

Connect Sickle Cell Disease and Malaria: Natural Selection in Humans

Essential Knowledge 1.A.1 Natural selection is a major mechanism of evolution.

Challenge Area 1.2 You can evaluate evidence provided by data to qualitatively and/or quantitatively investigate the role of natural selection in evolution.

Building Block C Evidence for Evolution via Natural Selection

Goal of task

Genetic variation and mutation play key roles in natural selection. An adaptation is a genetic variation that is favored by selection and is manifested as a trait that provides an advantage to an organism in a particular environment. Evidence of evolution in a population is determined by changes in allele frequencies. Using data for a population, evolutionary change by natural selection can be evaluated to determine the frequency of alleles.

For this task you will be evaluated on your ability to

- Describe the relationships between sickle cell disease and malaria in the context of genetic variation, adaptations, natural selection and evolution.
- Evaluate population data to determine evidence of evolution in a population based on changes in gene frequency.

Task summary

You will be introduced to the connection between sickle cell disease and malaria in a short video. Take notes during the video so you can answer questions connecting sickle cell disease, malaria, adaptations, natural selection and evolution. You will then evaluate population data to determine evidence of evolution in a population based on changes in gene frequencies.

Task 1: Sickle cell disease and malaria (Individual)

As you watch the video and answer the questions that follow, think about the meaning of “the fittest” in terms of evolution and natural selection. Take note of the factors that link sickle cell disease and malaria.

1. Watch *The Making of the Fittest: Natural Selection in Humans* at http://media.hhmi.org/fittest/human_selection.html. During the video try to answer this question: How is sickle cell disease an example of adaptive evolution?

2. After watching the video, answer the questions that follow.

a. What is the genetic cause of the sickle cell allele?

b. What are some physiological effects of sickle cell disease?

c. What is the relationship between sickle cell disease and malaria in Africa?

d. Predict the expected frequency of the sickle cell allele in areas of Africa where malaria is not prevalent compared to areas where malaria is prevalent. Justify your prediction.

e. Give the predictions below for the frequency of the normal HbA hemoglobin allele and sickle cell HbS hemoglobin allele

Generations of study	Frequency of p allele for normal hemoglobin	Frequency of q allele for sickle cell hemoglobin	Frequency of homozygote-dominant hemoglobin p^2	Frequency of heterozygote hemoglobin $2pq$	Frequency of recessive sickle cell hemoglobin q^2
1		.16			
2		.2			
3	.3				
4		.22			
5	.2				
6		.18			
7	.84	.16			
8		.16			

- f. An outbreak of malaria occurred in the second and third generations of a population study. Explain the shift in frequency of the sickle cell allele.
- g. If malaria was controlled and eradicated in the region, what would happen to the frequency of the sickle cell allele? Explain your answer.
- h. Explain the relationship between natural selection and changes in allelic frequency for this population

Check your understanding

Can you

- Explain the relationship between malaria and sickle cell disease.
- Explain the importance of the discovery of the connection between malaria and sickle cell disease.
- Explain its place in evolutionary science.

This activity was developed by the College Board, based on “The Making of the Fittest: Natural Selection in Humans,” a video from the Howard Hughes Medical Institute website: http://media.hhmi.org/fittest/human_selection.html.