

FOSS® POPULATION AND ECOSYSTEMS TEACHER PREPARATION VIDEO TRANSCRIPT

<An Introduction to FOSS Middle School>

Larry Malone: Hi I'm Larry Malone.

Linda De Lucchi: And I'm Linda De Lucchi.

Larry: We're the co directors of the Full Option Science System or simply FOSS.

Linda: The FOSS Middle School Program developed at the Lawrence Hall of Science with funding from the National Science Foundation includes 9 courses for grades 6 through 8. The courses are organized into 3 strands: Earth and Space Science, Life Science, and Physical Science and Technology.

Larry: Each course includes 8 to 10 sequential investigations and lasts 9 to 12 weeks. The 9 courses can form a complete 3 year science curriculum. Three topics to a year or individual 9 to 12 week courses can be integrated into an existing program.

Linda: With FOSS students learn science by doing science. They develop deep durable understanding of science concepts and principles through authentic investigations, analysis, and reflection.

Larry: The FOSS middle school activities are informed by cognitive research about how adolescents think and learn and field tested in middle school classes around the country. The result is a program that reliably teaches important science content and critical scientific thinking processes such as logical analysis and database decision making.

Linda: Students engage the FOSS course content in 4 ways: active investigation, reading, multimedia, and assessment. These 4 learning modalities are seamlessly integrated to maximize every student's opportunity to learn. Experiences in the 4 learning modalities build on and reinforce one another resulting in comprehensive understanding of science concepts.

Larry: Students in FOSS middle school classrooms are engaged and thoughtful. They love to study science in collaborative learning groups with their peers using real scientific equipment. And FOSS makes science fun for you too. It's easy to maintain interest and motivate learning with FOSS. Welcome to the FOSS family. You and your students are about to embark on a wonderful science learning adventure.

<Assessment>

Linda: The FOSS Middle School Assessment materials are designed to be used throughout the course. They can be used to monitor progress during the investigations and as evaluation tools at the end of the course. There are three overarching goals for the program: Science Content, Conducting Investigations, and Building Explanations.

On the first page of each investigation, these goals are listed with the Objectives for each. Science Content is the facts and concepts of science that students learn throughout the course. Conducting Investigations includes designing experiments and the skills needed for successfully engaging in scientific inquiry. Building Explanations includes the discussion students have, their ability to articulate

concepts developed during the investigations, and to use evidence to support ideas and conclusions.

Unlike many curriculums that treat assessment as a separate component only related to giving grades, FOSS Assessments are integrated into the instruction throughout the course. Assessment activities in FOSS provide teachers with immediate feedback about student understanding and give students the opportunity to reflect on their own learning.

In each investigation you'll find suggestions for Embedded Assessments in the Getting Ready section as well as in the Conducting the Investigation section.

There are two kinds of Assessments in the FOSS curriculum: Formative and Summative Assessment. Read through the Overview and Assessment chapters of your Teacher Guide for complete information about the two types of FOSS Assessment. There are scoring guides for both Formative and Summative Assessments in the Teacher Answer Masters and Assessment chapters of your Teacher Guide.

Formative Assessments are embedded throughout the course to provide diagnostic information. This information will help you make decisions about instruction for individual students and for the class. In general, FOSS suggests that these Formative Assessments not be graded. Although you might score them with a check, plus, or minus to keep a record of student's progress.

Formative Assessment Strategies include: informal notes, teacher observation, student sheets, quick writes, response sheets, self assessments, and group projects. Additional information about using each of the Formative Assessment Strategies can be found in the Assessment chapter of your Teacher Guide.

It's important to remember that all Formative Assessments are intended to give you greater insight into student's thinking and guide your instructional decisions. Formative Assessment is an important part of each day's lesson. It may be a look at a notebook sheet or a response sheet to look for content understanding, or an observation in which you look over student's shoulder to see if they're developing inquiry skills. In any case, Embedded Assessment is integrated into instruction so your students may not even realize that assessment is part of the activity.

FOSS provides a Mid-summative Exam for most investigations and a Final Exam for the course. The Mid-summative exams are short tests presented in a number of formats including: multiple choice, short answer, and narrative questions. The Mid-summative Exams serve as checkpoints for student learning. Even though these are considered Summative Assessments they can be used formatively.

If you notice particular areas where students seem to have developed a misunderstanding you can make a note to yourself and come back to that idea during the next investigation. Remember to give students an opportunity to gather and process the information from the course before you have them take the Mid-summative Exams.

Understanding the big ideas of science requires that students construct relationships among many different pieces of evidence. It's important that students have time to build these higher levels of understanding before they are assessed. A final exam for the course is included it can also be used as a pretest or survey before students begin the course.

<Course Introduction>

Narrator/Virginia Reed: Hello my name is Virginia Reed in this presentation I will be discussing each of the investigations in the FOSS Middle School Populations and Ecosystems course. This video is a visual aid to help you prepare for teaching the investigation. The focus is on the materials and their use. The inquiry questions that are the heart and soul of the curriculum are in the Teacher Guide.

This course explores ecosystems as the largest organizational unit of life on Earth, defined by its physical environment and the organisms that live in the physical environment. Students learn that every organism has a role to play in its ecosystem and has structures and behaviors that allow it to survive. Students raise populations of organisms to discover population dynamics and interactions over a range of conditions. They learn that food is the source of energy used by all life forms in all ecosystems to conduct life processes. Reproduction, including limiting factors, heredity and natural selection are explored as ways to understand both the similarity and the variation within and between species.

This 12-week course comes in three boxes, with enough consumable equipment for 5 classes of 32 students each. In addition to the boxes of equipment, the course comes with a detailed Teacher Guide, a lab notebook containing the student sheets and organizers for students to use while they engage in the investigations, 32 Resource books containing data and readings that are used throughout the course, and 5 CD-ROMs for use as a whole-class demonstration tool as well as an individual or small-group interactive instructional tool.

Both the lab notebook masters and the multimedia are also available on-line at FOSSweb.com.

Four weeks before you begin this course you need to think about the live organisms your students will be studying. Because live organisms cannot be shipped with the kit, you need to plan when you need the organisms to arrive at your school. You need to check with your school or district to see if the organisms were purchased with the kit. If they were purchased from Delta, you will find a coupon for ordering the organisms.

Some of the organisms can be obtained from local sources or collected from the local environment. Read page 31 of the Teacher Guide for additional information on obtaining the organisms.

<Teacher Guide Overview>

Narrator: Before you begin the Populations and Ecosystems course, it's important that you read the Teacher Guide. The Teacher Guide is in a three-ring binder. Look at the Table of Contents to see how the Teacher Guide is assembled.

You'll notice that the Guide is subdivided into 19 tabbed chapters: Overview, Materials, Investigation Chapters, Transparency Masters, Special Teacher Masters, Teacher Answer Masters, Assessment, Assessment Masters, CD-ROM User Guide, and References.

Be sure to read the Overview chapter before you begin teaching the module. It contains many helpful suggestions for getting started. In it you will find:

- The National Science Education Standards that are addressed in this course
- A complete description of the Program Components
- Populations and Ecosystems: Life is Organized
- Why Study Populations and Ecosystems?
- Can I teach this? I'm not an Ecologist

- Instructional Methods for All Students. Note the symbols in the left hand margin. You will see these same symbols in the Investigation chapters of the Teacher Guide. Look for other symbols in the margins of the Overview section.
- Assessing Progress
- Reading and Writing in Science
- Encouraging Discourse
- Management Strategies
- Using FOSS Technology, and
- Safety in the Classroom

Notice the safety symbol in the margin. As I discuss each Investigation, I'll point out specific safety issues you should consider. You can download the Materials Safety Data Sheets by looking under the Course Notes section of the Populations and Ecosystems course at FOSSweb.com.

The Course Matrix gives a quick overview of the course, including a synopsis of each investigation, how many class sessions it will take to complete the investigation, the science concepts and process skills covered, the media used in that investigation, readings from the Resource book, and extension activities.

In the Materials chapter there is an inventory of the equipment provided in the kit and directions for its preparation and maintenance. An inventory sheet is also enclosed in drawer one of the kit and each drawer has an inventory list on the outside of the drawer listing the equipment contained. Starred items on the inventory list indicate consumable items. You can order replacement parts for all FOSS modules and courses at the Delta Education website or by calling this number (1-800-442-5444).

Some items for this course need to be supplied by the teacher. Most of these are common items found in science classrooms. You should look over this list before beginning to teach the course to identify items that might need to be collected or ordered. For example, you will need to order 30 milkweed bugs before you start Investigation 1. Updated information on ordering and caring for organisms can be found on FOSSweb.com.

The Preparation section provides guidance for preparing a new kit, which is done only once by the first user and preparation tasks that will need to be done each time that the kit is used. Reminders for when to reserve computer time, how to best organize the materials for sequential classes, and the care, maintenance, and disposal of living materials can also be found in this section.

The next Chapters are the Investigations that are the heart of the course. The first page of each chapter lists the Goals and Objectives for the Investigation. The At a Glance chart summarizes the Investigation and helps you plan for assessing, preparing, and executing each part of the Investigation. Next you'll find background information specific to the Investigation, including a section explaining why this investigation is important for middle school students. Common student misconceptions are listed in this section.

Each Investigation has several parts. For each part you'll find a Materials List, a Getting Ready section, and step by step directions for conducting the activity with your students. At the end of the chapter you will find extensions for further investigation.

After the Investigation chapters, you will find the Transparency Masters. The actual transparencies are in drawer one of the kit, but the masters are provided in case you need to replace one.

The Special Teacher Masters chapter contains both masters to replace lost items like the student ecosystem cards provided in the kit, and masters for items like the Kelp Fish that you will need to copy and cut out.

The Teacher Answer Masters chapter has answers for most of the student lab notebook sheets.

There are many ways to assess your students learning as they progress through the course. Read through the Assessment chapter for more information about Formative and Summative Assessment.

This chapter contains the scoring rubrics for Formative Assessments, and scoring guides for the Summative Assessments. These will assist you in evaluating student progress throughout the course.

After the Assessment chapter, you'll find the Assessment Masters. Assessment Charts can be used to record individual student progress. These are followed by a Summative Exam for each Investigation and a Final Exam for the whole course.

Another helpful chapter is The CD-ROM User Guide. The CD-ROM is an integral part of the course. Students can use it to interact with simulations, images, and text that can enhance their understanding of concepts. System requirements, Program basics, and Specific navigation tips are included.

The Reference chapter has an annotated list of print and web-based materials for both the teacher and student.

<Multimedia Overview>

Narrator: The FOSS Populations and Ecosystems CD-ROM is an integral part of the Populations and Ecosystems Course. Specific directions for using the CD are in the CD-ROM User Guide Chapter of the Teacher Guide.

The information and simulations can also be accessed online.

- Go to FOSS web at www.fossweb.com.
- Select "Middle School."
- Select Populations and Ecosystems.
- Select the Populations and Ecosystems Multimedia.

The multimedia is available to teachers with passwords. After registering, teachers can share their usernames and passwords with students. For this reason, be sure to create a unique username and password for this site; do not use usernames and passwords that you use for other sites, such as personal email or online banking. For example, use your last name and the name of your school or the school mascot as a password. Students may then use their teacher's username and password to access this site. For privacy reasons, students under the age of 18 cannot register for their own passwords, but may use the ones given to their teachers.

To register, teachers should fill out the information and click on submit. A verification email with an activation link will be sent to you. Once you have accessed the multimedia you can choose to select "Enter the Teacher Guide", and then select an Investigation.

I'm going to select Investigation 4: Mono Lake. As you select a part of the Investigation, you will notice

that available selections appear in the fields to the right of the screen. I'm going to select Part 2. Selecting a multimedia opportunity takes you directly to the multimedia for that part if it's available on the computer. If it's a video in the kit, only the title will appear on the screen. Selecting Lab Notebook sheets or Transparencies will bring up the appropriate file as an Adobe Acrobat document.

Readings from the Resource book will be listed, but are not available online.

You can also choose to enter the program; this is the best option for students. Click the continue button. This is a more student friendly menu that leads only to the multimedia. For example, if I choose Milkweed Bugs I go to an interactive simulation where students explore reproductive potential.

In the Teacher Guide more details about each multimedia option are given in the Investigation chapters. Look for the CD-ROM icon in the margin. You can also find more information in the CD-ROM user guide chapter.

Going back to the Welcome page for students you'll find updated websites, books, and a glossary. For teachers and parents, a course summary, information about plant and animal care, a link to the PDF duplication masters for the Lab Notebook, a list of references, and course notes with important information about corrections, ordering, and the link to the Material Safety Data Sheets.

Accessing the Lab Notebook file takes a separate password from the one you give the students to access the multimedia. Select Duplication Masters, fill in the information and a password will be sent to you within 24 hours. This username and password should not be given to students.

Once you have a password, you can select the files that you need.

<Safety Considerations>

Narrator: Refer to the Overview chapter and to the Materials chapter of your Teacher Guide for complete safety information. In addition, look for this safety icon in the Getting Ready section and in the Conducting section of the Investigations.

There's a safety poster in your kit. Display it in a prominent location. Be sure to go over the rules on the poster. Your district might have additional safety considerations that you'll want to go over with your students at this time.

The Overview chapter of your Teacher Guide has more general safety rules that you'll want to share with students. Food allergies can be a serious concern, check to see if any of your students have food allergies especially to legumes or peanuts. Because of the increasing number of nut allergies in students you shouldn't burn peanuts or any other nut if any student in the building has a severe nut allergy. Other possible allergens might be the raw sunflower seeds used in Investigation 1 and the alfalfa, rye, and wheat seeds used in Investigation 3. Your Teacher Guide has additional information on allergies. Be sure to remind students never to eat anything during science class.

In Investigation 5, students will be burning a cheese ball or other food. Be sure that students have removed all flammable materials from their desks before they light their snack. If you're concerned about this process you might want to allow only one group at a time to burn their cheese ball. That way you can be standing by each group as the ball is lit and as it burns. Move to the next group when the

cheese ball is through burning. During the burning activity make sure that students are wearing goggles and that long hair is tied back.

Students should always behave responsibly during science investigations. For example in this course students will use push pins and rubber bands to assemble habitats for their milkweed bugs. Be sure to insist that students do not misuse the rubber bands and that they're careful when using the sharp push pins.

Students should wear goggles any time that there's a risk of something getting in their eye especially during the burning activities in Investigation 5. Very rarely a burning cheese ball could pop causing a bit of food to fly through the air. Remember your Teacher Guide has specific safety information in the Investigation chapters. Be sure you look ahead for any safety information before you begin an investigation.

<Investigation 1, Introduction>

Narrator: In this Investigation students raise milkweed bugs in a habitat like this to study the reproductive biology. The information from this part will be used to study milkweed-bug population dynamics in Investigation 6.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment opportunities, Preparation, an outline conducting the investigation, and when to use the student Resource book.

Be sure to read through the Scientific and Historical Background pages for information about the milkweed bug life cycle, and tips on maintaining the milkweed bugs in the classroom.

The Why Do I Have to Learn This? section provides information on typical student responses to the Investigation and information about the design of the course.

<Investigation 1, Getting Ready for Part 1>

Narrator: In this part students are introduced to adult milkweed bugs in Petri dishes. They will observe the milkweed bugs carefully in order to discover gender differences, and suggest the materials necessary to provide a successful habitat that will allow the milkweed bugs to reproduce.

This is what you will need from the kit: For each group of 4 students, you will need 2 Petri dishes, 2 hand lenses, and 4 copies of Lab Notebook sheet page 1, Milkweed-Bug Observations.

For the class you'll need 2 vials with caps, 2 4-liter zip bags, a one-hole punch, a large pointed dowel, 2 rubber bands, 2 jumbo paper clips, 2 pieces of netting, 2 pieces of paper toweling, a push pin, and some sunflower seeds.

All of the equipment items can be found in drawer 2 of the kit. Most of the smaller items are packaged together.

You will also need an Transparency #1, Male and Female Milkweed Bugs and a copy of the assessment chart for Investigations 1 through 4.

All of the Transparencies for the course are in a white envelope at the very bottom of Drawer One.

The Assessment Chart can be found in the Assessment Master Chapter of the Teacher Guide. Make one copy for each class.

In addition to locating the items in the kit, there are some items you need to supply. You will need to provide an overhead projector, 15 by 30 centimeter piece of cardboard, transparent tape, and of course the milkweed bugs. You need to make a holding habitat for the bugs before you start the course and before the milkweed bugs arrive.

To make the holding habitat for the bugs, you'll need the netting and paper toweling from the kit. Cut the netting and paper toweling to 10 by 10 centimeter squares. You'll need two of each for the holding habitat. It's easier to cut the netting if you iron it first. In Part 2 of this Investigation, you'll need additional cut netting and paper toweling. You might want to consider cutting them now to save time.

You'll also need a 15 x 30 centimeter piece of cardboard. For Part 2 you'll need a total of 8 pieces of cardboard, so again, you might want to cut them all now. The teacher guide will give you more directions for preparing the paper toweling, netting, and cardboard. It will take about 30 to 45 minutes to make the 2 holding habitats – 1 for the female milkweed bugs and 1 for the male milkweed bugs.

Now make air holes in the bag. Use the push pin with the cardboard backing to make about 100 small holes in the top third of the bag. Punch a hole in the center of the caps of two vials to start making a modified water fountain. Tightly roll the toweling, and push it through the hole to make a wick. You'll need to make two of these. I'm going to use the large pointed dowel to make a hole in the bottom of the bag so that I can install the water fountain. It's easier if you stand the dowel on end. Push the dowel all the way through. I need to push the vial through the hole. It's easier if I wet the vial first. Gently stretch the plastic. Push the vial all the way through. Now I'm going to add water. Fill the vial half full of water. Tap water is fine.

We're now going to make two food bundles. Place about 50 shelled sunflower seeds into the piece of cut netting. Use a rubber band to hold the bundle of seeds shut, like this one. Use a jumbo paper clip to make a hanging hook. If you open the paper clip like this, it will break. Instead, open the paper clip this way to make a "C." Tape the seed bundle into the upper inside third of the bag. We now have food and water for our milkweed bugs. We're ready to add the bugs when they arrive.

Label the bags male and female. When the milkweed bugs arrive, transfer the females to one bag and the males to the other bag. Place the bags out of sight of the students. The bugs can stay in this Spartan habitat for a week or more.

Decide if you are going to use the provided lab sheet – Milkweed-bug Observations, or if you want students to use a more open form of recording by using a blank piece of paper or a blank page in their Science Notebooks.

If you are using the Assessment Charts, have them ready on a clip board. The charts might be easier to use if you list students' names by group rather than in alphabetical order.

Each group of 4 students will need 2 Petri dishes, each with a single milkweed bug inside. You can transfer the milkweed bugs from their holding habitat before first period, or even the day before. Remember, students shouldn't see the holding habitat.

Half of the Petri dishes will contain male milkweed bugs and half will contain females. Do not label the dishes. Carefully transfer the milkweed bugs to their Petri dish and use two bits of tape to hold the dishes shut. Students will not be opening the Petri dish during this first session. If you fold the sticky side of the tape to the sticky side, it will make it easier to remove the tape for Part 2.

Here's a tip: If you use different widths of tape for the male and female Petri dishes, it will allow you to quickly check the sex of the milkweed bugs and students will be none the wiser.

An important part of this activity is for students to discover the gender difference. If you mix the male and female Petri dishes and place them on a tray, students can randomly select a dish. A table group does not need to have both a male and female at their table.

<Investigation 1, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Introduce the milkweed bug as one of the many different kinds of organisms on Earth. After students have had time to observe and record their observations and make drawings of the milkweed bugs, you will propose that they could learn more about the bugs if they were able to raise a lot of them.

Students brainstorm what they would need to provide for the milkweed bugs in order for them to survive. Students will see that the bugs have two different patterns. They usually conclude that one must be male and one female. Confirm that this is the way to tell male from female and show Transparency number 1, Male and Female Milkweed bugs so the students will know which is which.

As students observe the milkweed bugs to determine their gender differences, check their lab skills by assessing how they handle living organisms. Look at the scoring guide in the Assessment chapter to evaluate their progress.

At the end of the class session, collect the Petri dishes and hand lenses for the next group of students. At the end of the day, you can leave the milkweed bugs in their Petri dishes and store them in a cool dark location. If the bugs are going to be in the Petri dishes for more than 24 hours total, add a postage stamp size piece of damp paper towel and a sunflower seed to the Petri dish, or return the bugs to their holding habitats .

<Investigation 1, Getting Ready for Part 2>

Narrator: In Part Two, students assemble habitats to house the milkweed bugs during the reproduction study. Students also review the core vocabulary for this Investigation: organism, individual, and habitat.

This is what you will need from the kit:

For each group of 4 students, you will need a male and a female milkweed bug in Petri dishes from part 1, a 4-liter zip bag, a piece of paper toweling, 2 pieces of netting, and about 5 rubber bands, a push pin, a jumbo paper clip, a piece of clear tubing, a vial and cap, about a walnut size piece of polyester wool, and the raw shelled sunflower seeds.

You'll also need 4 copies of Lab Notebook sheets pages 2, 3, and 4, A Habitat for Milkweed Bugs.

For the class from the kit you need: a syringe, the one-hole punch, and the large dowel with pointed end.

You'll also need Transparencies 2, 3, and 4, A Habitat for Milkweed Bugs

You'll need the Assessment Chart for Investigations 1 through 4.

For each group of four students, you'll need to provide a piece of cardboard, a sharp pencil, and several 20 to 30 centimeter long twigs.

For the class you'll need to provide several permanent marking pens, water, and an overhead projector.

The Getting Ready section for Part 2, has detailed directions for planning for and preparing for the habitat assembly. The habitat bags are put together over the course of the day. Each class period will assemble a specific part of the habitat. The habitat that a table group works on will be the same habitat that they observe over the next several weeks.

If you typically have 32 students in a class working in groups of 4, then you will have one set of 8 habitat bags for all of your classes. Students at table 1 for all 6 periods will share the same table 1 habitat bag. Students at table 2 for all 6 periods will share the table 2 habitat bag and so on.

Cut additional paper towel wicks, netting, and cardboard pieces if you've not already done so. Look at the Getting Ready section for additional details.

Decide if you want students to collect twigs on the schoolyard or if you are going to collect and bring in twigs. Each habitat bag will need 3 to 4 lightweight twigs, about 20 to 30 centimeters long.

To assemble the habitats, the tasks are divided for 6 class periods. If you have more periods, or fewer, adjust the tasks so that each class period has at least 1 task to do. This is the suggested assembly plan for a teacher with 6 class periods: For task 1 you'll need 4-liter zip bags, twigs, rubber bands, and permanent marking pens. For task 2 you'll need vials with caps, paper towel squares, clear flexible tubing, and a one-hole punch. Students will share the one-hole punch. For task 3 you'll need shelled sunflower seeds, netting squares, and rubber bands. For task 4 you'll need small walnut size pieces of polyester wool, pushpins, and cardboard pieces. For task 5 you'll need water, the pointed dowel, a syringe, and sharpened pencils. The groups will share the pointed dowel and syringe. Finally, for the last task, you'll need the milkweed bugs, and large paper clips.

Think about an appropriate place in the classroom to position the completed habitats. If you have fewer than 6 classes, some tasks can be combined. Using trays will make setup and cleanup between classes easier.

Temperature will affect the growth rate of the bugs. The warmer the environment is, the faster the bugs advance through their life cycle. Freezing temperatures will kill them. If your school reduces the temperature at night and on the weekend, here's one option for keeping the bugs warm. Get a large cardboard box. Run a stick from one side to the other near the top. Hang all the bags on the stick, and direct a 60 watt lamp into the box.

<Investigation 1, Conducting Part 2>

This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher

Guide.

Remind students that they are going to raise milkweed bugs in order to learn more about life on Earth. For that they'll need to make a suitable habitat and introduce two milkweed bugs into it, a male and a female.

Assign the task for that period and make sure that table groups are identified by table number, letter or other name. The number or name of the table will be written in permanent ink on the corner of the habitat bag.

Students will refer to their lab notebook pages 2, 3, and 4 as they complete their assigned task.

For first period, students will construct the twig structure; they'll take twigs and rubber bands to assemble a climbing structure shaped like a capital A. They'll also need to label their 4-liter bag with their table number.

Second period will make the water fountain: First, students will take the hole punch and punch a hole towards the side of the cap. Next they'll roll up the paper towel wicking and pull it through the hole. Put the cap on the vial. Use the sharpened pencil to punch a second hole through the cap. Take the plastic tubing and push it all the way to the bottom of the vial. Don't use the hole punch to punch the second hole. The hole will be too big and the babies can fall into the water fountain and drown. Now the water fountain is complete.

Third period will assemble the food bundles. Students will need to make two bundles for each habitat. Use a loop of the rubber band to hang each food bundle on a twig high on the climbing structure. This keeps them from touching the water fountain wick when the food is in the habitat.

Period four will make the air holes in the bag. Remind students to keep the holes small or else the newly hatched milkweed bugs will escape. Period four will also attach the polyester wool to the climbing structure. Stretch the wool a bit and then attach it near the top.

Period five will install the water fountain in the bottom of the bag just like you did for the holding habitat. This time, holding the vial, rotate it, keeping the tubing on the bottom of the vial, so that you can poke a hole through the plastic bag into the rubber tubing. Students will need to push the tubing through the bag and then pull the tubing up a few centimeters off the bottom of the vial, so that the tubing will extend through the bag.

The last period will complete the habitat. Insert the climbing structure. Have a partner help you hold the bag. Use a syringe to add water. Now you'll add the milkweed bugs, making sure that you have both a male and a female. Close the bag, and add a hanging hook. Have the students hang the completed habitat bags in a location you've chosen, for example along a clothesline or from a chalk tray.

To assess your students during the activity, note students' ability to work effectively as a group. You might want to note groups that are exemplary or groups that need help developing collaborative skills. If you are using the Assessment Chart from the Teacher Guide, you can record a simple check mark or jot down comments.

<Investigation 1, Getting Ready for Part 3>

Narrator: In Part 3, students observe and record events in their milkweed bug habitats over a period of several weeks.

This is what you will need from the kit: For each group of 4 students a dowel, a dowel stand, a medium binder clip and 2 hand lenses. Students will also need their completed habitat bag from Part 2. Each group need 4 copies of the Student Lab notebook pages 6 and 7, Milkweed Bug Changes, and 4 student Resource books.

The dowel stand and clip make it easy for the students to hang the milkweed bug habitats at their tables while they make their observations. For the class you will need Transparency number 5, Milkweed Bug Changes, and the Assessment Chart for Investigations 1 through 4.

For the class you'll need to provide: permanent marking pens, an overhead transparency marker, and an overhead projector.

<Investigation 1, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

In Part 3 students will make observations as significant events occur in the milkweed bug habitats. Most observations and recordings will only take a few minutes, so you will need to continue onto Investigations 2 and 3, stopping periodically to allow students time to observe and record events such as mating, egg laying, egg hatching, molting, and instar stages.

Students should be encouraged to record the date on which an observation is made. You will want to use the Transparency to model how you want students to record their observation entries. Students should mark the egg clutches they've discovered by drawing a circle on the outside of the bag with a permanent marker.

Have students read the Resource Book article, Milkweed Bugs, after they have had a few days to observe milkweed bug structures and behaviors.

<Investigation 2, Introduction>

Narrator: In Investigation 2, students are introduced to some of the big organizing concepts in ecology, and they develop the vocabulary associated with those concepts.

Look over the At-A-Glance Chart paying close attention to the Objectives, Assessment Opportunities, Preparation, an outline for conducting the investigation, and when to use the Student Resource book and video.

Be sure to read through the Scientific and Historical Background pages for information about the scientific vocabulary introduced in this Investigation.

The Why Do I Have to Learn This? section provides information on typical student responses to the Investigation and information about the design of the course.

<Investigation 2, Getting Ready for Part 1>

Narrator: In this part, students are introduced to basic definitions used in ecological studies: individual,

population, community, ecosystem, and biotic and abiotic factors. They work in groups to sort picture cards into categories based on the definitions.

This is what you'll need from the kit. For each group of 4 students, you will need: 2 sets of ecosystem sorting cards and 2 one-liter zip bags.

Each group will need 4 Student Resource books. You'll need 4 copies of Lab Notebook pages 8 and 9, the Ecosystem Glossary; and 4 copies of Lab Notebook page 11, Ecosystem Card Sort Results.

For the class you'll need the display size of ecosystem sorting cards and a one-liter zip bag.

You'll need Transparency number 6, Ecosystem Definitions, and the Assessment Chart for Investigations 1 through 4.

Here's what you need to provide. For the class you'll need: 2 pieces of chart paper, marking pens, tape, and an overhead projector.

If this is the first time the kit is being used, you'll need to cut the large ecosystem sorting cards apart and store them in a liter zip bag. You'll need to punch out the die-cut student ecosystem sorting cards if this is the first time the kit is used, and store each set in a liter zip bag. There are 2 different sheets. Punch out both to make each complete set.

Take the two pieces of chart paper and on one write the headings, Individual, Population, and Undecided. On the other, write Community, Ecosystem, and Abiotic. Make sure that there's enough room under each heading to post a number of the large cards.

<Investigation 2, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

First, students will work in groups of 4 to come up with their own definitions for the words individual, population, community, ecosystem, and abiotic. Have your students share their definitions and tell them that these words have certain meanings when they are used in everyday conversations, but they have specific scientific definitions as well. During this course we will be using the scientific definitions.

Use Transparency 6 to establish the scientific definitions. Hand out the student ecosystem sorting cards, and have your students work with a partner to sort the cards into different piles that represent individuals, populations, communities, ecosystems, and abiotic factors.

Once students have their cards sorted, have them record their results on Lab Notebook page 11, Ecosystem Card Sort Results. They should also write a brief justification for their decision. Have students take one more look at their card sort while you give each group 4 of the large laminated cards and a small piece of tape. Have 1 member from each group come up to post their cards on the chart paper.

After students have posted the cards, ask if anyone would like to suggest any changes. Make sure that if there is a disagreement, the cards are moved to the undecided category. Some of the cards were included to spark discussions between groups. For example, the Elodea and guppies might end up in the

Community group or the Ecosystem group depending on whether students include the water the fish are swimming in. Encourage this kind of discussion.

After the class discussion, collect Lab Sheet page 11, Ecosystem Card Sort Results. Look at the suggested answers on this page in the Teacher Answer Masters chapter, focusing on student reasoning. Use the scoring guide in the Assessment chapter, and the Assessment Chart to record your student's understanding of the basic definitions. At the end of this part, students read the short article called Life in a Community from the Student Resource book.

<Investigation 2, Getting Ready for Part 2>

Narrator: In Part 2, students are introduced to how populations are studied. They compare the isolated laboratory observations of their milkweed bug populations to that of a study of populations in their natural surroundings.

From the kit you'll need the video, Among the Wild Chimpanzees. Make sure that you have a VCR and TV available.

For each group of 4 students, you will need 4 copies of Lab Notebook sheet page 13, Among the Wild Chimpanzees.

You'll also need the Assessment Chart for Investigations 1 through 4, and copies of the Mid-summative Exam Investigations 1 and 2. The master for the Mid-summative Exam is in the Assessment Masters chapter of the Teacher Guide.

Preview the video and decide if it will be shown in 1 class period or 2.

<Investigation 2, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Students will view the video, Among the Wild Chimpanzees, seeing how Jane Goodall studied chimpanzees living and interacting in their natural ecosystem. At the end of the video, students will discuss the differences between a controlled experiment in a laboratory setting and an observational study in a natural setting. Use what the students have seen in the video to reinforce the concept of interactions in an ecosystem. Ask students to keep Goodall's studies in mind when they build their own miniecosystems in the next Investigation.

Because there was very little new content presented in Investigation 1, it has been combined with Investigation 2 for the first exam. When you think that the students are ready, administer the exam. Use the scoring guide in the Assessment chapter of the Teacher Guide to score the exam. Return the exams to the students and allow them to discuss the questions and make changes to their answers.

<Investigation 3, Introduction>

Narrator: In Investigation 3, students construct aquariums and terrariums. They observe them over time to increase their understanding of interactions in an ecosystem. Before starting this Investigation, make sure that your organisms have been ordered and will arrive at the appropriate time. Most suppliers will only ship living materials on Monday or Tuesday.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book.

Read through the Scientific and Historical Background pages, for tips on planning for this Investigation, caring for the aquatic and terrestrial organisms, and information on obtaining the optional organisms.

The Why Do I Have to Learn This? section provides information on typical student responses to the Investigation and information about the design of the course.

<Investigation 3, Getting Ready for Part 1>

Narrator: In Part 1, students assemble the abiotic components of an aquarium and a terrarium, and learn about the organisms that they will place in the miniecosystems later on.

This is what you will need from the kit. For each group of 4 students, you will need: 2 6-liter basins, 2 basin covers, and 1 half-liter container.

You will need 4 copies of Lab Notebook page 15, Miniecosystem Needs and 4 Student Resource books.

For the class you will need the gravel, the sand, the two sized of pebbles, and the soil. You'll also need the 2 water misters, 3 plastic cups, and the bottle of chloramine treatment.

And the last items from the kit you'll need are the wheat, rye, and alfalfa seeds.

You and your students need to provide a bus tray, clean rocks, dead leaves and twigs, items that can be turned into shelters, and boxes and trays to hold what your students collect. You'll need to provide newspaper, scratch paper, and sticky notes. You'll also need a few large jugs or pitchers to hold water.

You will need to decide where to store 8 terrariums and 8 aquariums during the rest of the course. A well-lit table or counter with natural light is best. You could also use a lab cart to store and move some of the aquariums and terrariums.

The aquariums and terrariums are set up and shared by all of your classes, with each table group sharing 1 aquarium and 1 terrarium with the same table group in subsequent periods.

Several days before you begin, plant 3 plastic cups of wheat, rye, and alfalfa seeds. In Part 2 these will be used as references to help students identify the type of seeds that have germinated in their terrariums. Remember one safety issue: Alfalfa is a legume. Students who have an allergic reaction to legumes should not handle the alfalfa seeds or plants. If you have students with legume allergies, you might not want to use the alfalfa at all, depending on the severity of the student's allergy. Be sure to water the cups with a mister and place them in a well-lit location. Keep the soil damp but not wet.

Transfer the soil to a tub or box just before you're going to use it. Mix it with some of the sand about 1 part sand to 4 part soil, be sure you save some and for the aquariums. The soil should be slightly damp, but not wet. Use your mister to add a bit of water if necessary. Keep the soil sand mixture in a tightly closed plastic bag when not in use.

Prepare the aquarium water by adding chloramine neutralizing drops. Put the treated water in large jugs or pitchers at the materials station. Decide how you want to identify the aquariums and terrariums during

the setup procedure. Either number the aquariums and terrariums using sticky notes, or label the location where they will be placed.

Depending on the number of classes that you have, decide how to divide up the tasks. These tasks are given as an example of a teacher with 5 class periods. You might want to set out only the materials for 1 task at a time as each class completes its part.

<Investigation 3, Conducting 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Students start this Investigation by reading about the miniecosystem organisms on pages 64-68, of their Resource books. They sort the organisms into 2 sets based on the type of ecosystem they might live in, aquatic or terrestrial. They use the information in the resource books to help them identify what abiotic factors they need to consider when setting up their 2 miniecosystems.

Over the course of the day students assemble the abiotic elements in the aquariums and terrariums. Period 1 will fill the terrarium basin one-fourth full of the soil and sand mixture. They will decide whether to keep the landscape flat or with hills. Period 2 will add a shelter using leaves, twigs, sticks, and rocks to the terrarium. Period 3 will fill the aquarium basin three-fourths full of treated water. Period 4 will add rocks, gravel, and sand to different parts of the bottom of the aquarium. Period 5 will add shelters to the aquarium using a plastic cup, small flowerpot, or rocks. Observe the students as they work, and use the Assessment Chart to jot down informal notes.

<Investigation 3, Getting Ready for Part 2 – Session 1>

Narrator: In Part 2, students observe the aquatic and terrestrial organisms that will be placed in their miniecosystems. They predict how the organisms will interact, and then place the organisms into the appropriate system. Plan on 2 sessions for this part. Session 1 involves only the aquatic organisms, and session 2, only the terrestrial organisms.

This is what you will need for session 1. For each group of 4 students you'll need the aquariums from the last session, and from the kit you'll need 4 plastic cups with lids and a half-liter container. You'll need 4 Student Source books, and 4 copies of Lab Notebook page 16, Aquatic Organism Observations.

For the class from the kit you'll need: a fish net, a bottle of chloramine treatment, the two-ml spoon, a dropper, some rulers, a push pin, a plastic cup, and hand lenses for students who'd like to use them. Also from the kit you'll need the 2 water misters and some soil. You'll need the 3 reference gardens made in part 1, and the Assessment Chart for Investigations 1 through 4.

You'll need to provide a basin or aquarium for holding the fish, gallon jugs or pitchers, trays or basins for distributing materials, and also a sharp knife that you'll use to cut the tip off the plastic dropper.

You'll need these living organisms for each group of 4 students: 2 to 3 guppies make sure you have at least one male and one female, some Elodea and duckweed, 3 to 4 aquatic snails, and about 4 to 6 scuds.

All of these organisms can be ordered using your Delta Living Organisms coupons, or purchased from any biological supply company or a local aquarium store. tubifex worms do not ship well, but if you can obtain them locally, give each group a few. Some areas restrict the distribution of certain aquatic snails,

Elodea, and duckweed. If that's the case in your area, substitute with species that can be used locally.

When you receive the organisms transfer the fish to a basin or small aquarium until you are ready to use them. Be sure to treat the water with the chloramines drops first. You can put the Elodea into the tank with the guppies. Put the scuds and tubifex worms in half-liter containers about half full of treated water. Store the tubifex worms in a refrigerator. Put the duckweed in a half-liter container with treated water.

The Materials chapter and the Getting Ready section of the Teacher Guide give you full instructions for caring for your organisms.

To prepare for session one, you'll need to treat about one liter of tap water per group with the chloramine neutralizing drops. If your local water supply uses chloramine instead of chlorine, you must use the water treatment drops. Chloramine cannot be removed by letting the water sit and age. Cup the tip off the dropper with a sharp knife. This will enlarge the dropper opening enough so that you can easily remove the scuds from their holding container. You can also use the dropper to remove the tubifex worms. Or, you can use a fork to transfer the worms to cups.

The day before you start part two, put the snails, scuds, and plants into cups. You'll need 3 cups per group. Add about this much treated water to each cup. Put a couple of sprigs of Elodea and some duckweed into the same cup. You can use a spoon to transfer the duckweed. Use a pushpin to make a few air holes in each lid. Snap on the lids to prevent spills when students are moving the cups.

The morning of the Investigation, transfer the tubifex worms with the treated water to their cups. Snap on lids. Use the net to put one male and one female guppy into half-liter containers of treated water. Distribute any remaining guppies evenly into the containers. Don't put a lid on the guppy container so that they receive enough oxygen throughout the day. If you have extra trays or basins, you can use those to distribute a set of organisms to each group.

<Investigation 3, Conducting Part 2 – Session 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Introduce the organisms to the students. They will observe the organisms carefully and record information about each organism, including an illustration and an estimate of size on Lab Notebook page 16. Students share their observations about the appearance and behaviors of the organisms and discuss whether they have populations or not and why. As the students work, visit each group and assess whether they're making reasonable predictions on how the organisms might interact with each other and with the abiotic elements in their miniecosystems.

At the end of the day, your last class will add the organisms to their aquariums. They'll add the organisms in this order and observe the behavior of each organism as it is introduced. Here's how to do it. This allows the organisms to swim or tumble gently into the aquarium. From now on, store the aquariums with the lid on. Return the aquariums to their designated location and clean up.

<Investigation 3, Getting Ready for Part 2 – Session 2>

Narrator: This is what you'll need for session 2. The terrariums from Part 1, and from the kit, for each group of 4 students: 4 cups and lids, and the alfalfa, rye, and wheat seeds.

You'll need four Resource books, and 4 copies of Lab Notebook page 17.

For the class also from the kit, you will need hand lenses, rulers, and the 2 milliliter spoon. You'll also need the 2 water misters and soil.

You'll need the Assessment Chart, and you'll need the pre-planted reference garden cups of wheat, rye grass, and alfalfa.

You'll need to provide for each group of 4 students: 4 to 6 isopods, 2 to 3 earthworms, and 2 to 3 land snails if possible. To prepare for session 2, you'll need to move the animals and seeds to cups for distribution to each group. You can do this the day before. Be sure to punch air holes in all the lids.

Place a little bit of damp soil in the cups that will be used for the isopods. Put about 4 to 6 isopods on the soil. Put a little bit of damp soil in the cups that will be used for the earthworms. Place 2 to 3 earthworms on the soil. Put the lids on the isopod and earthworm cups to keep the soil from drying out. Place 2 to 3 snails in the cups for each group. Immediately place the lids on the cups to keep the snails from escaping.

Use the 2 milliliter spoon to measure one spoon of each type of seed wheat, rye, and alfalfa into the same cup for each group. Snap on a lid to prevent spills. Be sure to check that the soil in your reference garden cups is staying moist and that the seeds are growing.

<Investigation 3, Conducting Part 2 – Session 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Distribute the organisms to your students. Have them observe the organisms carefully. They will record their observations, including illustrations and estimates of size, on Lab Notebook page 17. Students share observations about the appearance and behaviors they noticed and discuss whether they have populations or not, and why. As the students work, visit each group and assess whether they're making reasonable predictions on how the organisms might interact with each other and with the abiotic elements in their miniecosystems.

Have them record their predictions in their Science Notebooks. Remind them that they can refer to the information about the organisms in their Resource books.

Ask students how they can tell which plant is from which seed. Show the students the reference gardens.

At the end of the day, students will add the organisms to their terrariums 1 at a time. They can add the organisms in any order they want, but they should observe and record the behavior of each kind of organism as it is introduced.

They need to spray the terrarium soil lightly once the seeds are planted. Caution them to keep the soil moist but not wet. Students return the terrariums to their designated location and clean up.

After the students have finished recording their observations, they'll read the story called Biosphere 2 in their Resource books.

<Investigation 3, Getting Ready for Part 3>

Narrator: In Part 3, students begin a long-term observation of the miniecosystems, using a scientific log to record interactions and changes over time.

Here's what you need for each group of 4 students: their aquariums and terrariums, and from the kit: a thermometer, 2 clear plastic sheet protectors, and 2 small binder clips.

Make 2 copies of the Miniecosystem Log Sheets from the Special Teacher Master Chapter of the Teacher Guide.

For the class you will need from the kit: fish nets, the fish food, and the FOSS CD-ROM. You'll also need Transparency number 7, the Miniecosystem Log Sheet, and the Assessment Chart for investigations 1 through 4.

For the class you'll need to provide lettuce or carrots to feed the snails in the terrarium, overhead markers and an overhead projector, and if possible, provide a computer in the classroom for students to view the organism database on the CD-ROM or online.

To prepare for this part of the Investigation, put the log sheets into the plastic sheet protectors.

Decide how you want to schedule the observation recordings of the aquariums and terrariums. It's best if period 1 makes formal observations on Monday, period 2 on Tuesday, and so on, so that you have a record of change and maintenance for each day of the week.

Decide on whether you will allow students to add local materials or replace dead organisms. The Getting Ready section of the Teacher Guide will give you additional suggestions.

<Investigation 3, Conducting Part 3>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Students spend a few minutes observing both their aquarium and terrarium. They should look for evidence that the predictions they made in the last session were accurate.

The CD-ROM has a database of organisms. Encourage the students to use the database on the CD-ROM throughout the period as they observe their miniecosystems.

Using Transparency number 7 to explain the observation schedule and model the log sheet recording.

Students will fill in the date and time of the observation, list the populations and number of each, describe the observed behaviors and interactions, and prepare a careful drawing of anything that would be interesting to students in other classes. The last column is where students should record maintenance and modification information. They should record the temperatures of the aquarium and terrarium and add the data to their charts.

After students have had an opportunity to observe and record data, they attach the record sheet to their miniecosystems. Listen to see if students are scientifically accurate in their use of the words individual,

species, organisms, population, community, ecosystem, biotic, and abiotic.

Set up a rotational schedule for different classes to feed the fish and to add lettuce or carrots to the terrariums. The Teacher Guide has suggestions for adding local organisms and for extending the experience.

<Investigation 4, Introduction>

Narrator: In this Investigation, students are introduced to the elements of an ecosystem and the way in which all parts of the ecosystem are interrelated.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book, video, and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information about the Mono Lake ecosystem.

The Why Do I Have to Learn This? section explains why we chose Mono Lake as the first ecosystem for students to explore.

<Investigation 4, Getting Ready for Part 1>

Narrator: Students are introduced to Mono Lake as an example of an alkaline lake ecosystem.

This is what you will need from the kit: For each group of 4 students, you will need 4 copies of Lab Sheet page 19.

For the class you'll need the video, Of Ice and Fire: A Portrait of the Mono Basin, and the Assessment Chart for Investigations 1 through 4

You will need to provide a map of the United States, and a VCR.

To prepare for this part, you might want to hang a map of the United States and locate Mono Lake on it.

Be sure to watch the 20 minute video before you show it to the class.

<Investigation 4, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Show students where Mono Lake is on the map and direct them to the think questions on page 19 of the Lab Notebook. Encourage students to make a few notes while the video is playing, but not to try to answer the questions thoroughly at this time.

After students have viewed the video, give the groups time to discuss and write complete answers to the items on the lab sheet. Collect the lab sheets at the end of class to check that students understand that Mono Lake is an ecosystem and that they can identify several biotic and abiotic interactions in the ecosystem.

<Investigation 4, Getting Ready for Part 2>

Narrator: In this part, students use arrows to indicate feeding relationships between organisms in Mono Lake. They learn the feeding roles played by organisms in an ecosystem.

This is what you will need from the kit. For each group of 4 students, you will need a set of Mono Lake organism cards. You'll also need 4 copies of Lab Notebook page 21, and 4 copies of Mid-summative Exam 3-4.

For the class you will need from the kit The Populations and Ecosystems CD-ROM. You'll also need Transparency number 8 and the Assessment Chart for Investigations 1 through 4.

For each group of 4 students you'll need to provide paper - recycled paper is fine, scissors, masking tape, and a marking pen

For the class you'll need to provide an overhead projector and a multimedia setup that will allow the entire class to see the food web.

In this part of the Investigation, students will need paper arrows. You can have students cut their own strips for arrows, or you can cut strips ahead of time using a paper cutter. Students will draw their own arrows on the paper strips.

Students will need to access the CD-ROM or go online during this part of the Investigation. You will want students to work as individuals or pairs so plan on scheduling computer time for your classes. At the end of this Investigation, students will take a Mid-summative Exam on Investigations 3 and 4. Schedule about 15 minutes for students to complete the exam.

<Investigation 4, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Give each group a set of Mono Lake organism cards. The students will read the cards to become familiar with the organisms and their natural history. Next, they will organize the cards picture side up and use the paper strip arrows to show feeding relationships between organisms.

The direction the arrow goes shows the direction of the food energy, so for example this indicates that the food value of the planktonic algae is going into the brine shrimp.

When students are finished, point out a food chain, and introduce the concept of food web. Introduce the terms producer, consumer, and decomposer to the students. They will identify examples of each in their food webs. Then they reorganize their food webs to show the levels of feeding roles in the ecosystem. The concept is reinforced by having the students work individually or in small groups with the Mono Lake food-web simulation. When they are done, their finished food web can be printed out.

Students work alone to complete the Mono Lake Response Sheet. This Response Sheet is a Formative Assessment you use to see if students are making sense of the feeding relationships and the feeding roles of organisms in an ecosystem. After students have had time to work alone, lead a class discussion so students can further develop their conceptual understanding of food webs. A Response Sheet scoring guide can be found in the Assessment chapter of the Teacher Guide.

There is a Summative Exam provided for Investigations 3 and 4. When you feel students are ready, allow about 15 minutes for them to complete the exam.

<Investigation 5, Introduction>

Narrator: In this Investigation, students learn that food is produced by photosynthetic organisms, that food contains energy from the Sun, and that food energy moves from one trophic level to another through feeding relationships.

Quickly look over the At-A-Glance chart, paying close attention to the Objectives, Assessment Opportunities, Preparation, an outline of steps for conducting the Investigation, and opportunities for using the Resource book.

Be sure to read through the Scientific and Historical Background pages for additional information about photosynthesis, energy transfer between trophic levels, and the unit used to measure heat energy – the calorie.

The Why Do I Have to Learn This? section provides students with information on how energy starts with the sun and ends up as the food they eat.

<Investigation 5, Getting Ready for Part 1>

Narrator: In Part One, students burn snack foods and calculate calories to confirm that there is energy in food.

This is what you will need from the kit. For each group of 4 students, you will need: A 15 by 15 centimeter aluminum foil square, 1 regular paper clip, 1 match striker, a medium binder clip, a dowel stand - which includes the dowel, ring, and base, a vial and cap, and a thermometer.

You'll also need 4 copies of Lab Notebook pages 22 and 23.

In addition, for the class, you'll need 8 15 by 15 centimeter aluminum foil squares. You'll need Transparency number 9 and the Assessment Chart for Investigations 5 through 7.

You'll need to provide for each group of 4 students: 4 safety goggles, 1 cardboard square - 7 by 7 centimeters, snack food, safety matches, and a 25 to 50 milliliter graduated cylinder.

For the class you'll need: a paper cutter or scissors, a utility knife, extra matches, and more of the same snack food. You'll need paper towels and a pitcher of water, and an overhead projector.

Students will be burning a snack food, such as cheese balls. Let administrators and nearby teachers know that they might smell burning food. Make sure that you have goggles available for every student. The classic item burned to demonstrate energy in food, is the peanut, but more and more students are showing serious peanut allergies, so we suggest using cheese balls or another snack food instead.

The kit includes a sheet of striker material. Cut the material into pieces about 6 by 2 centimeters. For each group put a striker and a single match in a vial, and put the cap on. When students are through with the match, they will return it to the vial. If they need a second match, they will exchange their spent match for a new one.

Cut one 15 centimeter square of aluminum foil for each group in each class. These squares are used to make foil cups. Cut 8 additional squares for classes to share. These squares are used to cover the cardboard snack holders. Make some spares in case some of the squares get damaged.

Each group of 4 students will need a cardboard snack holder like this one. The same snack holders can be used from class to class. Here's how you make one. Use a paper cutter to cut a 7 centimeter cardboard square. Use a utility knife to cut a short slit in the center of the square. The slit needs to be perpendicular to the flutes, to hold a paper clip securely. To finish the snack holder, open a regular paper clip into a "C" shape. Bend the 2 loops up at 90 degrees. Slide the smaller loop into the slit in the cardboard. Cut one of the 15 by 15 centimeter foil squares in half to make two rectangles. Cut a slit in the rectangle and fold it over the cardboard for fire protection. Push a cheese ball over the loop, or insert a snack into the large loop. If necessary, squeeze the loop together a bit.

Each group will make and use an aluminum foil cup. Practice making a cup and setting up the holder, so that you'll be able to demonstrate the steps when you introduce the procedure to students in session 2. To form an aluminum cup, carefully mold the aluminum foil square around a vial. Be careful not to make holes in the foil. Begin by bringing all 4 corners up to the top and then gently form the foil to the vial. Don't wrap it around the vial, this will cause the water to leak out, and don't smooth out the foil too much, this causes tiny pinholes and the cup will leak. Squeeze the dowel stand ring a bit and insert the ends into the binder clip. Slide the ring and clip assembly down over the dowel so that it is about 10 cm above the base. Spread the top of the foil cup a bit to make a flange to hold the cup in the ring. Drop the cup into the ring holder. Slide the snack holder with its food sample under the cup. Slide the clip up or down a bit until the distance between the snack and the bottom of the cup is about 1 and one-half to 2 centimeters.

It's a good idea not to have the food sample under the cup when students add the water. If the cup leaks, it will get the food sample wet and both a new cup and a new food sample will be needed. Students move the food sample back under the cup once they are sure that the cup isn't leaking. Be sure to practice assembling and setting up the cup holders, and burning the snack before you do this with your students.

Part 1 is taught in 3 sessions. In the first session, students only need a snack holder, snack, and matches. In the second session, students also need the aluminum foil cups, supports, and water measuring tools. No equipment is needed for the third session of Part 1.

<Investigation 5, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

In session 1, students begin with a Quick Write on "How does your body get energy to do what you want to do?" Collect the quick writes. Use the quick writes as a Formative Assessment. Read them to identify students' misconceptions, but don't grade them. Students will have the opportunity to make revisions at the end of Part 3 of this Investigation.

Students discuss food as an energy source and are introduced to burning as a way to test food to see if it contains energy. Because this part of the Investigation involves an open flame, students should wear goggles; they should clear their desks of all materials, and make sure long hair is tied back.

Students burn their snack food and discover that, yes; there is energy in the snack. Groups brainstorm a procedure to measure the energy given off by the burning food. After confirming that a burning snack food can be used to heat water, students are shown a water heating system. They will assemble the system in the next class session.

In the second class session, students make an aluminum foil cup and assemble the water heating setup. They use a graduated cylinder to carefully measure 20 milliliters of water and pour it into the aluminum foil cup. Students record the beginning temperature of the water. After the snack food is burned, students record the final temperature of the water. The soot on the foil cup is very messy. Carefully remove the cup and throw it away without touching the bottom. Keep the cardboard squares for next year.

In the third session, students review the temperature change they observed in the water, and calculate the calories in their snack food. Students will notice that their calculations seem off. By their calculations they would only need 2 to 4 cheese balls a day. They learn that they have calculated scientific calories and when nutrition scientists describe the energy in food, they are using food calories, or kilocalories. One food calorie is equal to 1000 small or scientific calories. Their calculations are correct.

Students compare their results to the calorie information on the generic food label on Transparency 9. They suggest sources of experimental error.

Collect the student Lab Sheet page 23. Check to see if students have collected and organized data, performed accurate calculations, and described the calorie accurately. Use the answer sheet and the scoring guide in your teacher guide to assess student progress.

<Investigation 5, Getting Ready for Part 2>

Narrator: In this part, students discover that photosynthesis is the process that produces energy-rich biomass called food.

This is what you will need from the kit. For each group of 4 students, you'll need 4 Student Resource books and 4 copies of Lab Notebook page 25.

For the class you will need from the kit Transparency number 10 and Transparency number 11, and the Assessment Chart for Investigations 5 through 7.

You'll need to provide an overhead projector and transparency markers.

To prepare for this part, look over the experimental data on Lab Notebook page 25 to become familiar with the data, and Transparency number 11, to become familiar with the content information.

<Investigation 5, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Students begin by discussing human food webs. Ask them, "What do plants make food out of?" and "What materials do plants need to produce food?"

Students answer this last question by looking at the experiment described on Lab Notebook page 25. Students analyze the data, then complete the results and conclusion questions. Next, the class discusses the results of the experiment, and the process of photosynthesis is introduced using Transparency 11. Expand the concept of photosynthesis with the reading, *Where Does Food Come From?*, starting on page 14 of the Student Resource book.

Collect the student sheet at the end of the class session. Check that students are able to correctly calculate mass changes and that they conclude that producers add mass only when they are supplied with water, carbon dioxide, and light.

<Investigation 5, Getting Ready for Part 3>

Narrator: In Part 3, students learn that all organism functions require energy.

This is what you'll need from the kit. A one-liter zip bag and small paper clips, a copy of pages 364 – 367 Special Teacher Masters Energy-Use Strips, and the Assessment Chart for Investigations 5 through 7

You'll need to provide a 25 to 30 centimeter strip of masking tape for each group of 4 students.

To prepare for this part, you'll need to make copies of the energy use strips. Decide if you want to reuse the strips from class to class. Because students will be taping the strips onto the board or chart paper, it might be easier to make copies for each class period instead of reusing the strips for each class. Each group gets 4 to 6 strips depending on the number of groups in your class. You will need to make headings for the 4 categories of energy use: Movement, Maintenance, Waste, and Growth/Reproduction.

If you stack one copy of each sheet and then cut all four sheets at once, each stack of 4 strips will have one strip from each category. The small stacks can be held with a paper clip and placed in an envelope or zip bag for each class period.

Locate the student quick writes from Part 1. You will be returning the quick writes and having students revise their original ideas.

<Investigation 5, Conducting Part 3>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

After students review the relationship between food, energy, and calories, have them brainstorm what kinds of work they do that require energy. As students share examples, write their ideas on the board. After you have 10 to 12 ideas, stop and have students suggest several categories that their ideas could be grouped into. Be sure to refer to the Teacher Guide, for suggestions for facilitating the discussion.

Make sure that the categories of Movement, Maintenance, Waste Production, and Growth and Reproduction are introduced, and post them on the board. Students will tape the strips under the headings so be sure to leave enough room for several students to be at the board at the same time.

Pass out the energy use strips and some masking tape to each group. The group decides which category the word or phrase belongs in, and sends one member up to the board to post the strip. It's OK if they make mistakes in their posting. The strips can be moved during the class discussion. When all the strips

have been posted, quickly go through the list under each category. There will be differences of opinion about where several strips should be placed. Let students suggest reasons for moving strips. If the reasoning is sound and the class generally agrees, move the strip.

Return the quick writes from Part 1. Students read through their answers and number ideas or sentences they wish to comment on or revise. Students can use the rest of the page to write about the ideas they've numbered, explaining how their thinking has changed, what additions they might want to make, or what they have learned that supports their original ideas. Collect the revisions and use the scoring guide in your Teacher Guide Assessment chapter to assess student progress.

<Investigation 5, Getting Ready for Part 4>

Narrator: In Part 4, students describe the movement of food energy from organism to organism in a food web, learning about the efficiency of transfer across trophic levels.

This is what you will need from the kit. For each group of 4 students, you will need: a set of Mono Lake organism cards, a container of colored beads, and 20 chenille stems about 5 inches long. You'll also need 4 Student Resource books.

For the class you will need: 1 uncut chenille stem, and 1 brown bead. You'll need Transparency number 12 and the Assessment Chart for Investigations 5 through 7. Finally, you'll need copies of the Mid-summative Exam for Investigation 5

For the class, you'll need to provide a coat hanger, a pair of old scissors or tin snips, and an overhead projector.

Put this combination of beads into each of the ten half-liter containers -use the vials in the kit to measure the two shades of green beads: 1 vial of dark green beads, 1 vial of light green beads, 10 red beads, 10 black beads, and 2 gray beads. Nest the half-liter container of beads or put each container in a plastic bag with 20 chenille stems. The chenille stems come in 12-inch lengths. They need to be cut into 2 5-inch lengths. 20 of the 5 inch stems go with each set of beads. Prepare a few examples of beads on the chenille stems for students to see. If you have 2 extra sets of beads ready they can be used to complete the model if students don't complete enough.

At the end of each class, return the beads to the groups to be taken apart. Students need to carefully remove the beads from the stem and return them to the containers. They should also straighten the chenille stems. Groups do not need to take apart the exact beads that they assembled.

<Investigation 5, Conducting Part 4 – Session 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

After a quick review of food and food web roles, distribute the Mono Lake organism cards to each group, and ask the students to lay them out in a representative food web with producers at the bottom. Introduce trophic levels. Students will trace the energy through a food chain. Ask students: "Is all of the food energy consumed by a primary consumer, such as a brine shrimp, transferred to the secondary consumer, like a gull, when the brine shrimp is eaten?"

“For instance, if a brine shrimp eats 10 grams of algae in its life before the gull eats it, does the gull get 10 grams of food energy when it eats the brine shrimp?”

Students should keep these questions in mind as they read the article Trophic Levels in their Student Resource books. In their reading, students are introduced to the 10% rule: An average of about 10% of the energy consumed at a trophic level is incorporated into body tissue and/or offspring at that level. Only 10% of the food energy consumed at one trophic level is available as food - or biomass - for the next trophic level.

Students draw a Mono Lake food chain with the planktonic algae, benthic algae, brine shrimp, brine fly, California gull, and coyote, showing the production of biomass at each level. They can use the organism cards to help them.

<Investigation 5, Conducting Part 4 – Session 2>

Narrator: Give each group a container of beads and chenille stems, and use Transparency 12 to show the key to the bead colors.

Students use their beads to make 1 kilogram biomass models of brine flies and brine shrimp and the algae to support them. Each bead represents 1 kilogram of biomass of the organism, not 1 organism. Next, each group uses their fly and shrimp models to assemble a model of the biomass needed to support 1 kilogram of gull biomass. Finally, collect the 1 kilogram gull models from each of the 10 groups and assemble them on a coat hanger. The completed class model represents the amount of biomass needed to produce 1 kilogram of coyote biomass at the highest trophic level in the Mono Lake ecosystem. Leave students with this hypothetical question: “How much algae would it take to provide the food energy to make 1 20-kilogram coyote, if the coyote only ate Wilson’s phalaropes?”

When you think students have a good understanding of the concepts, give Mid-summative Exam 5. It should take about 10 to 15 minutes for students to complete the exam. See the Assessment chapter of your teacher guide for the scoring guide.

<Investigation 6, Introduction>

Narrator: In this Investigation, students explore some of the variables in an ecosystem that limit population size. They’ll use their milkweed bug populations they’ve been observing since Investigation 1.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information about population dynamics, reproductive potential and limiting factors.

The Why Do I Have to Learn This? section describes population dynamics and the problems of overpopulation here on Earth.

Students have been observing their milkweed bugs for several weeks now. They will have seen eggs laid and hatched. The young milkweed bugs are now crawling all over the habitat.

<Investigation 6, Getting Ready for Part 1>

Narrator: In Part 1, students calculate the potential population growth of their milkweed bugs. Students will need their Lab Sheets describing their observations of the milkweed bugs from Investigation 1.

This is what you'll need from the kit. For each 4 of four students, you'll need 4 copies of Lab Notebook pages 27, 29, 31 32, and page 33.

For the class you will need the Populations and Ecosystems CD-ROM. You'll also need Transparency 13 and Transparency 14, and the Assessment chart for Investigations 5 through 7.

For each group of 4 students, you'll need to provide a calculator. For the class, you'll need an overhead projector and a multimedia setup so all students can see the milkweed bug simulation in the multimedia. You'll also want to have internet access.

To prepare for this Investigation, read through the milkweed bug lab experiment to become familiar with the format of each sheet and the major concepts. Also preview the multimedia simulations. The simulations will have greater impact if students can work at computers as individuals or in small groups.

<Investigation 6, Conducting Part 1 – Session 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Ask students if they have a population of milkweed bugs in their habitat bags, and if the population will continue to grow. Ask them to determine what they would need to know in order to predict how large the population of milkweed bugs will be at the end of one 1.

The Lab Sheets have some basic information about the lives of milkweed bugs. The students use this information to predict how many milkweed bugs will be in the population after one 1, if they start with 1 male and 1 female.

Use Transparency 13 to demonstrate how to calculate the first couple of generations. Then let students work in their groups to complete the calculations. Clearly in the real world, the population does not increase at this calculated rate. Introduce limiting factors and ask groups to list things that would limit the milkweed bug population.

<Investigation 6, Conducting Part 1 – Session 2>

Narrator: Have the students work with the multimedia, to experiment with various limiting factors, such as habitat size, percentage of females, clutch frequency, number of eggs, and the survival rate of eggs.

<Investigation 6, Conducting Part 1 – Session 3>

Narrator: Next, students analyze the results of a milkweed bug hatching experiment to see if humidity, light, or temperature affect the hatching of milkweed bug eggs. Collect the student Lab Sheets and use the scoring rubrics in your Teacher Guide to see if students can process the data efficiently and reach valid conclusions.

<Investigation 6, Getting Ready for Part 2>

Narrator: For Part 2, students analyze data from lab experiments to determine the effects of abiotic factors on population size.

This is what you will need from the kit. For each group of 4 students, you will need: 4 Student Resource books, and 4 copies of Lab Notebook pages 34 to 36, and 4 copies of Lab Notebook page 37. For the class you will need from the kit a copy of the Assessment Chart for Investigations 5 through 7

To get ready for this part of the Investigation, read through pages 34 to 36 in the Lab Notebook to become familiar with the design of the experiment. It is important for students to understand that the experiments took an entire year to complete.

<Investigation 6, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Have students recall the Mono Lake community and the key organisms that act as producers, primary consumers, and secondary consumers. Give students time to read the experimental setup and procedure described on pages 34 and 35 of the Lab Notebook.

Have students work in groups to analyze the data and record answers to the questions on page 37. As students work, you might need to help them focus their thinking by asking one or more of the strategic questions in the Teacher Guide.

After students have had time to work, ask them to share their group's conclusions about the effects of light and temperature on the two populations from Mono Lake.

At the conclusion of this part of the Investigation, have students read the article, Limiting Factors, in their Student Resource book. Collect page 37 from their Lab Notebooks and use the answer sheet and the scoring sheet in your Teacher Guide to assess students' ability to analyze and discuss the factors that affected algae and brine shrimp populations in this controlled laboratory setting.

<Investigation 6, Getting Ready for Part 3>

Narrator: Up to this point students have been looking at theoretical population growth, and laboratory data. Now in Part 3, they are going to look at real data collected from the field. They determine that both biotic and abiotic factors can affect population sizes.

This is what you'll need from the kit. For each group of four students, you'll need: 4 copies of the Resource book, 4 copies of lab notebook pages 38 through 41, and 4 copies of Mid-summative Exam number 6.

For the class you'll need Transparency number 15. You'll need to provide an overhead projector. To get ready for this part, look over Transparency 15 to prepare for the class discussion.

<Investigation 6, Conducting Part 3>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Students predict the populations of planktonic algae and brine shrimp at Mono Lake over the course of a year. Then they study the graphs on Lab Notebook pages 38 through 40 and see how accurate their predictions were compared with the real data. Students will identify limiting factors as they learn that

ecosystems are dynamic and always changing. They will discuss and support their ideas as they respond to questions on Lab Notebook page 41.

The article, Mono Lake in the Spotlight, from the Resource Book introduces students to stresses that can be placed on an ecosystem. Extension activities give students the opportunity to explore limitations on populations in environments different from Mono Lake.

There is a Summative Exam provided for Investigation 6. When you feel students are ready, allow about 15 minutes for them to complete the exam. You'll find the answer sheet in the teacher guide.

<Investigation 7, Introduction>

Narrator: In this investigation, students are introduced to 10 new ecosystems in the United States and Puerto Rico. Each group of students will research an ecosystem, and report on pressures that could threaten that ecosystem.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information about each of the ecosystems featured in this Investigation, their similarities, and the impact of humans.

The Why Do I Have to Learn This? section provides information on why preserving native habitats is important for the health of an ecosystem.

<Investigation 7, Getting Ready for Part 1>

Narrator: This is what you'll need from the kit. For each group of 4 students, you'll need: a set of ecoscenario cards, 4 Student Resource books, and 4 copies of Lab Notebook pages 42 through 44, and pages 46 through 47.

For the class you'll need the Populations and Ecosystems CD-ROM.

For each group of four students, you'll need to provide presentation materials such as poster board, colored marking pens, construction paper, string, tape, glue, and scissors. You might also want to provide books on ecosystems.

For the class, you'll need to provide a multimedia setup that will allow the entire class to see how to navigate to the ecoscenarios on the CD or online, and internet access for groups of students. You can also print out PDF files on each of the ten ecoscenarios from the CD-ROM or from the Internet. You'll find additional suggestions on accessing the research information in your Teacher Guide.

Students need to access information on the internet for this investigation. The Getting Ready section of the Teacher Guide has suggestions on how to structure your class depending on the number of computers your students have access to and the amount of time available for computer use. If Internet and computer access is limited, print out the ecoscenario PDF files from the CD-ROM or from the internet.

Decide how to assign the ecoscenarios to groups. You can have groups randomly draw ecosystems,

assign them yourself, or have groups sign up for specific ecosystems. Start to assemble a folder for each ecosystem. Request printed materials from government agencies and conservation organizations. Print out additional material from websites. Look for books, magazines, and newspaper articles about the ecosystem location.

You will find a list of suggested print and web resources in the Resources chapter of the Teacher Guide.

Review the project guidelines in the Lab Notebook and decide which activities you would like students to do. Then, depending on the amount of time you want to devote to this Investigation, determine a timeline for each part of the project.

<Investigation 7, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Introduce the ecoscenario project by reviewing the Mono Lake ecosystem and having students talk about other ecosystems they've heard of. Ask students to open the Resources books to the Ecoscenario Introduction article to read about each of the new ecosystems.

After the ecoscenarios have been assigned, use pages 42 through 44 of the Lab Notebook to preview the project guidelines. Show students the resources that they will use and the timeline for completing the project. If students are using the ecoscenario section on the CD or online at fossweb.com, they will navigate to the map and select their ecosystem. From here they can access information, link to other websites, and complete a food web. Students spend the next few days researching their ecoscenario and preparing group posters and individual reports.

As groups make their ecoscenario presentations, the other students will use Lab Notebook pages 46 and 47 to record a few key notes about each ecosystem. The Conducting Ecoscenarios section of your Teacher Guide has additional information on presentation formats. At the end of the presentations, be sure to wrap up the Investigation by having students reflect on what they have learned. Possible discussion topics are listed in the Teacher Guide.

See the Assessment chapter in your teacher guide for scoring guides to help assess the poster produced by each group and the report produced by each student. Extension activities give students the opportunity to explore local environmental issues.

<Investigation 8, Introduction>

Narrator: In Investigation 8, students learn about the concept of adaptation, and study the impact of predation on insects in different environments.

Look over the At-A-Glance chart, paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book, video, and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information about adaptation, and the origin of variation in organisms.

The Why Do I Have to Learn This? section provides information on typical student misconceptions about how adaptations and variations in a population occur.

<Investigation 8, Getting Ready for Part 1>

Narrator: In Part 1, students learn about adaptations and identify adaptations that affect the survival of organisms on the island of Hawaii.

This is what you'll need from the kit. For each group of 4 students, you'll need 4 student resource books and 4 copies of Lab Notebook page 42

For the class you'll need: copies of the Special Teacher Masters Kelp Fish, Kelp Environment, and Rocky Environment, Transparency number 16, and the Assessment Chart for Investigations 8 through 10. You'll also need the Video, Hawaii: Strangers in Paradise, a paper clip, and the CD-ROM. You will need to provide 4 sheets of notebook paper for each group of 4 students. For the class, you'll need to provide 1 8 ½ by 11 inch sheet of paper and masking tape. You'll also need to provide an overhead projector, a TV and VCR, and a multimedia setup so all students can see the octopus video clip in the multimedia database.

To prepare for this part, copy the special teacher master called Kelp Fish. Carefully cut around the picture. Straighten the paper clip, keeping a little angle bend at the tip. Tape the straightened paper clip to the back of the fish cutout. Photocopy the Special Teacher Masters called Kelp Environment and Rocky Environment and tape them to the board. Tape a blank sheet of paper next to them to represent a Sandy environment.

During the classroom demonstration, the fish will “swim” from the kelp to the rocks to the sand. Preview the multimedia so that you are familiar with the features and navigation pathways of the Octopus demonstration and the predation simulations.

<Investigation 8, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide

Start this part of the Investigation by having students respond on paper to the Quick Write question: “What does the word adaptation mean to you? Give examples to support your ideas.”

Collect the quick writes. Use the quick writes as a Formative Assessment. Read them to identify students' misconceptions, but don't grade them. Students will have the opportunity to make revisions at the end of Part 2 of this Investigation.

Point out and identify the three marine environments posted on the board. Introduce the kelp fish into each of the environments for a few seconds. Ask students to comment on what they observe when the fish is in each of the environments. This last question is pivotal. Listen carefully to see what their ideas are concerning the origin of adaptations.

Write the definition of adaptation on the board, and have students read the article, Adaptations, in their Student Resource books. Using the Populations and Ecosystems CD-ROM and your multimedia setup show students the short clip of the octopus changing color. Play the video several times so students can see the octopus blend into its surroundings as it changes color. See the Teacher Guide for specific questions to ask the students as they observe the color change.

Ask students to recall 1 of organisms they studied in their ecoscenario from the last Investigation. Have students list 3 different adaptations that their organism has for surviving and reproducing successfully. Give students time to share the adaptations they came up with.

Introduce Hawaii as an example of a unique ecosystem because it's an isolated group of islands. Use Transparency 16 to preview the 8 organisms students should pay particular attention to as they view the video Hawaii, Strangers in Paradise. As they view the video, students should respond to the questions on page 49 from the Lab Notebook. It might take two class periods to watch the 60 minute video.

At the end of the video, have students select one of the Hawaiian organisms and write a one-page report on the adaptations that organism has that affect its ability to survive and reproduce in its environment. Finish up this part of the Investigation by having students identify the adaptations each of the 8 Hawaiian organisms have and how those adaptations help each organism survive and reproduce. They should also be able to give an example of an adaptation that has worked to an organism's disadvantage as the environment in Hawaii changed.

Collect the Strangers in Paradise Lab Sheet and use the answer sheet in the Teacher Answer chapter and the scoring guide in the Assessment chapter to see if students have identified and understood adaptations that affect the survival of the Hawaiian organisms. Note student progress on the Assessment chart for Investigations 8 through 10.

<Investigation 8, Getting Ready for Part 2>

Narrator: In Part 2, students work with a simulated population of walkingsticks to investigate the impact of predation on the insects in three different environments.

This is what you will need from the kit. For each group of four students, you'll need: 4 copies of Lab Notebook pages 51, 52, and 53, and 4 copies of Mid-Summative Exam 8.

For the class you'll need a Walkingstick El Yunque organism card, and the Populations and Ecosystems CD-ROM. You'll also need Transparencies number 17, 18, and 19, and the Assessment Chart for Investigations 8 through 10.

For each group of 4 students, you'll need to provide colored pencils or pens, and their quick writes from Part 1. For the class you'll need to provide an overhead projector, and multiple computers or Internet access so students can access the multimedia as individuals or in small groups. This part is most effective if students can work at computers in pairs or as individuals. Schedule the computer lab if possible, or rotate groups through multiple computers in your classroom or the school library.

To prepare for this part of the Investigation, look over the Walkingstick Predation Simulation on the FOSS CD-ROM or on the online multimedia. Practice navigating levels 1 and 2. See the Getting Ready part of your Teacher Guide and the CD-ROM User's Guide chapter for specific directions.

<Investigation 8, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide

Use Transparency number 17 to introduce the Walkingstick simulation. Read the natural history information from the Walkingstick organism card to explain that walkingsticks come in different shades

of greens and browns. Have students follow along on Lab Notebook page 51, as you demonstrate the use of the first-level simulation on a classroom computer.

Open the multimedia to “Walkingstick Predation.” Click on “Level 1 – Eat Insects.” Choose “30 Clicks.”

The person using the simulation takes the role of a bird looking for walkingsticks living in a bush environment. Students will use the simulation to try to eat as many walkingsticks as they can by putting the pointer on a walkingstick and clicking the mouse button. They only have 30 clicks to catch as many walkingsticks as they can. When students are done with their 30 clicks, they can select the “See Insects” button to see where the surviving walkingsticks are. They will click “Results” to see how many of each color they ate and how many survived. They will transfer the information to their Walkingstick Predation Sheet.

Students select level 1 again, but this time choose the “30 Seconds to Eat Insects” option. They now eat as many insects as possible in 30 seconds, review the results, and transfer the information to their Lab Sheet. Once students have collected data from the simulation, have them answer the 3 questions at the bottom of the Lab Sheet. Students will share their responses to the questions, and the term “protective coloration” is introduced.

Introduce students to the second level of the simulation by posing a question: If the surviving walkingsticks produced offspring, and birds continued to eat the walkingsticks, what would happen to the populations of walkingsticks and predatory birds in the bush environment.

Students use the Five Generations of Walkingsticks Lab Sheet to record data from level 2 of the simulation. Show students how to navigate to “Find Insects in Three Environments.” Students will select either “30 clicks,” or “30 seconds” to catch as many walkingsticks as possible. In the beginning, everyone selects the bush environment. After running the simulation, students review their results and return to the environment screen clicking “Next Generation.” After completing 5 rounds, students record their results on the Lab Sheet.

Use Transparency 18 to help orient students to their Walkingstick Population Graph Lab Sheet. Students will use their data to make bar graphs displaying the numbers of surviving walkingsticks over five generations to show the population changes over time. Once the graphs are made, have students analyze the results, then introduce the terms “feature” and “trait”. Students return to the walkingstick simulation to investigate 1 of the other 2 environments: Wood chips or bamboo. After they collect their data, they share their results and finish graphing their data on their Lab Sheets.

Use Transparency 19 to guide a discussion with the students about the results of predation. Introduce the term “variation” to explain how populations are able to survive even if the environment changes or if the population is displaced to a new environment.

Students are now able to compare and contrast the adaptations of the walkingstick and the octopus that they saw in the first part of this Investigation. See the Teacher guide for suggested questions to facilitate this discussion.

Return the quick writes from part 1 of this Investigation and have students comment on their original ideas. Give students an opportunity to correct, modify, add to, or delete items from their quick writes.

Collect the corrected quick writes and use the scoring guide in the Assessment chapter to assess student progress.

There is a Summative Exam provided for Investigation 8. When you feel students are ready, allow about 15 minutes for them to complete the exam. The answer sheet is in the Assessment chapter of the Teacher Guide.

<Investigation 9, Introduction>

Narrator: In Investigation 9, students learn the basic genetic mechanisms that determine the traits expressed by individuals in a population by breeding imaginary animals called larkeys. They learn how organisms inherit traits from their parents, and how dominant and recessive alleles interact to produce traits in a population.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information about the genetic transfer of information, the pioneer work on heredity by Gregory Mendel, and using Punnett Squares to predict characteristics of offspring.

The Why Do I Have to Learn This? section provides information on typical student responses to the Investigation and information about the need for students to understand the basics of genetics.

<Investigation 9, Getting Ready for Part 1>

Narrator: In Part 1, Variation of Features, students look at four of their features to determine what trait they have and determine the distribution of the four traits in the class. They also study a population of larkeys determine their traits.

This is what you will need from the kit. For each group of 4 students, you'll need 4 Populations and Ecosystems Resources books. For the class Transparencies 20 and 21, And the Assessment Chart for Investigations 8 through 10

You'll need to provide scratch paper for each group of 4 students. For the class you'll need to provide a red permanent marking pen, an overhead projector with transparency markers, and some mirrors.

Students will be investigating 4 features of the human body: little fingers, ears, tongue, and hairline.

Pinky fingers are either straight or bent at the last joint. Bring your hands together like this to determine this trait. Here's an example of straight fingers. This is an example of bent fingers.

Earlobes are either free hanging or attached to the side of the head. This is an example of free hanging earlobes. Here's an example of attached earlobes.

Can you roll your tongue or not? Here's an example of tongue rolling. This is an example of someone who can't roll their tongue and believe me she's really trying.

Do you have downward point on your forehead hairline? If so, it's called a widow's peak. This is an

example of a widow's peak and here's an example of a flat hairline.

You might want to find examples in your class to help students determine their own traits.

Use a red permanent marker to color in the eyes of these two larkeys on transparency 21. Look at the larkey yammer on pages 56 and 57 in the Student Resource book and review Step 8 of conducting the Investigation to decide how you will assign larkeys to your students. Each student will represent 1 of the larkeys. It's not necessary to assign all 32 larkeys if you have fewer than 32 students. If you have more than 32 students, start over with number 1 and continue until every student has a larkey.

<Investigation 9, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide

Remind students of the walkingstick simulations from the last Investigation. Point out that while the walkingsticks all had the same features: size, shape, color, legs, and so on, one feature varied – color. Walkingsticks were not all the same color. Difference in a feature is variation. Walkingsticks vary in color – some are brown, some are green, and some are in between. The variation an individual has is a trait of that individual. Point out to your students that while all walkingsticks have the feature of color; only some of them have the green trait.

Ask students if there is variation among humans and have them look at the 4 features on themselves: little fingers, ears, tongue, and hairline. After students have determined their trait for the 4 features, use Transparency 20, Features and Traits to poll the class, recording the results on the transparency. After all of the traits are recorded on the transparency, have students consider the results: “Is there variation in the classroom population?” “Which trait occurred most often for each feature?” “Are any traits linked?” Yes, there is variation in human populations. Variation is what makes every individual different from everybody else.

Use Transparency 21 to introduce the little make-believe dog-like rodents called Larkeys. Have students point out the 4 larkey features that show variation. Their legs can be either long or short. Their eyes red or gray. Their fur can be spotted, striped, or solid. And their tails bushy or bare. Once students can recognize these traits, have them open their Resource books to pages 56 and 57. The word to describe a group of larkeys is yammer. There are 32 larkeys in this yammer.

Assign one larkey to each student and have them study their larkey's traits. Using the bottom chart on Transparency 20, poll the students to collect data on the traits of the larkey yammer. If you use all 32 larkeys, your chart will look like this.

Have students revisit their graphs from Investigation 8 showing the walkingstick population change after birds ate the various colors of walkingsticks. Have them discuss what happened after several generations. Your Teacher Guide has various questions to engage your students in this Investigation. These and other questions will be explored in the next part of the course.

To assess this part of the Investigation, watch students to see how well they work together.

<Investigation 9, Getting Ready for Part 2>

Narrator: In Part 2, students are introduced to the structures and mechanisms of heredity, and practice

decoding the genotype of a larkey to discover its traits.

This is what you will need from the kit. For each group of 4 students, you'll need: 4 Student Resource books, and 4 copies of Lab Notebook page 55.

For the class you'll need: Transparency 22, Transparency 23, Transparency 24, , Transparency 25, and Transparency 26. You'll also need the Assessment chart for Investigations 8 through 10. For the class you'll need to provide overhead transparency markers, including red, and an overhead projector

Part 2 is a mini-lecture supported by the 5 transparencies that you'll use as visual aids during the introduction to the structures and process of genetics. You'll need to look at the 5 transparencies to see how they will be used during the lecture. Also look at the Student Lab Sheet, Genetics Vocabulary, and the Reading, From Mendel to Human Genome to see how they help students with the concepts presented in the lecture.

<Investigation 9, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide

Start out by introducing students to inheritance – the process of passing genetic information from 1 generation to the next.

Use Transparency 22, Animal Cell, to point out how DNA is coiled into structures called chromosomes inside the nucleus. This drawing on Transparency 23, shows the nucleus of a cell from our make-believe animal, the larkey. Use it to show that there are 8 chromosomes of different lengths. You'll see that the chromosomes come in pairs, so there are 4 pairs of chromosomes. Next point out the dark areas. Both of the chromosomes in a pair have dark areas in exactly the same location. These dark areas are called alleles. The 2 alleles on the paired chromosomes work together as a gene.

This is a big idea in genetics, so be sure to restate the structure/function arrangement. Nuclei contain chromosomes. Chromosomes come in almost identical pairs. Chromosomes have specific active locations called alleles. The 2 alleles in identical locations on paired chromosomes constitute a gene. A gene controls a trait.

This gene could be the one that determines the larkey's eye color, or perhaps the pattern of its fur. Let's say it determines eye color. Use Transparency 25, Gene Locations, to introduce Larkey genes. The larkey has 4 features of interest to us. Each feature is controlled by a single gene. Each of the 4 genes is on a different chromosome.

See these alleles labeled with the letter "A"? That stands for appendages or legs. These 2 alleles on this pair of chromosomes make up the gene for appendages. The gene for eye color is on these 2 chromosomes, the gene for fur pattern is here, and the gene for tail type is on these 2 chromosomes.

The alleles are the code that determines the traits of the larkeys. This chart at the bottom is the larkey genetics code. Some of the alleles are labeled with uppercase letters and some are lowercase letters. For this particular larkey, the alleles for legs are lowercase a's, the alleles for eye color are an uppercase E and lowercase e, the alleles for fur pattern are both uppercase F's, and the alleles for tail shape are both lowercase t's.

The combination of alleles in an individual organism's chromosomes is that organism's genotype. The genotype lists the paired alleles that are particular to that individual. This is the genotype of 1 of the larkeys in the resources book. Alleles don't have equal influence in determining traits. Some alleles have more influence and are called dominant alleles. They are represented by an uppercase letter.

Use Transparency 26, From Genotype to phenotype to show students how to transcribe the alleles to the genotype box and how that combination determines the larkey's traits. This table has 3 columns. The left one has the 4 alleles this larkey got from its mother and the right column has the 4 alleles it got from its father. Transcribe the alleles into the genotype box at the top of the sheet. Use the convention of listing the dominant allele -the uppercase letter- first, no matter which parent it comes from. The genotype box should look like this. The middle column shows all the possible combinations of alleles and the traits that result from each combination.

The alleles that make up our larkey's gene for leg length are 2 recessive alleles, so according to the chart, our larkey will have long legs. The combination of alleles for eye color shows that our larkey has red eyes. The fur pattern will be striped, this is an example of partial dominance. Three different traits are possible, depending on the combination of alleles. And the tail will be bare. This is what the larkey with this genotype looks like. The way a larkey looks is its phenotype.

Students will use the new vocabulary they've learned to complete Lab Sheet page 55, Genetics vocabulary.

Finally, have students read the article in their Resource book, From Mendel to Human Genome: Solving the Heredity Puzzle. Give students time to update their vocabulary glossary using the Ecosystems glossary from page 8 of the Lab Notebook, or using whatever method you have been using. Collect the Genetics Vocabulary sheet and note if students are using proper vocabulary and identifying genetic structures accurately.

<Investigation 9, Getting Ready for Part 3>

Narrator: In Part 3, students use tiles to simulate the transfer of genetic information during larkey breeding.

This is what you will need from the kit. For each group of 4 students you'll need: 2 gene pools in plastic cups, and 8 empty cups. You'll also need 4 copies of Lab Notebook pages 56, 57, 58, 59, and 61.

For the class you'll need: the pink and blue index cards, 4 plastic cups, the 2 Special Teacher Masters - Female and Male Parent Cards, and these transparencies – number 27, number 28, number 29, number 30, number 31, and number 32. You'll also need the Populations and Ecosystems CD-ROM, and the Assessment chart for Investigations 8 through 10.

You'll need to provide red pencils or pens for each group of 4 students. And for the class: scissors and pink and blue copy paper. You'll also need a multimedia setup and an overhead projector with transparency markers.

You will need to prepare the gene pools that students use to create their larkey genotypes. The kit contains sheets of die-cut letter tiles. There are 8 different letters: Upper case A, E, F, and T and lowercase a, e, f, and t. To prepare the gene pools, stack the sheets one on top of another and remove the

outer border. Now you can remove one complete set of tiles at a time and place them in the gene pool cup. To prepare the gene pools, place 8 of each different letter for a total of 64 tiles in a cup for each pair of students. The gene pools can be stored in zip bags when the Investigation is over.

Copy enough of the Female and Male Parent Cards so that each pair of students in every class will have 1 female parent card and 1 male parent card. Use pink and blue copy paper if it is available. Put the female parents in 1 cup and the male parents in another cup. Each pair of students will also need three blue ID tags and three pink ID tags. Cut the colored index cards into fourths to make the tags. It will take about 6 index cards of each color per class to make enough tags. Store the tags in plastic cups until you need them.

Make copies of Lab Notebook page 57, the Larkey Genetics Mat for each pair of students. You can reuse the mats from class to class. Preview the multimedia sections used in this part of the Investigation: The Larkey Breeding Video, the Offspring Genotype and Phenotype, and Impossible Traits.

To access the Larkey Breeding directions from the main menu select “Larkey Breeding Video.” Be sure to review the Larkey Breeding Video so you are familiar with the steps the students will go through to produce the larkey offspring.

Let’s look at the Offspring Genotype and Phenotype next. Students practice breeding 2 larkey parents. They enter their name and class period which will appear on the printout. There are 2 modes a “Practice Mode” and a “Quiz Mode.” In Practice Mode, users try as many answers as they like until the answer is correct. Quiz Mode moves onto the next question after 1 try. Let’s start with the “Practice Mode” each mode presents 5 questions using a pair of randomly chosen larkeys. The parents’ phenotype and genotype are visible. When you click “breed ‘em” each parent contributes a random selection of their alleles in a gamete. Use the pull down menus to indicate the correct genotype and phenotype for this particular offspring. When you’re done, click “Check Answers” to proceed. We’re ready to breed our second pair of parents. After 5 breedings a report appears with the questions, the answers, and the results. Students can print the report.

The last simulation in Part 3 is “Impossible Traits.” Students decide what phenotypes would be impossible in any of the offspring from a particular set of parents. Again there’s a “Practice Mode” and a “Quiz Mode.”

Let’s try the “Practice Mode.” The parents’ phenotype and genotype are visible. If these two larkeys mate, which traits would not be possible in their offspring? Let’s look at appendages first. Can’t remember which is dominant or recessive, check the “Genetics Key.” In this particular breeding short legs and long legs are possible as are red and gray eyes. The only impossible traits are spotted fur and bushy tail. Let’s check our answer, its correct. Just like the Offspring Genotype and Phenotype simulation there are 5 pairs of larkeys to breed in both the practice and quiz modes. After 5 questions a report appears with the questions, the answers, and the results. Use the print button to print the report.

Both the Getting Ready section of this part of the Investigation and the CD-ROM Users Guide chapter will have directions for accessing the multimedia. There are 6 transparencies you will use in teaching this part. Look them over to see how and where they are used.

<Investigation 9, Conducting Part 3>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the

Teacher Guide

Students are now ready to start a family of larkeys, by breeding a male and female larkey. Each pair of students will get a plastic cup of tiles. This is the larkey gene pool. The letters on the tiles represent the alleles for the 4 larkey features. They will also get 2 larkey parent cards showing the genotype of each parent.

You will use Transparency 28, Larkey Parents to point out the genotypes of the parents and describe their traits.

The female has short legs, red eyes, spotted fur, and a bare tail. The male has long legs, gray eyes, striped fur, and a bushy tail.

Have students look at Lab Notebook page 56, Larkey Breeding Record, while you use Transparency 29, Larkey ID Card to show them how to record information about each offspring on an ID card. The genotype of the larkey is recorded in the table on the right. The alleles are recorded in alphabetical order: appendages first, followed by eyes, fur, and tail. Note that the male and female symbols are already printed on the ID cards at the top of the left column. This shows a record for the male. Record the generation in the left column. The parents are the P generation. First-generation offspring are the F1 generation; their offspring are the F2 generation and so on.

Students will be assigned a group number. The group number goes in the last box on the left. Students will record the larkey's phenotype, by drawing the traits on the larkey torso in the center of the Larkey ID card. Have student groups get a gene pool, 4 empty cups, a red pencil, a female and male parent ID card and a larkey genetics mat. Start by having students prepare the female parent's genotype with you. Place one empty cup in the circle on the mat labeled female parent. Look at the 8 alleles that make up the female's genotype. The first two alleles are uppercase A's. Find two big A's in the gene pool and put them in the female parent's cup. Continue reading the alleles in the female's genotype, finding the letters in the gene pool, and transferring them to the cup. When you are done, you should have two uppercase A's, two uppercase E's, two lowercase f's, and two lowercase t's. Complete the female by adding the rest of her information to her ID card. The generation - P for Parent is already on the card. Students need to record their group number, decode the genotype, and draw the phenotype. Now that the female parent ID card is prepared and the alleles describing her genotype are in the female parent cup, it's time to assemble the male parent. This time students should work on their own.

When students have their parent larkeys ready, use Transparency 27, Eggs and Sperm as you describe the process for breeding offspring. Explain that female larkeys produce eggs, and male larkeys produce sperm. During fertilization, the sperm and egg cells join. Each parent passes only 1 of the chromosomes in each pair to the offspring. Use Transparency 30 demonstrate the process for randomly selecting alleles from each of the parents. If you think it'll be useful for your students you can also play the clip called Larkey Breeding Video. Here is how students will conduct the larkey breeding.

Narrator 2: I'm going to put the female parent genotype cup here, and I'm going to randomly select 4 alleles from the cup. I'm going to place those alleles on the mat next to the corresponding feature. T for tail shape, F for fur pattern, E for eye color, and I got another E. That's a duplicate, I already got eye color covered. So I just put that one back into the cup and select another allele until I get one for appendage.

Now I'm going to do the same thing for the male cup. I'm going to randomly select 4 alleles from the

male parent. Here's F for fur pattern, T for tail, A for appendage, and E for eye color. Those are the 8 alleles that will make up the female offspring.

Now I'm going to go to the gene pool cup and I'm going to select tiles to duplicate these alleles. I'm going to put those duplicates right next to the first ones I put down. Now I'm going to take an empty cup and I'm going to pick up the 8 alleles. Those 8 alleles make the female offspring I'll want to remember that so I'll put this pink tag with "F1" written on it in the cup and then I'll put that off to the side.

Now I have to put these alleles back into their original cups. So I'll pick up these 4 from the female parent and put them back into the cup so the female parent's genotype is complete and do the same thing for the male parent so that the male parent's genotype is complete.

Then I'll make a male offspring in the very same way, the only difference being that when I have the 8 alleles in the male offspring cup I'll put a blue tag with "F1" in that cup to designate that that is the male.

Narrator: Once students have completed their two offspring, use Transparency 31, Larkey Breeding Record to describe how to record the genotype and phenotype of the offspring on Lab Sheet 56. First students record the genotype of the male and female parents in the genotype box. Then they decode the genes and draw the parents' traits on the larkey torsos on each card. Next students record the genotype and phenotype of the F1 male offspring in the farthest left box of the second row. The female offspring is recorded on the card in the center of the second row. The third ID card gets filled in later. Each team's male will migrate to another team to breed with the resident F1 female. Call on a couple of students to describe the phenotype of their F1 female. Students soon realize that all the F1 offspring in the class look alike!

Students take a few minutes to figure out why all the F1 females look alike. Every gene in both parents is composed of two identical alleles, therefore there is only 1 combination that each parent can contribute to the F1 offspring. There is a scientific term for a genotype that has identical alleles. It's called homozygous. The alleles can be 2 dominant or 2 recessive alleles. If a gene has 1 dominant allele and 1 recessive allele, it is heterozygous for that gene. Using transparency 32, Larkey Breeding Results, tally the number of times each trait showed up in the population of larkeys in the parent and F1 generations.

Have 1 student from each team report on the male larkeys and the other student report on the female larkeys by holding up their hand if their larkey has that trait. Start with the parent generation and the first trait, short legs. Count the number of hands. Record the number in the first space on the chart. Continue in this manner, recording all 8 traits for the parents. Next record the information for the F1 generation. Because you know what the F1 generation will look like, this is a time for you to quickly assess which students are having problems interpreting the crosses. Students transcribe the data to Lab Notebook page 59, Larkey Breeding Results.

Students will note that none of the F1 generation has long legs, gray eyes, bare tails, striped or spotted fur. This brings up a very important question for students to ponder. "Does this mean that these five traits are gone forever from this yammer of larkeys?" "What will the F2 generation look like?"

Students trade male larkeys with another group and breed for the F2 generation. This trade is to avoid issues with students thinking siblings are mating. Even though this is an exercise in statistics, to students

the larkeys are real. After students have produced an F2 male and female offspring, again use transparency 32 to tally and record the F2 results. This time there will be quite a bit of variation in the results. Your class results will be different from these. Students transcribe the data to page 59 of their Lab Notebooks and discuss the results.

Be sure to look at your Teacher Guide for observations and explanations that your students might observe. If possible have students use the 2 simulations, Offspring Genotype and Phenotype and Impossible Traits to help them understand the concepts of genotype and phenotype. Both simulations have practice and quiz modes.

After students have had time to complete the activities and work with the multimedia, give them Lab Sheet page 61, Response Sheet: Genetic Variation to check their understanding of the basic principles of inheritance. The Assessment chapter has a scoring guide for this sheet.

<Investigation 9, Getting Ready for Part 4>

Narrator: In Part 4, Punnett squares, students learn how to use Punnett squares to predict the probability of offspring traits when the genotypes of the parent larkeys are known. The ideas are reinforced using a multimedia simulation.

This is what you will need from the kit. For each group of 4 students, you'll need 2 gene pools, 8 plastic cups, and the ID cards from part 3. You'll also need 4 copies of Lab Notebook pages 56, 57, 59, 63, and 65, and Mid-Summative Exam 9.

For the class you'll need the Populations and Ecosystems CD-ROM, and Transparency 32, Larkey Breeding Results. You'll also need the Assessment chart for Investigations 8 through 10. You'll need to provide a multimedia setup and an overhead projector and transparency markers for the class.

To prepare for this part of the Investigation, practice navigating the Punnett square simulation. The opening screen shows 16 randomly chosen larkeys. Female larkeys are represented with circles; male larkeys are represented with squares. Click any larkey to display its phenotype and genotype in the upper boxes.

To fill out the Punnett square, click and drag 1 set of alleles from either parent down to the Punnett square. Drag the corresponding alleles from the other parent to the square. Now click and drag each allele into its appropriate box. Having trouble? Roll over the question button, for instructions. Use the pull down menus in the table to record the ratios of phenotype in the offspring. Immediate feedback will appear to the right. The clear button will reset the Punnett square. Pull down the next set of alleles and repeat the process.

<Investigation 9, Conducting Part 4>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Use Transparency 32 from the last part to review the results from the 3 generations of larkeys, and have students predict what might happen in the F3 generation. Introduce Punnett squares by drawing a square on the board and dividing it in half both ways.

Let's say that we have 2 parents who are heterozygous for eye color. We write the alleles of 1 parent on

top of the square and the alleles of the other parent on the left side of the square. Remember that each parent contributes 1 allele to the offspring. The male can contribute either an uppercase E or a lowercase e, and the female can contribute either an uppercase E or a lowercase e.

We can write the 2 allele combinations in the squares to see all the possibilities. I'm going to write the uppercase E first because of convention. Three of the combinations produce the dominant trait because they include the dominant allele. Only 1 combination produces the recessive trait. This exercise tells us that 3 out of every 4 offspring will have red eyes, and 1 out of 4 will have gray eyes.

Another way to say it is that there is a 75% chance of red eyes and a 25% chance of gray eyes, or the ratio of red eyes to gray eyes is on average 3 to 1. What happens with 1 heterozygous parent and 1 homozygous recessive parent? Go over what this Punnett square looks like. In this case, the eye color is 50:50. On average half of the offspring will have red eyes and half will have gray eyes. Students will breed 2 offspring from the F2 generation. They will use their results from the part 3 to fill out ID cards and use the gene pool to reproduce the genotype of their F2 male and female offspring.

Students will swap males with another group and fill out the breeding information on their larkey breeding record. Before students actually breed the larkeys, they will use Lab Notebook page 63, Punnett Squares to record the genotype of the two F2 parents and complete the Punnett square to determine the probability of each trait.

Now students use the same procedure they used in part 3 to breed the F2 generation. They should record the genotype and phenotype of the 2 F3 offspring on their Larkey Breeding Record Sheets. After everyone is done, use Transparency 32 to tally the traits. Students will transcribe the class results to their Larkey Breeding Results Sheet.

Students should check their results for traits that were absent from the population for a time and then reappeared. They will discuss what mechanism allows this to happen and then write their explanation at the bottom of their Punnett Squares sheet. Students finally work with the Larkey simulation Punnett Square to see the ever-changing distribution of traits in a population as a result of random variation.

When students are done with the Punnett Square Lab Sheet, collect it and check to see that they can use Punnett squares to predict the probability of traits. Use the answer sheet to help score the student responses.

If students need more practice, have them complete lab sheet page 65, Genetic Variation Practice sheet.

There is a Summative Exam provided for Investigation 9. When you feel students are ready, allow about 15 minutes for them to complete the exam. The answer sheet can be found in the Assessment chapter of the Teacher Guide.

<Investigation 10, Introduction>

Narrator: In Investigation 10, students learn that natural selection is the mechanism that produces change in the genetic makeup of a population. They use all of the concepts presented in prior Investigations to explain changes in populations as the result of natural selection.

Look over the At-A-Glance chart paying close attention to the Objectives, Assessment Opportunities, Preparation, the outline for conducting the Investigation, and when to use the Student Resource book, video, and multimedia.

Be sure to read through the Scientific and Historical Background pages for additional information on Natural Selection and Artificial Selection.

The Why Do I Have to Learn This? section describes how students are introduced to the biological processes that result in new species. This lays the groundwork for later studies in biology.

<Investigation 10, Getting Ready for Part 1>

Narrator: In Part 1, Selective Pressure, students work with allele tiles to discover what happens to a population of larkeys when the environment changes.

This is what you will need from the kit. For each group of 4 students, you'll need 2 gene pools from Investigation 9, and 8 plastic cups. You'll also need Lab Notebook pages 57, 66, 67, 68, and 69. For the class you'll need 4 Special Teacher Masters: Female Parents: Mountains, Male Parents: Mountains, Replacement Larkeys: Prairie, and Replacement Larkeys: Forest.

You'll also need 4 more plastic cups, Transparencies 33 and 34, and the Assessment Chart for Investigations 8 through 10. You'll need to provide some coins for each group, and for the class: scissors, masking tape, and colored copy paper in pink, blue, yellow, and green. You'll also need to provide an overhead projector and overhead transparency markers.

Investigation 10 is divided into 3 parts. In Part 1, students use allele tiles to breed larkeys for 2 generations and observe the resulting phenotypes when a yammer of larkeys living in the mountains is forced to flee its environment because of a fire. Half of the larkeys leave for the forest, and the other half move to the prairie. Students see what happens when environmental factors put selective pressure on populations. Then in Part 2, the class is introduced to Charles Darwin and the natural selection studies conducted on the Galapagos Islands. And finally in Part 3, the mountain/forest/prairie larkey simulation explored in Part 1 is revisited, but this time students quickly breed 6 generations using a computer simulation.

To get ready for Part 1, decide if your students understand larkey genetics well enough to bypass the allele tile exercise and instead go straight to the computer simulation. In that case you would return for the analysis and discussion of selective pressure before going on to Part 2. Complete directions for bypassing the allele activity in Part 1 are discussed in the Getting Ready section of your Teacher Guide.

If you are bypassing the allele activity, preview the multimedia simulation: Larkeys, Natural Selection. A description of this simulation can be found in your Teacher Guide, and by viewing Investigation 10, Getting Ready for Part 3 of this video.

If you are having students use the allele activity, you'll need a coin for each group. You'll also need to duplicate and cut apart the larkey cards. See the Getting Ready pages of the Teacher Guide for which color of paper to use for each Larkey card master.

<Investigation 10, Conducting Part 1>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Set the stage for this Part by telling a story about a yammer of larkeys living on the slopes of a

mountain. A fire swept across the larkey habitat and the larkeys had to relocate. Half of the larkeys moved to the prairie grassland, and the other half headed for the deep forest. New environmental pressures were placed on the larkey populations as some larkey traits made it easier for them to survive.

See the Conducting section of this part for details on the Larkey story. Students breed the larkeys in these new environments to see: Will the larkeys all survive? Will the larkeys maintain the same level of variation in their populations? Will the population change in response to the change in the environment?

If your students are going to bypass the allele-tile simulation and go directly to the Natural Selection computer simulation, do so now before step 3 in the Teacher Guide.

See Part 3 of Investigation 10 of this video and Part 3 of the Teacher Guide for directions on accessing and using the simulation. Once students have completed the simulation return to Part 1, analyze the data and finish Part 1 of this Investigation.

If students still need to work with the allele tiles, have half of the students follow the prairie yammer and the other half follow the forest yammer. Use Transparency 33 to outline the rules for survival in the 2 populations of larkeys.

First let's look at the larkeys that moved to the prairie. Larkeys with striped or solid gray fur and long legs always survive because they could hide in the grass and run away fast. Larkeys with spotted fur and short legs are always eaten by coyotes. All other combinations have a 50/50 chance of survival.

Now let's look at the larkeys who moved to the forest. Larkeys with spotted or solid gray fur blend in with the dappled light in the forest, and short legged larkeys can dive under bushes to escape the bobcats. They always survive. Larkeys with striped fur and long legs are always caught by the bobcats. All other combinations of leg length and fur pattern have a 50/50 chance of survival.

If an offspring in either the prairie or forest has a 50/50 chance of survival, a coin flip determines its fate. Heads it lives, tails it is eaten by a predator. If an offspring is eaten, it is replaced by an immigrant larkey from another population living in another part of the prairie or forest.

If you are following prairie larkeys, take a replacement larkey from this cup.

If you are following forest larkeys, take a replacement larkey from this cup.

Students work with a partner, they get a gene pool and a Larkey Genetics Mat. They select a male parent and a female parent from the cups containing the cards Female Parents: Mountains and Male Parent: Mountains. Students use the gene pool tiles to reproduce the genotypes of the parents, recording their genotype and phenotype on Lab Sheet page 66, Prairie Larkey Breeding Record if they are following the larkeys who migrate to the prairie. If they are following the larkeys who migrate to the forest, students record the parent genotype and phenotype on Lab Sheet page 67, Forest Larkey Breeding Record.

Using the same technique used in Investigation 9, students produce 1 male and 1 female offspring, the F1 generation. If an offspring is adapted for survival students record its genotype and phenotype on the Larkey Breeding Record. In the prairie, the larkey would have long legs and striped or solid gray fur. In the forest, the larkey would have short legs and spotted or solid gray fur.

If an offspring is eaten by the predator – short legs with spotted fur in the prairie, and long legs with striped fur in the forest dump the dead larkey allele tiles into the gene pool, and get a replacement yellow larkey ID card for dead prairie larkeys, or a green ID card for forest larkeys. Record the replacement larkey ID card information on the Larkey Breeding Record.

Use tiles from the gene pool to recreate the replacement larkeys genotype in a plastic cup. If the offspring has a 50/50 chance of survival, students flip a coin. Heads, the larkey survives and its genotype and phenotype are recorded on the breeding record. If the coin is tails, the larkey is eaten by a predator. Dump its allele tiles into the gene pool and get a replacement larkey card. Students record the replacement larkey genotype and phenotype on their Larkey Breeding Record, and use tiles from the gene pool to re-create the replacement larkeys genotype in a plastic cup.

Now students exchange their male with another team in their yammer, record its ID information on their Larkey Breeding Record, and breed the new male with their F1 female to produce the F2 generation. They follow the same procedure of analysis, coin flipping, and replacement to produce and record a male and a female offspring of the F2 generation.

After reviewing features and traits that affect survival, use Transparency 34, Prairie and Forest Larkey Breeding Results to collect data for all 3 generations: parents, F1, and F2. Students will transcribe the data on the Transparency to Lab Sheet page 68, Prairie and Forest Larkey Breeding Results.

If students used the multimedia simulation instead of the tiles to collect data, this is where you will resume Part 1. Students analyze the results by responding to the questions posed in the Teacher Guide. You'll use a mini-lecture to introduce the idea of "selective pressure." And lead a discussion of how selective pressure changed the larkey population on the prairie.

Finally, connect the larkeys and walkingsticks by having students determine what selective pressure was brought on the population of walkingsticks, how the population of walkingsticks changed over time, and how the populations of larkeys and walkingsticks are similar?

Students complete the Response Sheet: Natural Selection. Use the answer sheet and the scoring guide in the Assessment chapter to check students understanding of acquired and selective traits.

<Investigation 10, Getting Ready for Part 2>

Narrator: In Part 2, students take a video field trip to the Galapagos Islands. Students learn about the history of change of the organisms living on the islands and they think about the island ecosystems and the effects of natural selection over time.

This is what you will need from the kit. For each group of 4 students, you'll need: 4 Student Resource books, and 4 copies of Lab Notebook pages 70 and 71.

For the class you'll need the video, Voyage to the Galapagos and a TV and VCR. You'll also need the Assessment Chart for Investigations 8 through 10.

To prepare for this part of Investigation 10, plan on showing the video in 2 parts on 2 consecutive days. On the first day spend about 25 minutes showing the Introduction, Darwin's Finches, and the Lizards of the Sea. This allows time for students to also answer the first 5 questions on the Voyage to the

Galapagos Lab Sheet. On the second day spend about 20 minutes to finish the video sections on Masked Killers and Paradise Lost. This allows time for students to answer the remaining questions on their Lab Sheet.

Also decide when you will have students read the article called Natural and Unnatural Selection in their Student Resource book.

<Investigation 10, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Start out by introducing students to Charles Darwin and his voyage to the Galapagos in the 1830's. Have students focus on these 2 questions as they watch the video: What was it about the plants and animals he observed that made an impression on Darwin? And, what was the mystery of mysteries that Darwin started to solve after observing the organisms on the Galapagos?

Show students the first 25 minutes of the video, stopping at the end of the Lizards of the Sea section. Ask students to answer the first 5 questions on their Lab Sheet, working in groups to help each other remember specific events in the video and to discuss answers to the questions.

On the next day, introduce the second section of the video with a mini-lecture on natural selection and the process of change that results from natural selection and that we call biological evolution. After students watch the rest of the video, they answer the rest of the questions on their Lab Sheet Voyage to the Galapagos. Once students have had an opportunity to finish the questions on their Lab Sheets, discuss their answers. In the Teacher Guide you'll find questions to help your students clarify their thinking.

At the end of this part, have students read the article, Natural and Unnatural Selection, in their Student Resource books. Collect the student Lab Sheets and use the Teacher Answer Sheet to help you determine the quality of their answers.

<Investigation 10, Getting Ready for Part 3>

Narrator: In Part 3, students use the multimedia to explore the effects of natural selection on a population to see how traits can change naturally over time.

This is what you will need from the kit. For each group of 4 students, you'll need 4 copies of Lab Notebook pages 73, and the Final Summative Exam. You'll also need the Voyage to the Galapagos Lab Sheets from part 2.

For the class you'll need the FOSS Populations and Ecosystems CD-ROM and a multimedia setup.

To get ready for this part of the Investigation, you need to preview the multimedia "Natural Selection" simulation. If you have already used this simulation in Part 1 and have already viewed this part of the video, you can skip this part and go straight to previewing the multimedia "Selective Breeding." Lets go through the simulation Natural Selection. This activity extends the larkey breeding in Investigation 9. The opening screen shows 16 pairs of parent larkeys with the starting genotypes used in the classroom activity. Female larkeys are represented with circles, male larkeys are represented with squares. Click any larkey to display its phenotype and genotype in the upper window. They displayed

larkey will be highlighted with the yellow halo.

To begin click “let ‘em breed.” Each pair will contribute one male and one female to the next generation. Lines indicate the pedigree of the new generation. The count of the traits in the new generation appears in the table. After the F2 generation a catastrophic event occurs. A fire has ruined the mountain larkeys habitat and has forced them to flee to a new environment.

Let’s see what happens to the larkeys who move to the forest. Here are the rules for survival. We’ll continue to breed the forest larkeys. Your study is now complete. At the end of the F6 generation students record the phenotypes in the population or they can print the table. Use the color symbols by feature to see how environmental pressures have changed the distribution of traits within the population. Lets look at leg length. If they tables in the way you can hide the table. You can see that short legs are now predominant.

When you’re through, click “new study” to repeat the activity. Now we can study what happens to the larkeys who move to the prairie.

This is a preview of the multimedia “Selective Breeding.” This activity allows users to breed larkeys with a particular trait. On the opening screen students can enter a target phenotype that you’ve given them or they can click “easier” for 1 trait or “harder” for 3 traits to have a breeding goal randomly selected.

Let’s try easier. The screen shows a collection of 16 randomly selected larkeys. Female larkeys are represented with circles male larkeys are represented with squares. Click any larkey to display its phenotype and genotype in the upper window. Use color symbols by feature to see a color code based on features of the animals phenotype.

We’ve been asked to breed for an F4 generation that breeds true for short legs. This feature will help students select parents with phenotypes appropriate for the breeding goal. After selecting 2 parent larkeys students can use the Punnett square tab to hide the tree and show the Punnett square interface. This feature can help students select parents with genotypes appropriate for the breeding goal. Let’s go back to our family tree, now that you’ve selected 2 larkeys, go ahead and breed them. Continue selecting parents and breed them until you’ve reached your F4 generation. We’ve met our breeding goal all the larkeys have short legs. Students can print this screen and turn it in.

You’ll find complete directions for using the multimedia can be found in the Getting Ready section of Part 3 and in the CD-ROM User Guide chapter of your Teacher Guide. Both of the multimedia experiences are more valuable if students can work in pairs at computers. If a computer lab or library computers are available, schedule it for the days you will be doing this part.

<Investigation 10, Conducting Part 2>

Narrator: This will be a brief outline of this part of the Investigation. Make sure you read and follow the Teacher Guide.

Use your multimedia setup to introduce students to the Larkey Natural Selection multimedia simulation. They will complete round 1 and round 2, recording the distribution of traits on Lab Sheet page 73, Natural Selection Larkeys. Make sure that students fill in the blanks that ask for the environment the larkeys emigrated to in each round. After students have collected their data, they need to analyze the

results. They should notice that natural selection will produce a prairie population with predominantly long legs and solid gray or striped fur, and a forest population with short legs and solid gray or spotted fur.

Because there was no selective pressure for eye color or tail shape in these environments, students should notice that these traits maintain a distribution of about 3 to 1, with the dominant trait occurring 3 times more often than the recessive trait. If you already used the Natural Selection simulation in Part 1, you'll have students start part 3 with this next simulation.

On the second day, use your multimedia setup to introduce students to the Selective Breeding simulation. This challenge is very much like the challenge facing dog breeders who are breeding for a predetermined phenotype. If you want students to have more experience with genetics, as an extension, challenge them to play level 3 of the walkingstick simulation in the multimedia. In level 3, the 3 walkingstick colors behave like color variation in a population. More information about this extension activity is found in your Teacher Guide at the end of the Investigation 10 chapter.

You are now at the end of the Populations and Ecosystems course. Consider a review session of the course before giving the Final Summative Exam. It will take students about an hour to complete this exam. The scoring guide for this exam can be found in the Assessment chapter of your Teacher Guide.

We hope you've found this presentation useful but remember its not a substitute for the Teacher Guide. Enjoy!