Activity 14

Giant Panda Heredity Exercise

Objective & Overview:

Donning the imaginary coats of geneticists, students will try their hands at identifying bear DNA strands to determine the relatedness of species. While narrowly focused, this activity provides ample avenues for expanding discussions about genetics and zoo breeding (issues also described in the Teacher Background Information below.)

Teacher Background Information:

G*enetics*--the study of how parents pass on *traits* to their young--plays an increasingly important role in charting a course for the giant panda's survival. The Teacher Background Information below details the various challenges geneticists face in trying to perfect panda breeding and keep the panda population genetically diverse. (These issues are not directly treated in the activity below.) The focus of this activity is to put students in the coats of geneticists trying to use DNA fingerprinting to identify different bear feces. This fingerprinting has other uses, as you will read. If you just want to focus on **DNA fingerprinting**, skip down the background information to the section describing this procedure.

Are giant pandas easy to breed in zoos?

No. For reasons scientists hope to soon learn, zoo giant pandas have poor and inconsistent breeding success. Natural breeding of zoo giant pandas is still a fairly rare occurrence. Few cubs are born each year and few of these survive longer than one year. While about 70 percent of the world's zoo giant panda population is of breeding age, only about 30 percent of males and 45 percent of females have successfully bred, either by natural (mating) or assisted (artificial insemination) means. Although efforts are underway to change this situation, zoo giant pandas are not currently managed as one unit, so coordination is difficult.

In zoos, giant pandas often show little interest in mating, have high infant mortality, or mothers do not adequately care for their young. Sometimes, males are overly aggressive to females. The zoo giant panda population cannot yet sustain itself.

How do zoos coordinate giant panda breeding?

In North America, zoos coordinate giant panda breeding through a program called a *Species Survival Plan*, or SSP. There are SSPs for a variety of rare species. In China, breeding facilities will soon work to maintain a genetically diverse breeding population through the first Genetic Management Plan for Giant Pandas in Captivity in China. Both of these efforts rely upon the careful documentation of giant panda pedigrees (relatedness) of every animal destined for breeding. The programs' primary goals are:

- to create self-sustaining, genetically diverse zoo populations
- to more efficiently produce offspring for potential reintroduction.

What are some high-tech techniques that Zoo scientists have in their arsenal to help improve zoo panda breeding?

Among the techniques Zoo scientists will use to improve giant panda breeding are:

- **Artificial insemination (AI).** *Artificial insemination* (AI) is the introduction of sperm to egg via an assisted procedure rather than the mating of two animals. Usually, a female is anesthetized and sperm is inserted into her vagina. AI greatly reduces risks and disturbance that sometimes happen when moving animals from one zoo to the next, or overseas, to breed. Also, it allows scientists to implement with greater precision plans to keep giant panda populations genetically varied, to avoid inbreeding. However, for AI to be a valuable tool, scientists must determine its effectiveness. This has been difficult to do because many female giant pandas both naturally mated with males and been artificially inseminated. This makes determining paternity difficult. Also, the growing number of sperm samples must be carefully maintained and catalogued so that matchmaking will be easier and more accurate, increasing the genetic variability of the zoo population both in China and other zoos. Many details need to be hashed out. For instance, Zoo scientists and their colleagues want to learn much more about giant panda sperm and how to preserve it. Freezing methods and thawing methods need to be tested and

improved to ensure that more sperm remains viable. (See cryopreservation, below.) Not all sperm used in AI is cryopreserved. Fresh samples are used as well.

- **Cryopreservation.** Once the stuff of science fiction and movies, *cryopreservation* has come into its own as a commonplace way to store for short or long term eggs and sperm, which are later used in artificial insemination. Specimens are frozen and later thawed when ready for use. The collection of data and samples will need to be centered at one or two repositories or "frozen zoos," called *genome resource banks*. This or these facilities still need to be planned and built.

- **DNA fingerprinting.** DNA, the basic raw material of *heredity*–the passing of traits from parents to their young–is composed of nucleotide bases that are usually connected in long strands, which store all of the information needed for a cell to function. DNA varies between individuals, populations, and species. DNA fingerprinting is a process in which geneticists extract DNA from a tissue or blood sample, separate it into different-sized fragments using an electric current, and generate a profile of different bands. This profile of DNA fragments gives the tested animal a distinctive and unique "fingerprint," which can be used to determine its relatedness to other animals. By analyzing DNA taken from feces and hair, Zoo geneticists hope to determine wild giant pandas' identities and genders. If they can perfect this procedure, they will be able to keep track of wild pandas' movements and home

ranges by what they leave behind, rather than having to capturing them. This procedure will also help scientists draw up pedigrees of wild animals, shed light on population structure and breeding success, and maybe help them track genetic diseases.

Directions:

1. Explain to your class that you will be investigating how scientists use DNA fingerprinting to study elusive animals such as wild members of the bear family. By collecting samples of their scat, or poop, they can create a distinctive DNA "fingerprint." In this exercise, we will be pretending to sleuth the identity of bear species from their scat. Scientists hope to use similar methods to differentiate between different giant panda individuals.

2. Have your students look up the following five species: American black bear, Asiatic black bear, giant panda, polar bear, and sloth bear. After they have looked at pictures and read a bit about each of these species, ask them:

- Which two species do you think are most closely related?
- Which is the most genetically distinct?

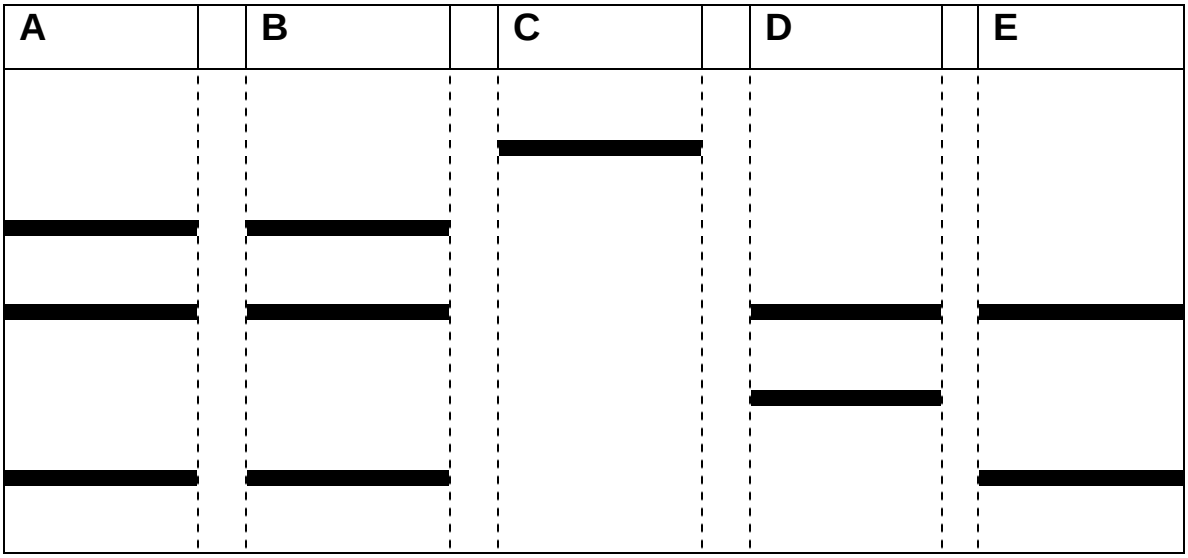
3. Once they have made their guesses, pass out the Bear Fingerprints Worksheet. Explain that they will play the part of geneticists trying to learn about members of the bear family using DNA fingerprints.

4. After the students finish working on the worksheet, discuss their answers to the three questions on the worksheet. For example, were your students surprised to find that the American and Asiatic black bears were most closely related?

5. Using the last question on the worksheet, brainstorm with your students about other problems scientists might solve by using DNA fingerprinting. Other problems include finding the true father of an animal (observation alone usually cannot reveal if a female has one or more mates); matching hair or other samples to a suspect in a criminal investigation; and identifying genetic disorders in people who may carry the gene for the disorder without exhibiting any of its symptoms.

Bear Fingerprints Worksheet

Below you will find a picture representing different DNA fragments lined up in electrified gel. Each column of bands is from the scat of one species. Examine this chart and answer the questions below:



A = American black bear B = Asiatic black bear
C = giant panda D = polar bear E = sloth bear

1. According to the DNA gel results, which of the five species listed are most closely related?

   _____ and _____

2. Which one is the most genetically distinct?

   _____

3. DNA fingerprinting is not only used to examine bear scat. List three other problems geneticists might solve by using DNA fingerprinting:

   A. _____

   B. _____

   C. _____