OSCI 7–10 Life Science

July 1, 2005

Teaching Notes and Significant Notebook and PowerPoint Amendments

The OSCI 7–10 Life Science author team has reviewed your comments and incorporated many of them into a revised version of the teacher and facilitator notebooks and PowerPoint presentations. We have been also correcting a variety of typos and other small errors. Teachers in your July and August workshops will receive the updated version of the teacher notebook. (The June notebooks had to be printed before revisions were completed.) You'll be notified by e-mail as new materials are available on the web. When significant changes are posted, please download relevant files and update your notebook and PowerPoint presentations.

Based on your comments and the feedback of instructors, we have compiled some brief teaching notes to help guide or clarify lessons as needed. These are provided below.

Welcome

TEACHING NOTE: As a facilitator, you must emphasize that the role of the course is to improve **teacher knowledge**. Also emphasize the ideas below at the start of and throughout your workshop:

- The role of the course is to improve teacher content knowledge, because improved teacher content knowledge leads to student learning.
- The course content will be challenging for some. Teachers need to be **patient** and **receptive** to new learning.
- All the content will not translate directly into every classroom.
- Although hands-on activities suitable for classrooms are part of the course, they are not the primary focus.
- Teachers will have access to computer files for all activities and presentations. They can modify the materials as needed for use in their own classrooms.
- Teachers who do not have a strong life science background will not become experts in evolutionary science after this one-week course. But, they **will** leave knowing more about evolution than when they started.
- With a better understanding of evolution, teachers will have an improved ability to select and use appropriate classroom materials relating to evolution.

Introduction > **Explore: Know-Need-Learn about Relevant Ohio Standards**

TEACHING NOTE: In the Facilitator workshop, you were not asked to complete the self-assessment of knowledge of Ohio life science benchmarks and indicators relevant to evolution. You must have your teachers in the workshop complete this exercise (found in the teacher notebook) and the questions that follow.

Introduction > **Extend: What Will This Course Do for You?**

TEACHING NOTE: Emphasize here and throughout the workshop that the purpose of the workshop is to **improve teachers' content knowledge**. While the workshop does contain some student lessons, the intent is not to provide a large collection of them. Studies indicate that improving teachers' content knowledge is a key component for improving student performance. With the appropriate content knowledge, teachers are able to locate and effectively use appropriate teaching materials. Teachers will be given sources for classroom lessons on evolution and the nature of science at the end of the course.

Unit 2 > **Explore: Hands-On Classroom Lesson—Reebop Reproduction**

TEACHING NOTE: Reebop Reproduction is the first of three genetics lessons featuring Reebops. These three activities are designed to help learners progress through understanding sources of genetic variation, understanding predictable patterns of inheritance, and understanding how gene frequencies in populations change. These ideas are the heart of understanding biological evolution. The paragraph below, summarized from *The Scientific Thinking Processes* by L.F. Lowery (Berkeley, CA: Lawrence Hall of Science), explains the rationale for having time gaps in the workshop schedule between these three Reebop activities. In the time between the Reebop activities, teachers will be exposed to many ideas about evolution. As they explore the second and third Reebop activities, they will recall and reuse information from the previous activities within a broader and broader context of understanding. This rehearsal helps ensure permanent learning.

> Knowledge is constructed through experience, but the quality of that construction is greatly affected by how well the brain organizes and stores relationships. As exploration continues, "learners try to link new perceptions to what they have already constructed in the brain's storage systems. They use this prior knowledge to interpret the new material in terms of established knowledge." Bits of information that are isolated from integration with prior knowledge are forgotten. The more opportunities students have to explore relationships among ideas and to use their prior knowledge, the richer and more permanent the constructions of knowledge will be. This is accomplished through a process called rehearsals—reinforcing what has been learned while adding new information and new contexts.

TEACHING NOTE: Remember that the focus of the Reebop Reproduction lesson is **not** to learn the phases of mitosis and meiosis in detail. Rather, the purpose is to introduce how meiosis and fertilization provide the genetic diversity on which natural selection acts. Here is one online source for teachers who want to independently explore mitosis and meiosis: *How Cells Divide: Mitosis vs. Meiosis:* http://www.pbs.org/wgbh/nova/miracle/divide.html

TEACHING NOTE: The teacher background for this activity provides a description of traits that show lack of dominance. Those of you who were in the program last year may remember the original version of this activity. Please note that the original version (from *http://www.wisc.edu/cbe/cbe_publications/reebops.html*) erroneously calls certain Reebop traits (nose color and number of humps) examples of co-dominance. Our version correctly calls these traits examples of lack of dominance. This may have caused some confusion. As explained in the Reebop Ratios activity, co-dominance is when both alleles affect phenotype in separate ways, such as in A and B blood types. Lack of dominance is when no one allele dominates the others and the heterozygous condition results in a phenotype that is distinctly different from any homozygous phenotype.

POWERPOINT UPDATE: The last few slides of the Reebop Reproduction PowerPoint presentation have been updated to include better illustrations of mitosis and meiosis.

Unit 3 > **Engage: Who's Curious About Life on Earth?**

NOTEBOOK UPDATE: The introduction to the reading of "How the Elephant Got His Trunk" has been updated as follows:

> People of all ages and from all cultures have always asked questions about how life on Earth got to be the way it is. Stories and myths are popular ways to answer such questions. Familiar stories—even if unscientific—often represent a comfortable "life-world" for students. In "Cross-Cultural Science Education: A Cognitive Explanation of a Cultural Phenomenon," Glen Aikenhead calls the transition from the student's life-world to the culture of science a "cultural border crossing," an idea that comes from cultural anthropology. Aikenhead explains that these border crossings can be made less threatening with flexibility and playfulness.
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> Let's play with a fanciful story for children who are curious about how one animal came to be (from *The Just-so Stories* by Rudyard Kipling). We'll then take a look at how the culture of science approaches similar questions.

Unit 4 > **Explore: Reebop Ratios**

TEACHING NOTES: Modify the Engage part of the lesson as described here: Begin the lesson by having teachers display the Reebops made in the Reebop Reproduction activity. Ask teachers to count how many have straight tails and how many have curly tails. Show teachers the question (on the PowerPoint) "If your Reebop parents had 100 offspring, how many of them would you expect to have a curly tail? How many of them would you expect to have a straight tail? Why do you think so?" Have teachers answer the question based on what they have observed about the Reebops so far. Also, discuss why someone would want to predict the number of offspring to have a particular trait. (Think about farmers, dog breeders, and insurance companies.)

Strongly emphasize the question on the Reebop Ratios PowerPoint that precedes the Explore activity: **How can we test the genotype and phenotype ratios predicted by the Punnett square?** Make sure that everyone understands that they are doing the Explore activity to answer this question.

> *Note: While counting the tail phenotypes on the Reebops you made in Reebop Reproduction is a good Engage step for this activity, the number of Reebops available is not large enough to provide a good test of the question. Therefore, additional offspring must be generated. Since we're only interested in the tail trait now, we generate the offspring through coin tosses (as described in the procedure), rather than actually building new Reebops.*

POWERPOINT UPDATE: The first few slides of the Reebop Ratios PowerPoint have been reordered. Be sure to download the updated PowerPoint file.

Unit 4 > **Explore: How to Create a Drug-Resistant Bacteria**

NOTEBOOK UPDATE: The Data Table for Natural Selection has been updated to be easier to use.

Unit 4 > **Extend: Natural Selection: A Cumulative Process**

TEACHING NOTES: The activity and computer simulation (available at www.terrificscience.org/osci/life/forbes) make an extremely valuable and often misunderstood point: genetic variation is a completely *random* process, but acting upon this randomly produced gene pool is the very *non-random* and cumulative process of natural selection. However, you must introduce and explain this exercise very carefully to avoid misconceptions.

The activity and computer simulation demonstrate the process of non-random selection acting upon a randomly generated "gene pool" (of cards or letters). Just as natural environments have limiting factors such as predation, competition, and drought, that select for or against certain characteristics (genes), the activity and computer simulation establish artificial environmental parameters—the "correct" card or letter in the sequence is selected for; "incorrect" cards or letters are selected against.

The card activity requires the random selection of cards from a numbered set. As cards are randomly picked, application of a non-random selection rule selects for a sequence of cards to produce an ordered set. Cards chosen in the incorrect sequence are discarded and cards chosen in the correct sequence are saved. In other words, the rules of the activity, like nature, save the advantageous and eliminate the non-advantageous.

The computer simulation requires the random generation of alpha-numeric characters produced by either manual keyboard entry (select Mode/Human) or by computer-generated random characters (select Mode/Computer). As these random characters are entered by either mode, a background program is running which selects for the correct sequence of characters to produce the Shakespearean phrase “To be or not to be, that is the question.” The program deletes entries made in the incorrect sequence and saves the correct character entries. In other words, the program, like nature, saves the advantageous and eliminates the non-advantageous. The program continues to save or delete characters until the phrase “To be or not to be, that is the question” is achieved.

When using this activity and computer simulation, strongly emphasize that natural selection (and therefore evolution) is NOT goal-oriented. However, it might be suggested that this activity and computer simulation are goal-oriented in that they select for a pre-determined order of cards or a pre-determined phrase. Emphasize that 1) the activity and computer simulation are only goal-oriented in that they pre-establish the parameters of the environment (limiting factors) by which selection will take place, and 2) the exercise is designed to demonstrate how a randomly produced “gene pool” is acted upon by a non-random process (natural selection) to produce outcomes (species) that would be an improbable outcome of random genetic variation alone. This exercise is not intended to meet all of the actual dynamic contingencies that occur in natural environments.

Unit 5 > **Explore: Reebop Populations**

NOTEBOOK UPDATE and TEACHING NOTES: The Engage phase of Reebop Populations ends earlier than in the original version of the activity and a transition between the Engage part of the lesson and the Explore activity is identified as “Getting Ready to Explore.” Getting Ready to Explore presents the basic vocabulary and concepts needed to give participants a frame of reference for the Explore activity.

Strongly emphasize the purpose of the Explore activity: **seeing what happens to allele frequencies when selection pressure is applied to the tail trait.** Make sure that everyone understands that they are doing the Explore activity to answer this question.

The Explore phase of Reebop Populations has been updated to have a clearer procedure and an easier data sheet. The procedure includes the option of pulling multiple offspring in each generation (for faster, more dramatic results), but the alleles must be replenished after each “pull” to keep the gene frequency constant WITHIN each generation. If you pull two alleles and put them aside, then pull two more, and put them aside, until all the alleles are gone, you are changing the allele frequency. The allele frequency should not change within one generation, only BETWEEN generations.

Remember that change in gene frequency over generations is evidence of evolution, whether large or small. Also, evolution proceeds at different rates under different circumstances. So, no matter how large or small a change in gene frequency you observe, the activity is showing evidence of evolution.

Some teachers will find the math or concepts of population genetics daunting. Be sure to emphasize that even if they don’t remember the details, the take-home message is 1)

changes in gene frequency are measurable evidence of evolution and 2) **gene frequencies change when forces, such as natural selection, act on populations**.

POWERPOINT UPDATE: The Reebop Populations PowerPoint has been reorganized and clarified. Be sure to download the updated PowerPoint file for this presentation.

Unit 5 > **Explore Part: Cracking the DNA Code**

NOTEBOOK UPDATE: This activity has been updated to correct the error where the codons provided for translation are incorrect.