



PART 1

Read the text below and answer questions 1–13.

GENE DRIVES: A POWERFUL AND CONTROVERSIAL TOOL

Gene drives are engineered genetic systems intended to bias inheritance so that a chosen trait spreads through a population more rapidly than it would by chance. Under normal Mendelian inheritance, a parent typically passes one of two gene variants to offspring with roughly equal probability, so changes in allele frequency usually occur gradually across generations. By contrast, a drive is designed to tip this balance, making a particular genetic element disproportionately likely to be inherited. Researchers view this as a potential tool for vector control, for suppressing invasive species in contained ecosystems, and for helping threatened populations resist pathogens, while critics emphasise that a self-amplifying intervention is fundamentally different from a conventional, locally contained treatment.

Most modern gene-drive prototypes rely on CRISPR technology, commonly pairing a Cas9 nuclease with one or more guide RNAs that direct DNA cutting to a specific genomic site. In the widely discussed “cut-and-copy” approach, the engineered construct is inserted into one chromosome. When the organism forms reproductive cells, Cas9 cuts the corresponding sequence on the paired chromosome. The cell then repairs the break, and if the drive is present, it can be used as a template during repair, copying the drive onto the previously unmodified chromosome. This “homing” process converts a heterozygote into a homozygote for the engineered element, meaning that most offspring inherit the drive rather than only half.

Potential public-health applications have received the greatest attention. Malaria remains a major cause of illness and death in several regions, and in some settings it has proved difficult to control sustainably. Conventional measures—bed nets, indoor spraying with insecticides, and habitat management—can reduce transmission, but they do not eliminate the disease and may be undermined by insecticide resistance or gaps in coverage. A gene drive could, in principle, spread traits that reduce a mosquito’s ability to host parasites or that suppress mosquito populations through sterility, offering a novel complement to existing interventions rather than a replacement for them.

Yet the ecological context complicates these promises. Mosquitoes and other target organisms are embedded in food webs and interact with predators, competitors, and pathogens. Reducing a vector species could have effects beyond the intended outcome, particularly in ecosystems where the target plays multiple roles. Moreover, evolution can produce second-order consequences: if selective pressure changes, other species may



expand into the same niche, or the target population may shift its behaviour or breeding patterns. Because gene drives are designed to spread, their effects may be difficult to confine geographically, raising concerns about transboundary movement and the potential for unintended spread across political borders.

Technical uncertainty is amplified by the problem of resistance. If the target DNA sequence mutates, the CRISPR system may fail to recognise and cut the site, allowing “drive-resistant” alleles to persist or even become favoured. Resistance can emerge through natural variation, error-prone repair pathways, or selection against the drive. To reduce this risk, researchers often aim at highly conserved regions of the genome and may deploy multiple guide RNAs so that the drive must be escaped at several sites simultaneously. Even so, laboratory conditions differ from natural environments, and long-term population dynamics can diverge from early experimental expectations.

Because of these uncertainties, governance and bioethics are central to debates about deployment. One issue is consent: if a release in one jurisdiction spreads into neighbouring regions, communities that never agreed to the intervention may still experience ecological and social consequences. Another issue concerns fairness in the distribution of risks and benefits. Field trials may occur in locations that bear ecological uncertainty, while the most visible benefits—reduced disease burden or protected agriculture—may be valued differently elsewhere. For this reason, many frameworks call for transparent decision-making, inclusive engagement, and accountability mechanisms that extend beyond scientific institutions.

Several design strategies aim to increase controllability and ecological containment. Threshold-dependent drives are intended to spread only if introduced above a certain frequency, making accidental establishment less likely and allowing for a more deliberate decision to initiate spread. Other approaches attempt to localise spread by using ecological isolation, staged releases, or physical containment measures during trials. Reversal drives have been proposed as a countermeasure that could, in theory, overwrite or neutralise a previous drive, but they are generally discussed as a concept rather than a guaranteed remedy, especially given the complexity of natural ecosystems and the possibility of evolving resistance to the reversal itself.

Public communication and political legitimacy can determine whether research proceeds at all. Past disputes over genetically modified crops illustrate that technical assurances do not automatically generate trust. Communities may weigh risks through cultural, ethical, or historical lenses, valuing ecological integrity, sovereignty, or spiritual beliefs alongside public-health goals. If governance is perceived as technocratic or extractive, gene drives can become symbols of imposed control rather than cooperative problem-solving.



Conversely, credible oversight, open data practices, and respectful engagement can improve the quality of deliberation even when disagreements remain.

Many experts therefore argue that the key question is not whether gene drives are powerful, but whether they can be governed responsibly. Responsible governance implies clear regulatory pathways, international coordination for transboundary movement, staged testing from laboratory to contained field trials, and realistic monitoring plans that can detect adverse outcomes early. It also requires humility about off-target effects, ecological feedbacks, and social consequences that are not easily captured in models. The promise of gene drives is substantial, but so is the requirement for caution and shared decision-making.

Questions 1–4

Complete the sentences below. Choose **NO MORE THAN TWO WORDS** from the text for each answer.

- 1 Gene drives spread through populations faster than would occur under normal
- 2 In the cut-and-copy process, the cell repairs the DNA break using the drive as a
- 3 One method used to reduce resistance is targeting conserved regions or using multiple
- 4 Because a release may cross borders, communities that never gave their may still be affected.

Questions 5–9

Select the correct answer.

- 5 According to the passage, what feature makes gene drives particularly difficult to manage once released?
A They work only in isolated laboratory strains
B They require constant human intervention to keep spreading
C They can be self-propagating and hard to control in the wild
D They prevent mutation at the target site
- 6 What ecological concern is raised about reducing a disease-vector species?
A Parasites immediately become more dangerous.
B Food webs cannot adapt to any change in species numbers.



- C** Mosquitoes cannot evolve resistance under any conditions.
- D** Interconnected ecosystems may be affected beyond the target species.

7 Why might a gene drive fail or behave unpredictably over time?

- A** The drive always eliminates the organism's ability to reproduce.
- B** The target site may mutate so the CRISPR system no longer recognises it.
- C** Bed nets and insecticides increase DNA repair errors in mosquitoes.
- D** Subcontracting in supply chains interferes with inheritance.

8 What limitation of “reversal” drives is emphasised in the passage?

- A** Their effectiveness in complex environments is uncertain
- B** They require no further monitoring once deployed
- C** They are designed to spread only above a threshold frequency
- D** They have already been proven reliable in long-term field studies

9 What does the passage imply about public acceptance of gene-drive projects?

- A** Trust is guaranteed if researchers publish technical results
- B** Oversight and community values shape whether projects gain legitimacy
- C** Communication is unnecessary when public health benefits exist
- D** People evaluate risks only in economic terms

Questions 10–13

Choose **TRUE** if the statement agrees with the information given in the text, choose **FALSE** if the statement contradicts the information, or choose **NOT GIVEN** if there is no information on this.

10 The passage states that conventional malaria controls have removed the disease as a major cause of death in some regions.

11 The passage suggests that a release could affect people in other areas who did not agree to it.

12 The passage claims that “threshold-dependent” drives are intended to spread only if introduced above a certain level.

13 The passage provides evidence that “reversal” drives reliably undo earlier changes in real-world ecosystems.

Answer Key



1. Mendelian inheritance
2. template
3. guide RNAs
4. consent
5. C
6. D
7. B
8. A
9. B
10. NOT GIVEN
11. TRUE
12. TRUE
13. FALSE