Part I - Teacher Handouts

Handout 1
Video Questionnaire

- What specific strategy or strategies is this teacher using to activate and build prior knowledge?

- What are the students doing? What is the teacher doing?

- How does the teacher scaffold the strategy?

- What did you like? What you didn't like?

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Handout 2
First Word Activity

E ____

V ____

O ____

L ____

U ____

T ____

I ____

O ____

N ____

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Handout 3
Reflection on First Word Activity

- How was your experience coming up with words relevant to the definition of the word evolution?

- Did you learn something new from the other groups?

- Would you use this strategy in your classrooms? How?

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Handout 4
Lesson Scenario to activate background knowledge

A teacher is about to introduce photosynthesis to his or her students. The teacher knows it is a multilevel class and the students have different educational backgrounds and wants to make sure to target all misconceptions about the topic and want to meet all the students' needs and expectations.

Select on teaching strategies to activate background and design an activity for this teacher. Feel free to use any of the activities found in the pdf provided to your group or even better you can come up with an original an idea to help this teacher.

Teaching Strategies to activate background knowledge:
http://www.classhelp.info/Biology/Strategies%20for%20Activating%20Prior%20Knowledge.pdf

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Part II – Teacher Handouts

Handout 5

From Rhodes, H. G., Feder, M. A., & National Research Council, (. (U.S.). (2014). Literacy for Science: Exploring the Intersection of the Next Generation Science Standards and Common Core for ELA Standards: a Workshop Summary. Washington, D.C.: National Academies Press.

“Reaching for the Light”

Light is so important to the survival of plants that they seem to reach toward it. But how does a plant ‘know’ which way to grow? A plant may not have eyes to tell it where the light is, but a plant does have hormones. Hormones are substances produced by plants (and animals) that regulate growth and development. Auxins are hormones that affect the growth of plant cells. Auxins cause cells on the shady side of a plant to grow faster than cells on the sunny side. As a result, a plant’s stem may bend toward the light to allow as much light as possible to reach the maximum number of food-making cells. This phenomenon is known as phototropism.

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Handout 6

Genetic variation helps rescue endangered panthers

December 2010

http://evolution.berkeley.edu/evolibrary/news/101201_panthers

This fall, biologists announced the apparent success of a last-ditch conservation effort: the Florida panther, once slated for **extinction**, has been given a second lease on life by the infusion of **genetic variation.** In the 1900s, this **population** nosedived because of hunting and habitat loss. By the 1990s, there were fewer than 30 Florida panthers left. To make matters worse, those survivors were in bad physical shape. They were riddled with diseases and parasites and had poor sperm quality and low fecundity, as well as a host of problems like undescended testicles, kinked tails, and heart defects. Scientists predicted that the Florida panther would be extinct within 20 years and, in 1995, formulated a bold plan to save them.

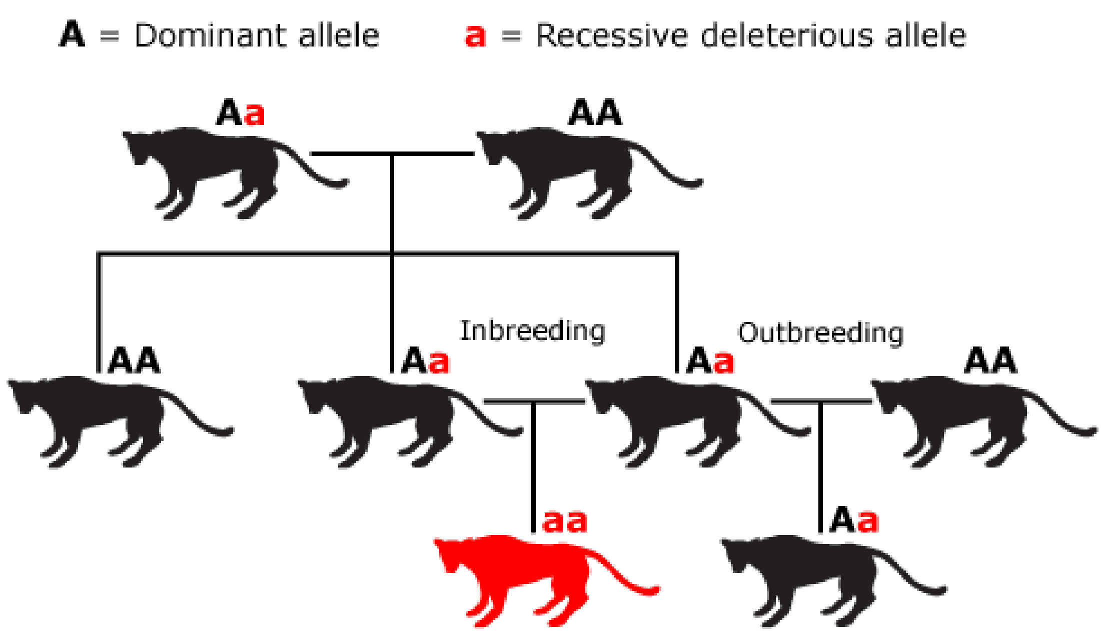
Where's the evolution?

The conservation plan involved improving the genetic status of the population with new blood. In 1995, eight female pumas from Texas (a different subspecies of panther) were moved into the area and took up residence with their Florida cousins. How could just eight panthers help save a whole population? The new panthers brought with them new **gene** versions, which help counteract two negative side effects of small population size: reduced genetic variation and **inbreeding**. To understand how the conservation plan worked, it helps to understand the evolutionary importance of genetic variation and the evolutionary underpinnings of inbreeding depression.

Genetic variation refers to all the different gene versions that are present in a population. In general, when a population loses a lot of individuals (i.e., decreases in size), its genetic variation goes down as well. This makes intuitive sense. The fewer individuals in a population, the fewer different gene versions they may carry. Over long time scales, decreased genetic variation can be a problem for a population because genetic variation is the raw material of evolution. **Natural selection** acts on the genetic variation present in a population, favoring some gene versions over others and eventually producing **adaptations** that allow individuals to thrive in new circumstances. So without a sufficient amount of genetic variation, a population cannot evolve in response to changing environmental conditions. Hence, bringing in new panthers probably improved the Florida panthers' evolutionary potential.

Over short time scales, genetic variation is important for a population's survival as well. For example, a genetically variable population is more resistant to pathogens and parasites. This occurs at two different levels. At an individual level, populations with high levels of genetic variation generally include many individuals who are **heterozygous** — that is, they carry two different gene versions — at important locations in the genome. Individuals with many heterozygous genes are less likely to be susceptible to diseases and parasites than are individuals with many genes that are **homozygous** (i.e., the individual carries two copies of the same gene version for a particular gene). That's because individuals that are heterozygous for genes involved in parasite and pathogen resistance have twice the chance of carrying the right gene version to resist the pathogen-of-the-day than do individuals homozygous for those genes. It's a bit like buying two tickets for a raffle instead of one. The more tickets you have, the more likely one of them will be a winner. The same reasoning applies at the population level. A genetically variable population is likely to include some individuals who happen to be genetically resistant to the disease or pest — enabling the population to survive to the next generation, even if many individual animals die or become sick. For the Florida panthers, bringing in new blood increased heterozygosity, improving the health of individuals, and made the population less likely to be wiped out by a single disease or parasite.

Another genetic side effect of small population size is inbreeding — a situation in which individuals mate with their close relatives. In very small populations, like that of the Florida panthers, this happens simply because the population is so small that all the individuals are closely related to one another. The offspring resulting from inbreeding tend to have health problems and lower reproductive success. This is known as inbreeding depression — and was seen in the Florida panthers in the form of poor sperm quality, low fecundity, undescended testes, kinked tails, and heart problems. Inbreeding depression occurs because of a quirk of natural selection and genetics. As natural selection acts on a population, it weeds out genes that have disadvantageous effects, but it can only weed out these genes if they are actually expressed in an individual. For dominant gene versions, that's no problem. Individuals carrying **dominant** genes with a detrimental effect will be selected against, and eventually, these genes will be purged from the population. For **recessive** gene versions, however, the story is a bit different. Recessive genes are only expressed when an individual carries two copies of them. Once natural selection has removed most of the detrimental recessive genes from a population, these seldom wind up paired with an identical copy and are effectively hidden from the effects of natural selection. This means that most populations carry many **deleterious** recessive gene versions that are very rarely expressed — except in cases of inbreeding. Closely related individuals are likely to carry the *same* deleterious recessive gene versions and pass two copies of that gene on to their offspring. Hence, the offspring of inbred matings tend to express many deleterious recessive genes, resulting in lower **fitness.** Introducing the new panthers to the Florida population helped reverse the effects of inbreeding by bringing in new gene versions that masked the negative effects of the recessive gene versions already present in the Florida panther population.



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With an evolutionary perspective, it's easy to understand why Florida panthers once seemed doomed. Their small population size not only put them closer to extinction in terms of sheer numbers, but also introduced the genetic risks of reduced genetic variation and increased inbreeding. Similarly, an evolutionary perspective helps explain why this conservation experiment was a success. Bringing in eight new panthers might seem like too little too late, but in fact, the genetic diversity they brought with them seems to have had significant benefits for the population. The new gene versions from the eight panthers outlasted their original carriers and have been passed down through the generations to individuals alive today. Now, the population size has tripled, genetic variation is up, and signs of inbreeding are down. And over the past 30 years, the panthers have gotten a further boost from increased legal protection and the establishment of additional protected panther habitat, as well as simple measures, like new freeway underpasses that help the cats avoid vehicles. Of course, the Florida panther is still endangered and will need continued protection and even more habitat to survive for the long term — but, as we've seen, understanding the evolutionary underpinnings of the panthers' plight will help biologists develop effective conservation plans for their future.

Handout 6
Vocabulary Think Chart

Modified from Fang, Z., Pringle, R. M., & Lamme, L. L. (2010). Language and Literacy in Inquiry-based Science Classrooms, Grades 3-8. Thousand Oaks, Calif: Corwin.

Complete the chart using the vocabulary words listed below

Questions	Answers
What is the target word?	
What does the word remind you of? Can you give a semantically related word, an orthographically similar word, or a real-life vignette triggered by the word?	
How is the word defined in the text? Can you paraphrase this definition?	
Can you come up with a sentence in which the target word is used in the scientific sense?	

Words:

Population

Genetic Variation

Gene

Inbreeding

Adaptations

Natural Selection

Heterozygote

Homozygote

Dominant gene

Recesive Gene

Deleterious gene

Fittness

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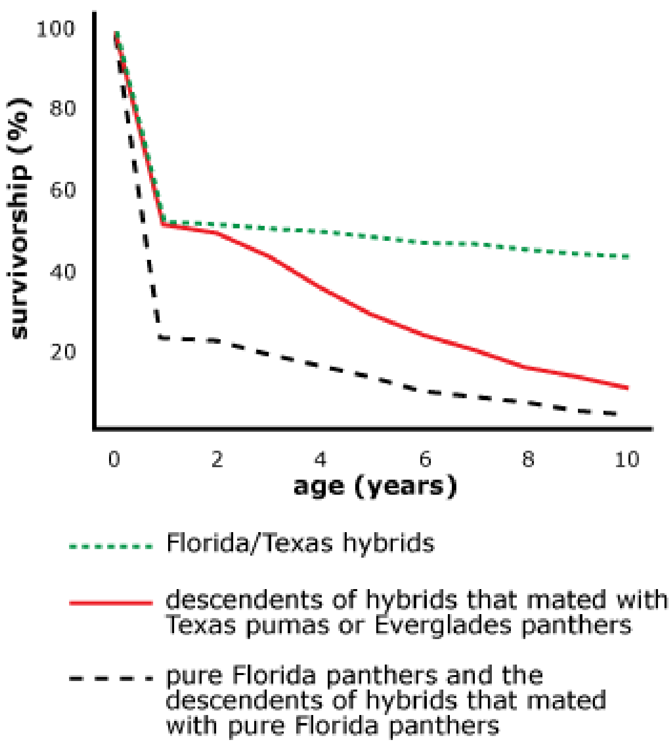
Handout 7
Text-Based Questions
Genetic variation helps rescue endangered panthers
December 2010
http://evolution.berkeley.edu/evolibrary/news/101201_panthers

1. Explain why genetic variation is so important to evolution.

2. How does genetic variation affect the population ability to stay healthy when facing pathogens and virus attack?

3. Analyze the graph to answer the following questions.



   a. Which panthers are most likely to survive to the oldest age?
   b. Which panthers exhibit the highest mortality at young ages?
   c. According to this graph, at what age range are panthers most likely to die?
   d. What does the slope of a line in a survivorship curve indicate?
   e. Give a potential genetic explanation for why the descendants of hybrids and other lineages don't survive as well as the hybrids themselves.

Exit Slip 1

- How does understanding evolution help us rescue endangered populations?
- How does knowledge of evolutionary history help us make conservation decisions?

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Part III – Teacher Handouts

Handout 8
Does air have matter?
Write a claim using evidence

Instructions:
Make a claim and support your claim by designing an experiment that will prove your reasoning. Participants will be asked to make a claim and support their claim by designing an experiment that

Use the following graphic organizer to consolidate your ideas.

Question: **Does air have matter?**	
Claim	Evidence
Reasoning: The evidence show … We know from (science disciplines) … We can apply (concepts) … Therefore, we conclude …	

Exit Slip 2:
What do you think will be the most challenging aspect about incorporation argumentation into your classes?

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Part IV – Student Lesson

Please refer to Cheating Cheetahs Prosper article and Index Cards Vocabulary Words in the Handouts.

Exit Slip 3:

Question from Audesirk, A., Audesirk, G., Byers, B. (2008). Biology Life on Earth. (8th Ed.). New Jersey: Pearson Prentice Hall Unit 3-Chapter 15

By the 1940s, the whooping crane population had been reduced to fewer than 50 individuals. Thanks to conservation measures, its numbers are now increasing. What special evolutionary problems do whooping cranes have now that they have passed through a population bottleneck?

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