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EDITORIAL ANALYSIS

Rewriting Inheritance: Why Gene Drives Need Governance Before Release

 THE HINDU

15 July 2026

SCIENCE & TECH

GS3

CURATED & WRITTEN BY

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THE LIFT LINE

A technology that can rewrite the inheritance of an entire wild species offers to erase diseases that have killed for millennia, yet the same power that makes it miraculous makes it irreversible, and the wise course is to build the brakes before we ever press the accelerator.

WHY THIS EDITORIAL MATTERS FOR YOUR EXAM

Gene-drive technology uses CRISPR-based genetic engineering to force a chosen trait through a wild population far faster than ordinary inheritance would allow, so that a released trait spreads to nearly all descendants. Its most promising application is public health, engineering mosquitoes so they cannot transmit malaria or so their populations crash. The prize is enormous, the potential end of some of humanity's deadliest vector-borne diseases. The peril is equally large, because a self-propagating genetic change in the wild cannot easily be recalled and could disrupt ecosystems in ways we cannot fully predict. The issue matters because it forces a decision on how to govern a powerful, dual-use, and potentially irreversible technology before, not after, it is deployed.

GS Paper 3: Developments in science and technology, biotechnology, and conservation and environmental impact.

For **Prelims**, hold the specifics: CRISPR-Cas gene editing and the concept of super-Mendelian or biased inheritance, whereby a gene-drive element is inherited by far more than the usual half of offspring; the precautionary principle in environmental governance; the Convention on Biological Diversity and its Cartagena Protocol on Biosafety, which governs the **transboundary** (<https://ujjari.com/vocab/transboundary/>) movement of living modified organisms; India's Genetic Engineering Appraisal Committee, GEAC, the apex

biosafety regulator under the Environment Protection Act; and the dual-use dilemma, where the same technology can heal or harm. **For Mains, argue that the governance of irreversible technologies must be anticipatory and international, since ecological effects respect no national boundary.**

BACKGROUND AND CONTEXT

Ordinary inheritance passes a gene to about half of an organism's offspring, so an engineered trait tends to dilute and disappear over generations. A gene drive breaks this rule by copying itself onto the partner chromosome, so nearly every descendant inherits it, allowing a trait to sweep through a population within a few generations. Applied to malaria-carrying mosquitoes, this could suppress the vector or block transmission at a scale no bed net or spray can match.

The very feature that makes gene drives effective, self-propagation through the wild, is what makes them hazardous. Once released, a drive spreads on its own, crosses borders with the insects that carry it, and may be hard to reverse. Removing a species from a food web, even a disease vector, can ripple through an ecosystem. This is why scientists themselves urge caution, reversibility, and staged testing rather than a rush to open release.

THE CORE ARGUMENT / ISSUE

The promise: disease elimination at scale

For diseases like malaria that kill hundreds of thousands annually, gene drives offer a durable, self-sustaining intervention. Unlike drugs or nets that require constant reapplication, a drive works continuously once established, which is transformative for regions with weak health infrastructure.

The peril: irreversibility and ecological disruption

A self-spreading genetic change is difficult to confine or recall. It could affect non-target species, alter predator-prey balances, or evolve in unexpected ways. The precautionary principle counsels that where an action risks serious or irreversible harm, the absence of full scientific certainty should not be a reason to proceed carelessly.

ASPECT	OPPORTUNITY	RISK TO WEIGH
Disease control	Self-sustaining suppression of vectors	Non-target and ecosystem effects
Reach	Spreads through wild populations	Crosses borders, hard to recall
Reversibility	Reversal drives being researched	No proven large-scale off-switch yet
Use	Public-health benefit	Dual-use and biosecurity (https://ujiyari.com/vocab/biosecurity/) concern

The governance gap

Existing frameworks such as the Cartagena Protocol address living modified organisms but were not designed for self-propagating drives that move autonomously across nations. This gap makes phased trials, reversible designs, and agreed international rules essential before any environmental release.

HOW TO THINK ABOUT THIS (ANALYTICAL FRAME)

Apply the precautionary principle [calibrated](https://ujiyari.com/vocab/calibrated/) (<https://ujiyari.com/vocab/calibrated/>) to irreversibility. The decision rule is not simply cost versus benefit but reversibility versus permanence, because a mistake that can be undone is tolerable while one that cannot may be catastrophic. The transferable rule for GS3 is that the governance intensity a technology deserves should scale with the irreversibility and geographic spread of its effects. The examiner rewards the candidate who neither dismisses gene drives as reckless nor embraces them uncritically, but who argues for a staged pathway, contained laboratory work, then confined field trials, then reversible designs, under domestic biosafety oversight through GEAC and an international regime anchored in the Convention on Biological Diversity.

THE DIAGRAM IN WORDS

CRISPR gene drive engineers super-Mendelian inheritance -> trait spreads to nearly all offspring -> released mosquitoes could end malaria transmission -> but drive self-propagates through wild populations -> crosses borders, hard to recall, may disrupt ecosystems -> precautionary principle: irreversible risk demands caution -> existing rules (Cartagena Protocol, CBD, GEAC) not built for autonomous drives -> path forward: phased trials, reversible designs, international governance before any field release

WAY FORWARD

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- 1 **Adopt a phased, contained pathway.** Government and regulators should require laboratory and confined field trials with rigorous monitoring before any open release is even considered, so that evidence precedes exposure.
- 2 **Prioritise reversible and self-limiting designs.** Fund research into drives that can be halted or reversed, and into daisy-chain or [threshold](https://ujivari.com/vocab/threshold/) designs that limit spread, building an off-switch before deployment.
- 3 **Strengthen domestic biosafety oversight.** Equip the GEAC with the expertise and [mandate](https://ujivari.com/vocab/mandate/) to appraise gene-drive proposals, ensuring transparent, science-led, and publicly accountable decisions.
- 4 **Build an international governance regime.** Since drives cross borders, pursue agreed rules under the Convention on Biological Diversity and the Cartagena Protocol, with community consent for affected regions, so that no single actor releases a drive unilaterally.

PYQ LINKAGE AND PRACTICE

UPSC has asked about genetic engineering, biotechnology regulation, and the balance between innovation and biosafety. This editorial applies the precautionary principle to a frontier technology, which is the analytical maturity the examiner rewards over a bare description of CRISPR.

Practice question: “The governance of an irreversible technology must be anticipatory and international.” Examine this statement with reference to gene-drive technology and India’s biosafety framework. (250 words, 15 marks)

Sources: The Hindu (<https://www.thehindu.com/>), *Convention on Biological Diversity* (<https://www.cbd.int/>), *Ministry of Environment, Forest and Climate Change* (<https://moef.gov.in/>)

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