In this take-home activity, you will be exploring one of these phenomena with family members and friends. You will record your observations in a notebook, and at a later date create a calendar of spring to share with others.

■ **Take a closer look at a springtime classic.** Pick some daffodils, or buy them at a local market. Look at the shape of the daffodil flower. Using a book on flowers, identify the parts you can see from the outside. Now, dissect the daffodil. With a very sharp knife or razor blade, carefully cut the flower in half all the way down to the stem. Lay the two halves side by side. Notice how similar the two sides are; they are almost mirror images. (Not all flowers are so symmetrical!) Using your flower guide, identify the various parts that you can now see.



■ **Take a spring wildflower walk.** In early spring, just as the grass is turning green, take a flower guide and a magnifying glass, and go for a nature walk. How many wildflowers can you see and identify? Using the magnifying glass observe the various parts of each different flower. Can you find species that have different shapes and symmetry? Return to the woods during different stages of spring – just as the trees flower, just as the leaves unfurl.



■ **Look at flowering trees in early spring.** Trees often have male and female flowers. They are usually wind-pollinated, but some are insect-pollinated. Can you see any differences in the design of flowers that are wind-pollinated rather than insect-pollinated? Watch these trees through the season to see when their flowers bloom, and identify how they are pollinated. Try to discover which insects are most important in your neighborhood.

■ **Create a calendar of the coming of spring.** Record the progression of species and their flowering dates. Note the arrival of birds by watching a bird feeder, or listening to bird songs in early morning. Even if species cannot be identified by song, note the increase in the variety of species as the weeks progress. Share your calendar with family, friends and classmates.



QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television



VERMONT
PUBLIC
TELEVISION
VPBS



Major funding for Quest is provided by the National Science Foundation. Additional support is provided by Irving Woodlands and by gifts to More Connected, More Maine. The Campaign for Maine Public Broadcasting Network's Programming.



more connected
more **Maine**
The Campaign For
Maine Public Broadcasting Network's Programming