Mutations and Evolution

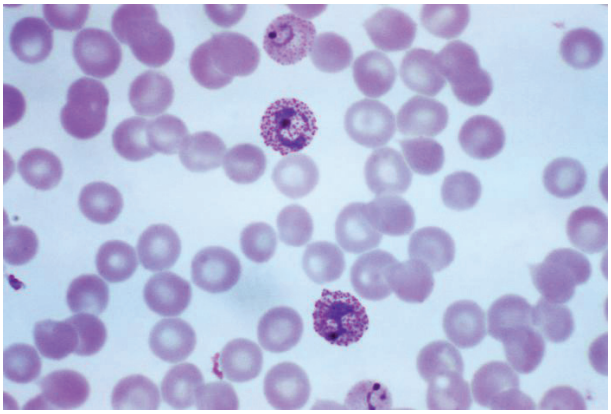
COMPUTER SIMULATION

Some traits are more advantageous than others in certain environments. Variations in traits result from mutations. Over time, the frequency of variations in a population can change. This change in trait frequency resulting from natural selection is central to the process of evolution.

In this activity, you will study a community in sub-Saharan Africa where malaria is a problem. You will use a computer simulation to predict and analyze how trait frequency changes in your population when there is a change in the environment, such as improvements in health care or decreased levels of malaria.

GUIDING QUESTION

Why does sickle cell trait frequency vary across the world?



Plasmodium *infecting red blood cells*

Sickle Cell Simulation

In the "Mutations: Good or Bad?" activity, you started a community in a remote part of sub-Saharan Africa and followed the sickle cell trait through two generations. Now you will first examine up to 30 generations of your community in the same environment. Then you will investigate how changes in the environment are likely to affect your population. These changes could include resources that help maintain health, such as building health clinics in your region or investing in better pest control to minimize the mosquito population.

MATERIALS

For each pair of students

computer with Internet access

PROCEDURE

Part A: Simulating More Generations

1. Visit the *SEPUP Third Edition Evolution* page of the SEPUP website at *www.sepuplhs.org/middle/third-edition* and go to the sickle cell simulation.
2. Set the variables to match your community from the previous activity.
   a. Percent chance of getting malaria: This is the percentage chance for each individual of getting malaria, or the incidence rate. The available choices are 0, 25, 50, 75, or 100%. In your community, the chance of getting malaria is 100%.
   b. How good is the health care: This is the level of health care and resources available. Three levels are available: no health care, ok health care, or great health care. Your community has no health care.
3. Press "Run Simulation." The simulation will generate two graphs with your results.
   - Graph 1: This bar graph shows how many children survived to adulthood and reproduced in each generation. This graph is similar to the graph you produced in the last activity.
   - Graph 2: This line graph shows the percentage of each trait in the population for each generation over time.

4. Record your results and any additional data or observations. Be sure to note any questions you have that you would like to test.
5. Answer Analysis item 1.

Part B: Changing Environments

6. Now use the simulation to test how changing the environment affects the frequency of the sickle cell trait in your population. Change the variables to alter the percent chance of getting malaria or the quality of health care.
   Hint: Change one variable at a time.
   a. Record your variables and the results.
   b. Write down any other questions that you would like to test.
   c. Continue to do this until you can explain the cause-and-effect relationship between the variable and the frequency of sickle cell carriers in the population.

ANALYSIS

1. Use the data you collected or observations you made about the environment to complete the following:
   a. Use a mathematical representation, like a ratio or percent, to explain what happened to the frequency of the sickle cell trait over time when the chance of getting malaria was high and there was no health care.
   b. Is there a cause-and-effect relationship? If so, describe that relationship. If not, explain why not.
2. Explain how environmental changes affect the sickle cell trait over time in your population. Use evidence, including mathematical representations, from your investigation to support your explanation.
3. Explain why the frequency of sickle cell trait is so much higher in sub-Saharan Africa than in most other parts of the world.
4. What do you think would happen to the sickle cell trait in an environment with no malaria and increased resources? Explain your prediction.