



The Science of an Extreme Animal Athlete

INTRODUCTION

This worksheet explores concepts shown in the Scientists at Work video [The Science of an Extreme Athlete](#). The video investigates adaptations that allow deer mice living at high elevations to stay warm and active during the winter.

Through watching the video and completing this worksheet, you'll learn how two different populations of mice survive in their respective environments: one on top of a mountain and the other close to sea level. You will also apply your knowledge of the body functions and adaptations in other species. The topics in this worksheet relate to all mammals, not just mice. You will be able to apply what you learn to how populations of modern humans evolved to survive in unique environments.

PROCEDURE

Answer the following questions based on the information provided and what you learned from the video. You may want to use the video's transcript as a reference.

1. Hemoglobin is a protein that is critical to humans and other animals. Which of the following does hemoglobin carry to the tissues of the body?
 - a. Oxygen (O_2)
 - b. ATP
 - c. Heat
 - d. Carbohydrates
2. How does the hemoglobin in highland vs. lowland deer mice differ?

An **adaptation** is a characteristic, either behavioral or physical, that makes an organism more likely to survive and reproduce in its environment.

3. Give **one** example of an adaptation in the highland deer mice.

Natural selection is a process by which certain adaptations become more common in a population over many generations. The conditions associated with natural selection are shown in Table 1.

Table 1. The conditions for evolution by natural selection — variation (V), inheritance (I), differential survival and reproduction (D), and adaptation (A) — also known by the acronym VIDIA.

Condition	Description
Variation	Individuals in a population or group differ in some trait of interest.

<p>Inheritance</p>	<p>The variation in the trait of interest is at least partially inherited (passed from parents to offspring).</p> <p>The variation stems from random genetic mutations and the recombination that accompanies sexual reproduction. The genetic variation may have arisen many generations in the past.</p>
<p>Differential survival and reproduction</p>	<p>More offspring are born than can survive, resulting in competition among individuals within a population. Some individuals with a particular trait are more likely to survive and/or have relatively more offspring compared to individuals that do not have that trait.</p> <p>Selection depends on the specific context of a species. Traits that are beneficial in one environment may cause problems in another environment.</p>
<p>Adaptation</p>	<p>The frequency of the trait that helps individuals survive or reproduce will increase in the population over time, as will the frequency of the alleles that affect the trait. This process can take many generations and extend over very long periods of time.</p>

4. List the conditions of natural selection (V, I, D, and/or A) that you observed in the video. Briefly describe how each condition you listed applies to the deer mice.

5. Explain why the hemoglobin difference described in the video is advantageous to highland deer mice. Your answer should include the role of oxygen in the body.

6. If a population of lowland deer mice was moved to a high-elevation environment, do you think the population could adapt in the long term? Explain your reasoning using the conditions in Table 1.

EXTENSION: Human Adaptations in Mountain Regions

At 8,849 meters (29,032 feet) tall, Mount Everest is the world's highest mountain above sea level. It is part of the Himalayas, a mountain range in Asia.

1. Which of the following might be used more in mountain regions compared to sea-level regions?
 - a. Fats
 - b. Carbohydrates
 - c. Both fats and carbohydrates
 - d. Neither fats nor carbohydrates

Many of the local guides who help people climb Mount Everest belong to an ethnic group known as the **Sherpa**. The Sherpa traditionally lived in mountain regions in the Himalayas and, similar to the highland deer mice, may have biological adaptations to **hypoxia** (low body levels of oxygen).

The following is an excerpt from a scientific paper that investigated these adaptations.

Human populations resident at high altitude in the Himalayas have evolved mechanisms that allow them to survive and perform, including adaptations that preserve oxygen delivery to the tissues. Here, we studied one such population, the Sherpas, and found metabolic adaptations, underpinned by genetic differences, that allow their tissues to use oxygen more efficiently, thereby conserving muscle energy levels at high altitude, and possibly contributing to the superior performance of elite climbing Sherpas at extreme altitudes...

Our findings suggest that metabolic adaptations underpin human evolution to life at high altitude, and could have an impact upon our understanding of human diseases in which hypoxia is a feature...

Adaptation involves more than just increased O₂ delivery. In fact, acclimatization also involves alterations in O₂ use.

2. Based on the excerpt, propose a hypothesis about how differences in oxygen (O₂) usage by the muscles might help Sherpas survive at high elevations (or altitudes).