The Mystery Disease Name:

Why Is There Such a High Prevalence of the Mystery Disease?

Student Challenge:

For this activity, your challenge is to come up with an explanation for why a seemingly deleterious allele (the allele for this mystery disease) is maintained in a population when, normally, deleterious alleles are removed from a population over time.

You will use some of the data that scientists used during the 1940s and 1950s to come up with your own explanation to account for the unusually high frequencies of this allele. The data are found on the following pages, and they come from Uganda, Africa.

Specifically, your goals will be to attempt to come up with theories to explain why:

a) There appear to be a high number (frequency) of carriers of the disease in certain locations.
b) Why there is such a mixture of high frequencies and low frequencies across the country.

Before you begin, answer the following question:

1. As scientists, you all have access to the same data for this problem. Do you think that you will all come up with the same explanation for the unusually high frequencies of this allele? Why or why not?

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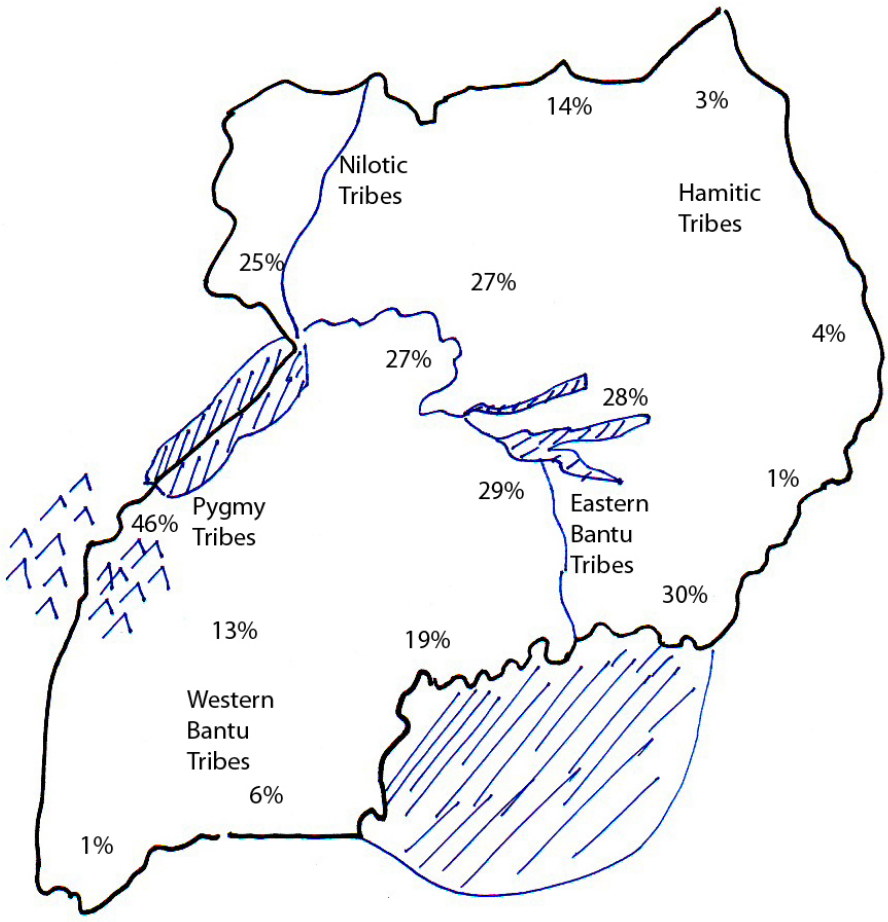
Uganda Tribes and Allele Frequencies



Data adapted from:
Herrick, A. (1969). Area Handbook for Uganda, U.S. Gov't. Printing Office, Washington, pp. 79-81.
Allison, A. C. (1954).
Lehmann, H. (1953).

Tribal Group	Allele Frequency	Between Group Contact*
Bantu (Eastern)	High	With Nilotic
Bantu (Western)	Moderate	None
Hamitic	Low	None
Nilotic	High	With Eastern Bantu
Pygmy	Very High	None

*Contact means the amount of immigration, emigration, and intermarriage that occurred with potential neighbors.

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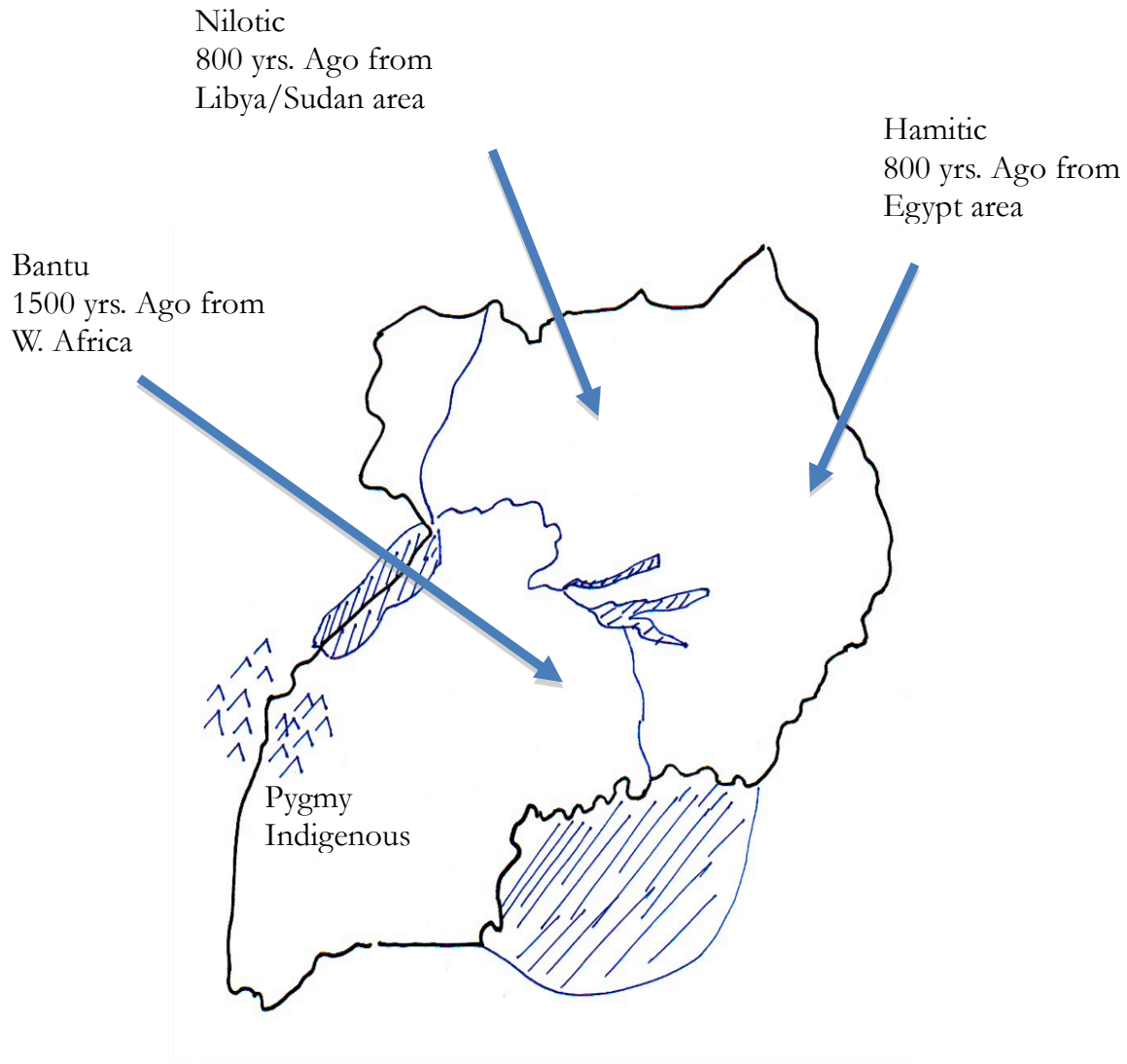
Uganda Tribal Group Immigration Data



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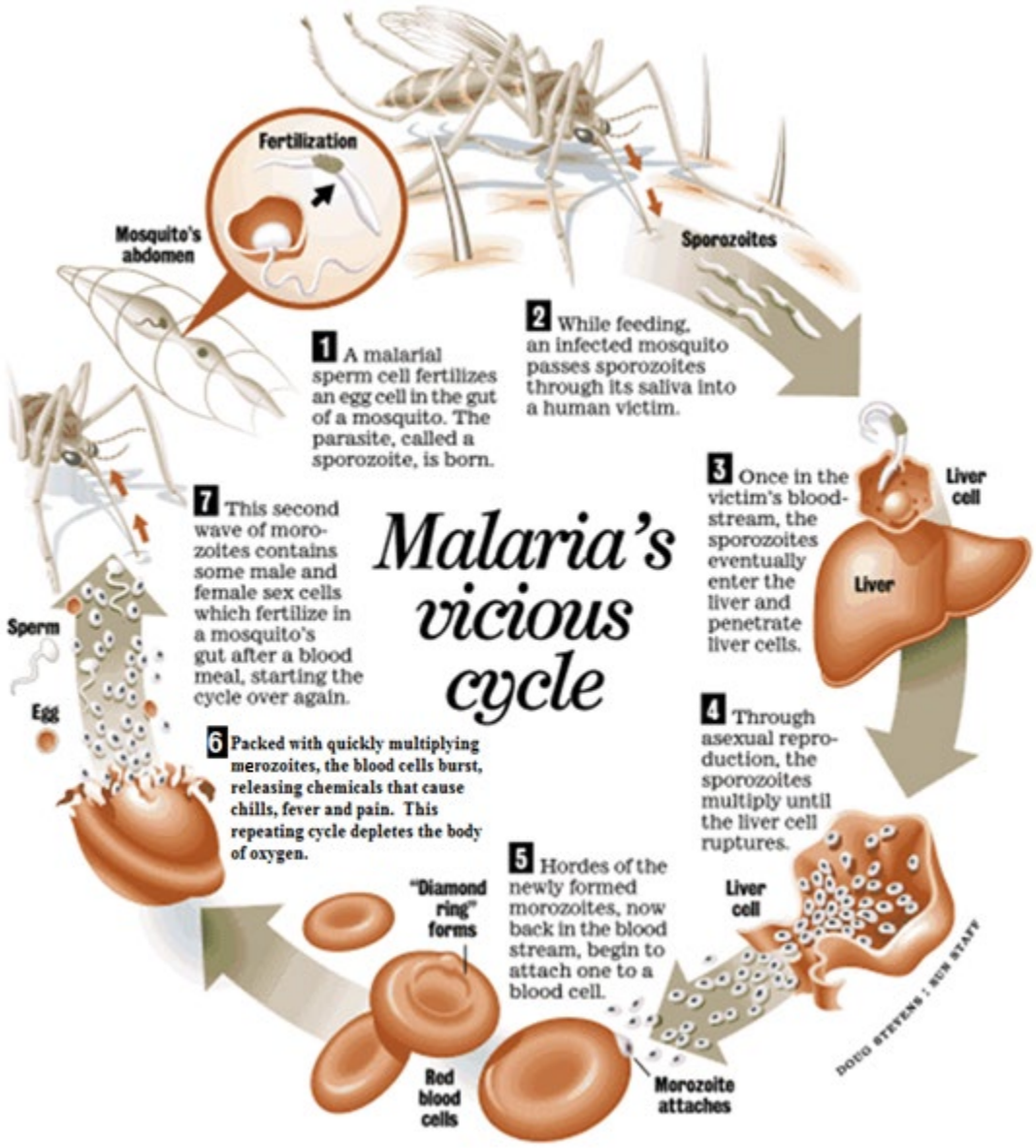
Malaria's Vicious Cycle

While medical researchers were performing blood tests on various tribal groups in Uganda, they noticed that certain infectious diseases, such as malaria, were prevalent in the area. So, the researchers also qualified and quantified the degree of severity of malaria across Uganda.

Below is information regarding the malarial parasite's life cycle and on the following pages are data regarding the incidence of malaria across Uganda.



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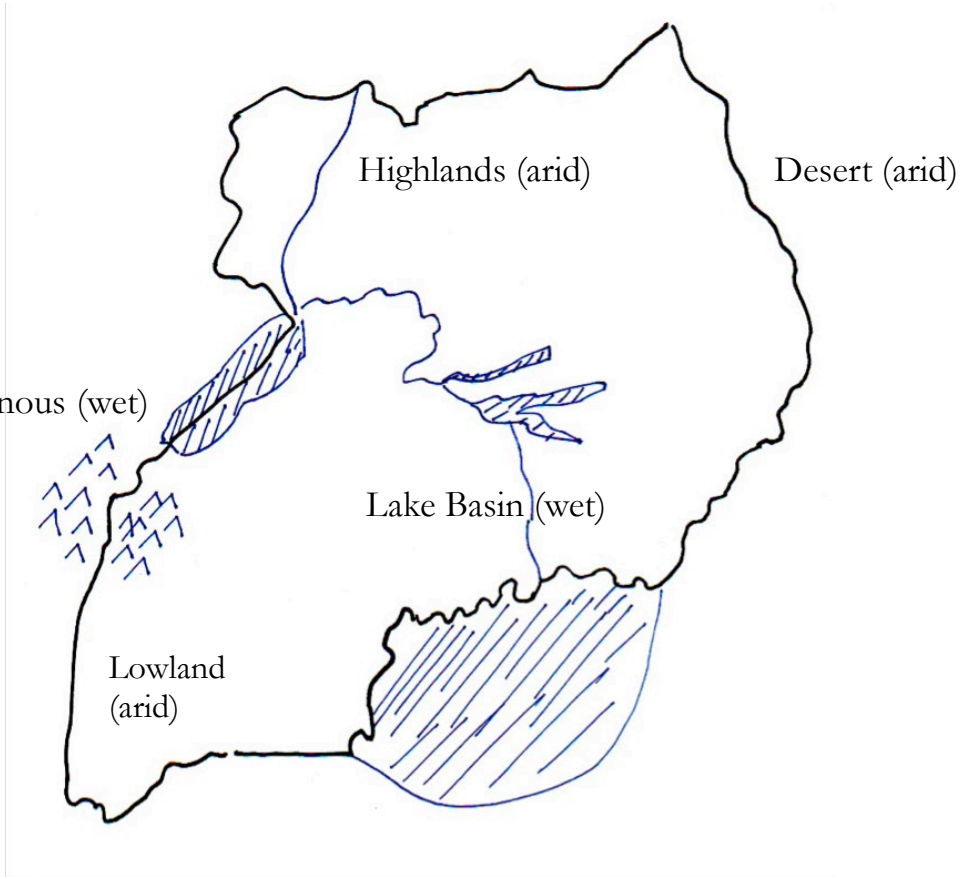
Weather in Uganda



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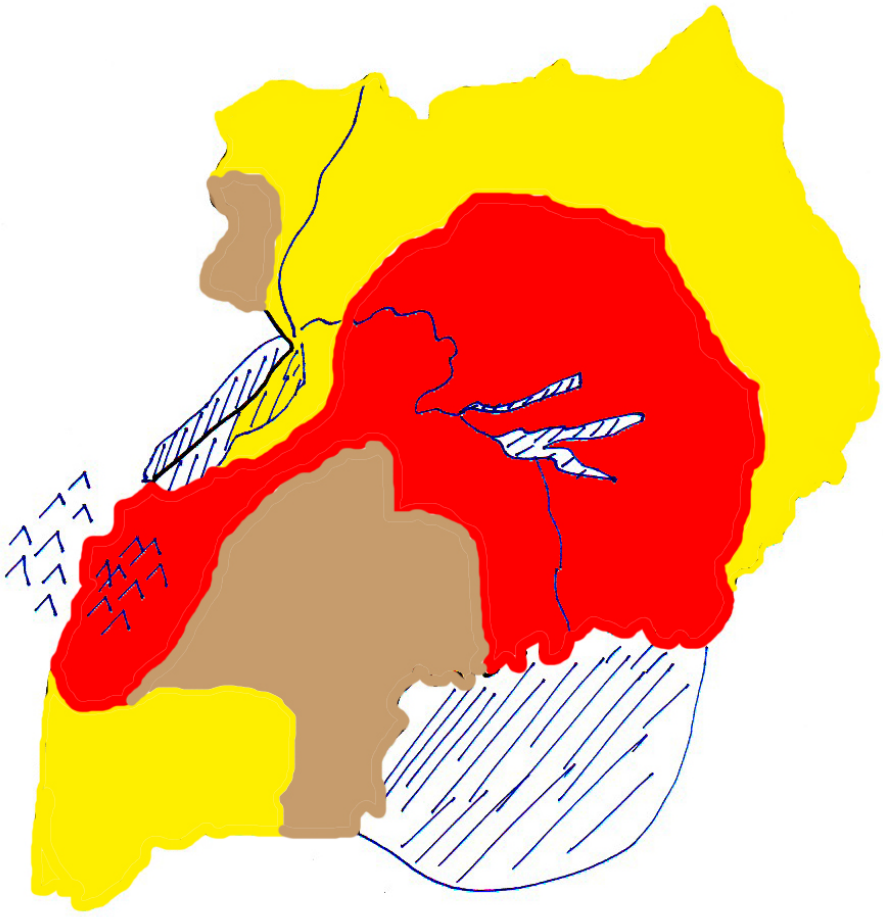
Exposure to Malaria in Uganda



Normally malaria free

Seasonal malaria (periods of exposure followed by relief)

Hyperendemic malaria (continual exposure)

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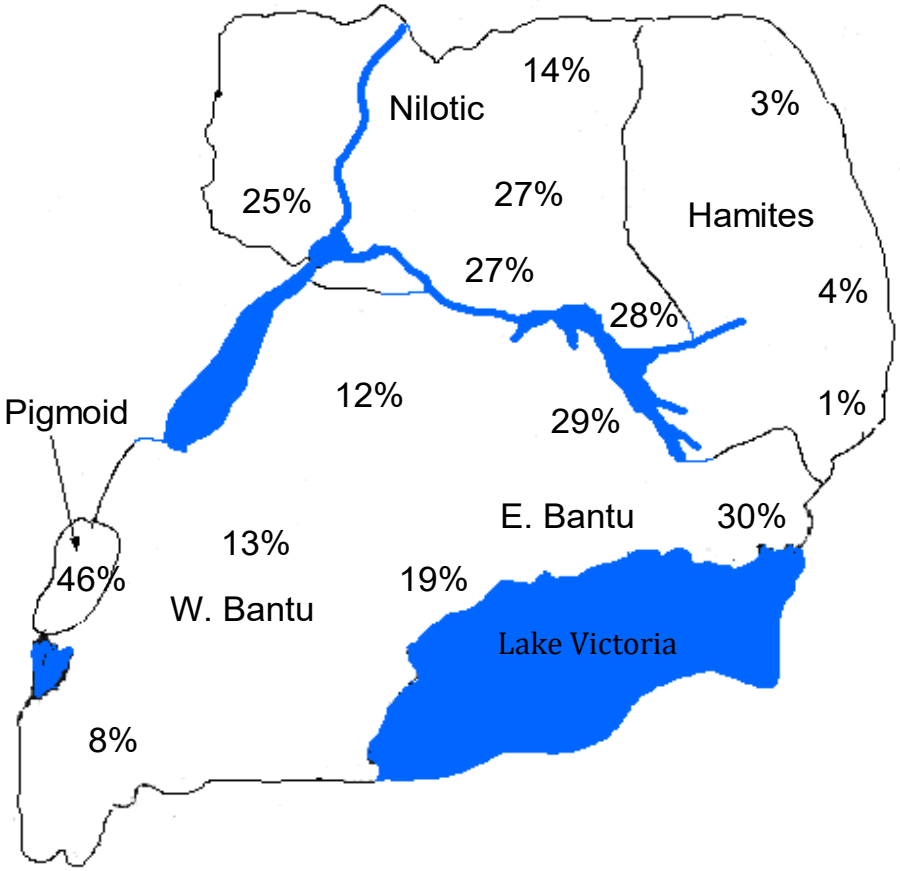
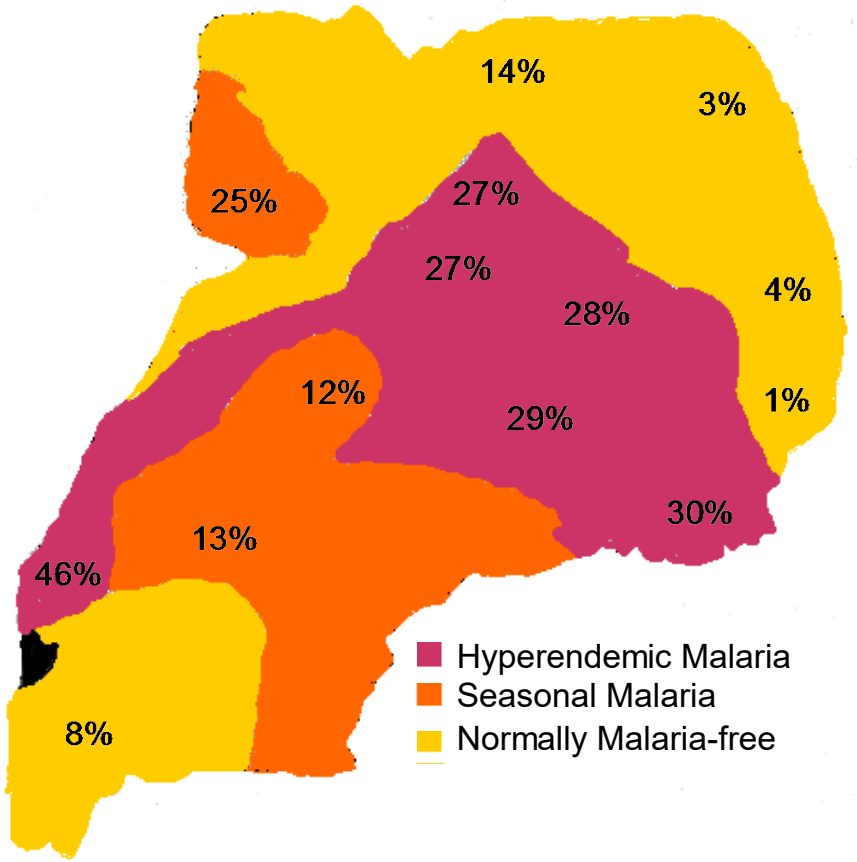
1954: Heterozygote Advantage

Allison's Research





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Anthony C. Allison's Research

Anthony C. Allison, a medical researcher in the early 1950's, was interested in conducting further analyses on the apparent correlation between the seemingly high frequencies of the mystery disease and the presence of malaria in Uganda. Allison drew blood samples from Ugandan children to use for his research on the mystery disease. He analyzed the blood of each child to determine whether they were a carrier for the disease or had a normal genotype, and for the presence of the malarial parasite, *Plasmodium falciparum,* including its density in the red blood cells.

Genetic Disposition	Total Number of Children Examined	% Children with *P. falciparum*	Parasite Density Index
Normal ("+/+)"	247	46	5.9
Carrier ("+/-")	43	28	4

Note: Parasite Density Index = a general measure of the amount of malarial parasites in the red blood cells per volume of blood.
(Adapted from: Allison, A. C. (1954) and Raper, A. (1959)).

2. Do you think these new data shed any light on why there are high versus low frequencies of the mystery disease in various areas of Uganda? Explain.

3. Do you find it troubling that you are basing your explanations for the seemingly high frequencies of the mystery disease on data collected using observational methods rather than controlled experiments? Why or why not?

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Data Analysis and Conclusions:

To help you with the following questions, fill in the following chart based on what you've learned about the mystery disease:

Genotype	+/+	+/-	-/-
Red Blood Cell Shape?			
Advantage?			
Disadvantage?			

4. Both the earlier in-vitro blood test and the later in-vivo blood test that you learned about measured the presence of structural changes in the red blood cells under low oxygen environments. What could be affected within the red blood cells to cause these structural changes?

5. Based on your answer to question #4, what are possible differences between the blood of a normal person, a carrier, and the mystery patient?

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6. Why do you suppose there is an increased resistance to malaria in those who are heterozygous for the mystery disease allele?

7. Do you think experiments are necessary for knowledge to develop in science?

8. Has your hypothesis to explain the frequencies changed? If so, what caused it to change? If not, why not?