Session 5

Variation, Adaptation, and Natural Selection

How is it that life always seems to find a way? Changes—both large and small—are ever-present in the environment that surrounds life. But despite sometimes extreme challenges to survival, life forms persist from generation to generation. In the last two sessions, we focused on life cycles and their connection to DNA, and we began to look at life at the level of populations. The next two sessions build upon this as we focus on the fundamentals of evolution: how populations change over time and how this can lead to new life forms.

The Video

Where do we find variation in the living world? Our Bottle Biologist, Dr. Paul Williams, switches hats for this program. As the developer of Wisconsin Fast Plants, he has first-hand experience observing variation and how it provides the raw material for change in populations over time. Fast Plants are the examples being studied in Dr. Kathy Vandiver's sixth-grade classroom in Lexington, Massachusetts, as her students assess variation in plant height and think about its causes.

Dr. Robert Murray and Dr. Georgia Dunston, of the National Human Genome Center, introduce us to the role of genes as a source of variation. We hear of one example that applies to humans—PTC tasting—and we are presented later with a scenario where the ability to taste PTC is an advantage that leads to change in a population. The role of genes is emphasized as mutation is introduced as one cause of *new* variation in populations.

As a contrast to natural selection, Dr. Williams describes how he developed Fast Plants through artificial selection. A bit of evolutionary history is highlighted as we introduce Charles Darwin's contributions and focus on the meaning of adaptation through natural selection. Throughout the program, we hear from children in the Science Studio—a new group of fourth and fifth graders. And Bottle Biology returns as Dr. Williams features a bottle system for studying the fundamentals of evolution.

Learning Goals

During this session, you will have an opportunity to build understandings to help you:

- Recognize how populations vary with regard to inherited traits
- Distinguish between DNA, chromosomes, and genes
- Relate genes to variation in populations
- Describe the process of adaptation through natural selection

On-Site Activities

Getting Ready (60 minutes)

Activity One—Problem Set and Reading Discussion (20 minutes)

Work in small groups.

1. Begin the session by reviewing questions 1–4 from the problem set for Session 4. For each question, select a single group member's response and discuss. Use this as an opportunity to clarify understandings of content.
2. Each group member should share several children's ideas identified from the reading for this discussion. Make a list of the questions formed about the content and cite the evidence you are using to support your answers.

Activity Two—The Fundamentals of Evolution (20 minutes)

1. As a whole group, generate a list of definitions for the following, without judging their merit at this time:
   - evolution
   - adaptation
   - natural selection
2. Team up with a partner. For today's session, you were asked to bring in 3–5 examples of one type of plant or animal. Consider this a population. You were asked to list characteristics that vary among the individuals in this population, and to collect data that quantifies the extent of variation. Share your specimens and data with your partner.
3. With your partner, choose one set of individuals and select one of the characteristics for which you collected data. Pick one "level" of variation (e.g., the highest or lowest measured value). Create a scenario in which the population changes over time so that individuals possessing this level of variation become more common than those that don't.
4. Reconvene the whole group. Share the different scenarios generated above. What do they have in common with regard to the process of change over time? Make a list of these commonalities.

Activity Three—The Role of DNA (20 minutes)

As a whole group, distinguish between DNA, chromosomes, and genes. Make a drawing that reflects these distinctions. Discuss ideas about the role of DNA with regard to change in a population over time.

Watch the Video (60 minutes)

As you view the video, think about the following focus questions:

1. How do variation, adaptation, and natural selection result in evolution?
2. In the Science Studio, the children observe varying amounts of "hair" on different individual plants in a population. They generate a scenario by which plants of this type become more hairy. Listen for their description of what happens to cause change of this sort. Do you agree or disagree with their explanations?
3. The students in our Featured Classroom are studying variation in height in a population of Fast Plants. How do their ideas about what is responsible for variation in height compare with yours?

On-Site Activities, cont'd.

Going Further (60 minutes)

1. With your partner, revisit the scenario you created in which a specific level of variation might become more common in a population. How does your scenario incorporate (if at all):
   - variation that is advantageous or disadvantageous
   - increased or decreased survival
   - increased or decreased reproduction
   - adaptation
   - natural or artificial selection
   - change over time
   - the role of DNA
2. As a whole group, pick one scenario described before viewing the video. Apply what you now understand about variation, adaptation, and natural selection to this scenario so that it accurately represents the process of evolution. Use this as an opportunity to clarify your ideas and descriptions of these fundamentals of evolution.
3. In both the Science Studio and Featured Classroom, children expressed ideas about the role that genes play in change in a population over time. With your partner, check your understandings about the role of genes by discussing the following questions:
   - How do genes cause variation in a population?
   - How does the environment affect variation in a population?
   - How are genes affected by the environment?
   - How do new variations in genes arise?
   - Can genes be changed by a variation developed during a life span? Explain.
4. Dr. Murray and Dr. Dunston, from the National Human Genome Center, discussed various details about the hereditary material, DNA. What new understandings, if any, do you have about the relationship between DNA, chromosomes, and genes? Discuss this with your partner, revising the drawing the group created earlier as needed. How would you summarize the role of DNA in evolution?
5. Revisit the questions generated from the reading assignment and check for remaining content issues.

Between Sessions

Homework (* = required)

Reading Assignment*

Driver, R., et al. (1992). *Life and Living Processes.* Leeds National Curriculum Support Project, Part 2. Leeds City Council and the University of Leeds, UK.

Research Summary: Children's Ideas About Reproduction and Inheritance (pp. 5–8: Variation and resemblance; mechanism of inheritance; sources of variation; adaptation; random chance)

This material is the same as last week's material. Review the material first and then look at the tables that follow. For each table, read "The Challenge for Pupils." Identify and be prepared to discuss ideas expressed by the authors that you think are most useful in teaching evolution.

Life Science Problem Set*

(Suggested answers are listed in the Appendix.)

1. The human population is remarkably variable. Pick a characteristic that varies among humans and describe how individuals vary. How might genes play a role in this variation? If you observed an individual who varied in a way you had never seen before, what might be true about this individual?
2. Distinguish between adaptation, natural selection, and evolution.
3. Mutations in genes are one source of new variation in a population. Mutations are actually rather common—some are harmful, some are neutral, and some are helpful. While a mutation may affect the individual in which it occurs, it may NOT affect that individual's offspring. Why? In order for a mutation to play a role in the evolution of a population, what must be true? Visit our Web site for more information about variation (A Closer Look: New Variation in a Population):

   http://www.learner.org/channel/courses/essential/life/session5/
4. The inheritance of acquired characteristics (Lamarck) and natural selection (Darwin) both account for change in a population over time. Compare these two theories, and explain why the former was eventually discarded.

Ongoing Concept Mapping*

Develop a concept map around the central concept of variation. Be sure to include adaptation, natural selection, evolution, artificial selection, genes, and mutation in your map. Try to make connections between this map and previous maps (i.e., to the characteristics of life in Session 1; to life cycles in Sessions 3 and 4).

Guided Journal Entry

In the video, Dr. Paul Williams described how he developed Fast Plants from populations of *Brassicas*—a group of plants that include broccoli, Brussels sprouts, turnips, bok choi, etc.). For your journal entry, pick one of your favorite food plants. If you wanted to develop a new variety that increased what you like most about this plant, how would you do it? How might this same change occur through natural selection?

Guided Channel-TalkLife Posting

Dogs and cats are great examples of animals whose diversity is the result of artificial selection. The variation that is evident among breeds has been purposefully developed by breeders. In your Channel-TalkLife posting for this session, describe how you could develop a unit on the fundamentals of evolution (e.g., variation, adaptation, natural selection) using these animals. Be sure to discuss how you would tailor the concepts addressed during this session to the grade level you teach.

Between Sessions, cont'd.

Textbook Reading Suggestions

- evolution
- adaptation
- artificial selection
- Jean Lamarck
- DNA
- genes
- mutation
- variation
- natural selection
- inheritance of acquired characteristics
- Charles Darwin
- chromosomes
- alleles
- symbiosis

Preparing for the Next Session*

For "Getting Ready"

Choose one type of vertebrate animal and bring in a specimen or some representation of it. Consider this animal to represent a species. Describe some of the external features of this animal and suggest how these features adapt it to its habitat and habits (e.g., feeding behavior, avoidance of predators, movement, reproduction, etc.). Bring your specimen and description to the next session.

Materials Needed for Next Time

- One specimen of a vertebrate animal (or some representation) and written description
- String

Ongoing Activities

Bottle Biology

Continue work on your Bottle Biology system. The bottle system that has been designed to accompany Session 5—Variation, Adaptation, and Natural Selection—and Session 6—Evolution and the Tree of Life—is called the "Field Population System." In this system, three types of plants are grown together, and subjected to a voracious herbivore. Does one of these plant populations have an advantage over the others? Visit the Web site for more information and check out Bottle Biology Spotlights to track the progress of our very own *Life Science* systems.

Bottle Biology Spotlights: Session 5

System	Activity
Field Population System	Assessing Variation

Graduate Credit Activities

Continue your work on the annotated bibliography and action research project.

Notes