



Enhancing Mosquito Control through Genetic Engineering

For Prelims: [Genetically Modified Mosquitoes](#), [Genetic Engineering](#), [Malaria](#), [Dengue](#), [Zika](#), [Yellow fever](#), Wolbachia, [Genome Sequencing](#), [DNA](#), OX5034 Mosquito.

For Mains: Benefits and Risks of Genetic Engineering for Mosquito Control.

Source: [TH](#)

Why in News?

The rapid [urbanization](#) of the world's populations, especially in **many large and economically developing countries like India**, has led to annual **surges in mosquito-borne illnesses**.

- One of the emerging innovative methods of mosquito control is genetic engineering, which involves altering the traits or behavior of mosquitoes.

Why the Need for Innovative Mosquito Control Approaches?

- **About:**
 - Mosquitoes are **small, flying insects belonging to the family Culicidae**. They are known for their distinctive **buzzing** sound and are **notorious for their role in transmitting diseases to humans and animals**.
 - They can transmit deadly diseases such as [Malaria](#), [Dengue](#), [Zika](#), and [Yellow fever](#), affecting millions of people every year.
- **Changing Landscape of Mosquito-Borne Diseases:**
 - **Urbanization and Climate Change:** The rapid urbanization of the global population, particularly in developing countries like India, has contributed to annual surges in mosquito-borne diseases like dengue.
 - Additionally, [climate change](#) has **expanded the territories where these diseases are prevalent**, exemplified by **indigenous cases of dengue in France**.
 - **Current Control Measures:** In the ongoing battle against mosquitoes, a range of tools has been employed, including **mosquito nets, insecticides, and the use of symbionts like [Wolbachia](#)**.
 - Despite the availability of a first-generation malaria vaccine, insecticide resistance in mosquitoes is a growing concern, **necessitating the exploration of new control approaches**.

How can Genetic Engineering be Harnessed for Mosquito Control?

- **Genome Sequencing:** Recent advancements in **next-generation sequencing techniques** have enabled researchers to obtain whole genome sequences for various mosquito species.
 - Notably, research institutions like the **University of California and institutes in**

Bengaluru, India, have contributed to **high-quality reference genomes for *Anopheles stephensi*, a major malaria vector.**

- The availability of mosquito genome sequences and our capacity to genetically manipulate them offer unprecedented opportunities for mosquito control.
- **Gene Drive Technology: Gene-drive technology**, developed by **Austin Burt** (Professor at Imperial College London) **in 2003**, aims to manage mosquito populations by **changing how they inherit certain genes, breaking the usual genetic rules explained by Mendel.**
 - This technology uses **special proteins to edit mosquito DNA**. When these proteins cut the mosquito's DNA, the **cell fixes it by adding a specific genetic sequence.**
 - This **change affects the mosquito's ability to have offspring and stops the malaria parasite from multiplying inside them**, making the mosquitoes unable to spread the disease.
 - Researchers at Imperial College London genetically enhanced a gene in mosquitoes to secrete **antimicrobial substances, disrupting the *Plasmodium* parasite's development** and reducing mosquito lifespan.

OX5034 Mosquito

- The US Environmental Protection Agency authorized the release of the **genetically modified OX5034 mosquito in Florida and Texas** in 2020.
 - This mosquito is developed with a gene sensitive to an antibiotic, **tetracycline.**
 - It carries a **self-limiting gene** that **prevents female offspring from surviving**, leading to a reduction in mosquito populations.

What are the Benefits and Risks of Genetic Engineering for Mosquito Control?

- **Benefits of Genetic Engineering for Mosquito Control:**
 - **Targeted Mosquito Control:** Genetic engineering allows for the precise modification of mosquito populations, focusing on disease-carrying species.
 - This targeted approach **reduces the need for broad-spectrum insecticides**, minimizing harm to non-target species.
 - **Reduced Environmental Impact:** Compared to traditional insecticides, genetic engineering may have a lower environmental impact because it **does not involve chemical pollution of ecosystems.**
 - This can help protect other beneficial insects and **aquatic life.**
 - **Sustainability:** Once released, genetically modified mosquitoes can continue to pass on their modified genes, **providing a sustainable and self-perpetuating method of mosquito control** without the need for frequent reapplications.
 - **Public Health:** By **reducing mosquito-borne diseases**, genetic engineering can have a significant positive impact on public health, potentially **saving countless lives and reducing healthcare costs** associated with treating these diseases.
- **Risks and Concerns of Genetic Engineering for Mosquito Control:**
 - **Unintended Consequences:** Genetic modifications can have **unforeseen consequences in ecosystems.**
 - Altered mosquito populations may **disrupt food chains or create ecological imbalances**, impacting other species in unintended ways.
 - **Ethical Concerns:** Critics have **ethical objections to manipulating the genes of organisms**, particularly when it involves altering the genetics of wild populations. **Questions of ecological responsibility arise.**
 - **Risk of Invasion:** Genetically modified mosquitoes may unintentionally **acquire traits that enhance their ability to invade new habitats**, potentially causing unforeseen ecological disruptions in regions outside their natural range.

Conclusion

Genetic engineering holds the potential to **revolutionize mosquito control for disease prevention**. However, it is imperative that we continue to address the associated risks of environment and ethical considerations through rigorous research and adaptable regulation

UPSC Civil Services Examination, Previous Year Question

Q. Consider the following statements: (2017)

1. In tropical regions, Zika virus disease is transmitted by the same mosquito that transmits dengue.
2. Sexual transmission of Zika virus disease is possible.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Ans: (c)

Q. 'Wolbachia method' is sometimes talked about with reference to which one of the following? (2023)

- (a) Controlling the viral diseases spread by mosquitoes
- (b) Converting crop residues into packing material
- (c) Producing biodegradable plastics
- (d) Producing biochar from thermo-chemical conversion of biomass

Ans: (a)

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