

How can we use genetic engineering to get rid of malaria for good?

TEACHER'S KEY

Check your understanding

1 *Anopheles gambiae* mosquitoes are a vector species for malaria. What is a vector species? Can you find out about some other vector species and the diseases they transmit?

Answer A vector is an organism that does not cause disease itself but which spreads infection by transmitting pathogens (virus, bacteria, parasites, etc.) from one host to another. Mosquitoes are vector species of many infectious diseases including malaria, dengue, yellow fever, Zika, and West Nile virus. Some other vector species are ticks (Lyme disease), fleas (bubonic plague), raccoons, bats, foxes, skunks (rabies).

2 Scientists genetically engineered *Anopheles gambiae* mosquitoes. What were the characteristics of engineered mosquitoes that drove the lab populations to extinction?

Answer Male mosquitoes with one or both copies of the mutated gene had no physical differences but they were carriers of the mutated gene and passed it onto their offspring. Female mosquitoes with one copy of the mutated gene were healthy but they had reduced fertility. They passed the mutated gene on to the next generation. Females with two copies of the mutated gene had male body parts (a mouth that is not structured to bite, claspers, and hairy antennae). Most importantly, they were infertile - they couldn't lay eggs. So once all females carried two copies of the mutated gene, the population collapsed.

3 Scientists used a new approach that made this study so successful at wiping out mosquito populations: CRISPR/Cas9 gene drive. What is the purpose of a gene drive? How does it speed up the spread of a useful genetic mutation?

Answer In sexual reproduction, half of the genes come from the male organism and the other half come from the female organism. So, there is a 50% chance of inheritance of the mutation. When CRISPR/Cas9 gene drive is used, the mutated gene copies itself to the other chromosome (the one that would come from the wild, unmutated parent) which ensures that 100% of the offspring population carries the mutated gene. With this increased ability of inheritance, caged populations that started with only 25% mutated heterozygous male mosquitoes, reached 100% spread at 7th (cage 2) and 11th (cage 1) generation.

4 **Writing connection:** This study gives us a very powerful tool in our fight against malaria and other mosquito-borne diseases. But, we need public support and approval to use it. Write a letter to a skeptical audience and persuade them to support the genetic engineering method used in this study. **Consider:** Who is your target audience? What are their concerns? How would you address these concerns using scientific evidence?

Answer Student's own. Claim-evidence-reasoning format could be introduced to the students through this question.

What happens as the mutated gene increases as a proportion of the population?

Answer As the mutated gene spreads through the population, the numbers of mosquitoes begin to decline until the population crashes.