FACTSHEET

Why use genetic tools to address global health and conservation challenges?

Over the past century, modern genetics – the study and manipulation of genes, heredity, and genetic variation in living organisms – has revolutionized our approach to confronting some of the world's most pressing challenges. From mitigating habitat loss and preventing species extinction to enhancing crop yields and combating diseases, genetics has played a pivotal role in human development. The future holds even more promise, with recent genetic breakthroughs holding potential to tackle vector-borne diseases like malaria and dengue, as well as managing invasive species.

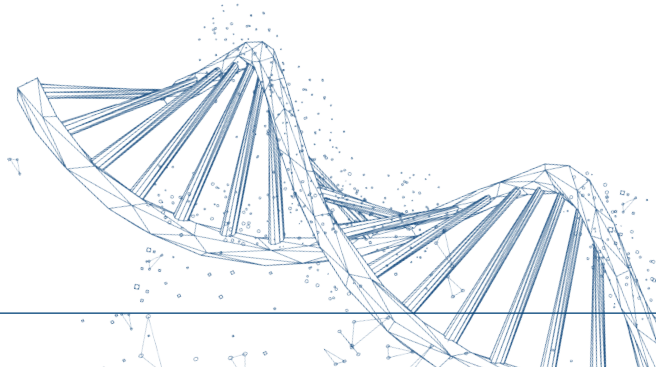
WHAT ARE GENETIC TOOLS?

Genetic tools encompass a broad range of techniques aimed at understanding and manipulating the genetic material of living organisms. They offer unprecedented precision by enabling scientists to target specific genetic sequences within an organism, focusing interventions on specific populations and expanding capabilities in both research and practical applications.

Genetic interventions are reshaping our approach to age-old challenges through modern methods. They range from the intricate process of RNA interference (RNAi) that silences specific genes to combat diseases to the precise methodology of molecular cloning. Examples in human health include gene therapy treatments for vision loss, to broader applications such as COVID-19 genetic vaccines. In agriculture, gene-edited crops offer enhanced resistance to pests and diseases, while established approaches like the Sterile Insect Technique (SIT) provide insecticide-free pest control. Such advancements underscore the diverse potential of genetic interventions.

Genetic tools hold particular potential for large-scale control of disease vectors or invasive species by precisely targeting the genetic frameworks of organisms. Examples include genetically modified mosquitoes designed by Oxitec to reduce populations of species carrying deadly diseases such as dengue and Zika or applications of mosquitoes with engineered gene drives potentially capable of reducing malaria and other vector-borne diseases. Such genetic tools could reduce dependence on harmful chemicals typically used for mosquito control, reflecting a potential shift towards more sustainable, targeted disease management.

Genetic tools also mark a significant transformation in biodiversity conservation strategies in the realm of environmental preservation. These include cloning to restore endangered animal populations, environmental DNA analysis to assess ecosystem health, and the potential use of gene drive tools to control invasive species.



WHY USE GENETIC TOOLS?

In the battle against vector-borne diseases, genetic technologies offer a promising addition to existing approaches. For instance, genetic technologies are considered as a valuable addition to an integrated approach for vector control when conventional methods hit their limits. These are most often designed to target either the reproductive capabilities of pests and disease carriers or aim to target the parasites they carry. This is especially relevant in the context of intensifying threats such as climate change and insecticide and drug resistance, which are bringing the fight against vector-borne diseases like malaria, which impacts over 200 million people yearly, to a stall.

> **Recent advancements in genetic technology offer promising avenues for innovation. In conjunction with existing methods, they have the potential to benefit global health and conservation.**

In terms of biodiversity conservation, genetic interventions offer solutions beyond the reach of conventional approaches to the eradication of invasive species from ecosystems, for instance. Traditional methods, such as the use of rodenticides or insecticides, often carry the risk of broader ecological harm. Genetic interventions, however, aim for targeted outcomes with reduced negative impacts. In addition, invasive species are sometimes introduced in very remote and inhabited areas, which poses a challenge to current methods in terms of reach.

Additionally, genomics, the study of an organism's complete set of DNA, can be employed for genetic rescue efforts, where genetic diversity is reintroduced to vulnerable or declining populations to bolster their resilience against environmental changes and disease. These approaches are considered a valuable addition to existing conservation strategies, often utilized in scenarios where traditional methods are no longer effective.

The development of genetic technologies is designed to enhance current approaches by offering potential or proven solutions that are particularly effective in challenging scenarios. Certain genetic strategies in vector control are aimed at reducing the frequency of interventions, which can be expensive and difficult, especially in remote areas. These technologies also strive to minimize externalities that are currently unavoidable with traditional methods. For example, utilizing gene drives in mosquitoes to combat malaria could potentially eliminate the need for repeated pesticide applications, which are known to negatively impact the environment and its inhabitants. Genetic tools are being considered to address challenges for which current solutions fall short, offering versatile alternatives while reducing negative externalities.

WHAT'S NEXT?

THE USE OF GENE DRIVES FOR HEALTH AND ENVIRONMENTAL PURPOSES

Gene drive is a genetic phenomenon that occurs in nature and causes a selected trait to spread rapidly through a species via sexual reproduction over several generations. Normally, genes have a 50/50 chance of being inherited, but gene drive systems could increase that chance to upwards of 99 percent. This means that over the course of several generations, a selected trait could become increasingly common within a specific species.

Scientists are exploring gene drives to address global challenges, notably in public health to lessen vector-borne diseases like malaria or dengue. They are considering two approaches: population suppression, which aims to reduce the number of disease vectors, and population replacement, which involves altering organisms to make them incapable of transmitting diseases. Beyond health, gene drives offer solutions for environmental conservation by targeting invasive species that endanger native species and harm fragile ecosystems.

Although many gene drive applications have been proposed, to tackle pressing issues such as eradication of vector-borne diseases and suppression of invasive alien species in fragile ecosystems, there have not yet been field tests or environmental releases of gene drive organisms.

HOW
CAN THE ACCEPTANCE AND DEVELOPMENT OF GENETIC TOOLS BE SUPPORTED?

While the development and application of genetic tools hold great promise for addressing global health and environmental challenges, their successful integration into society significantly depends on the means to develop these technologies and the acceptance of the general public. This necessitates a two-pronged approach: investing in public education and awareness programs and building capacity.

Capacity-building involves strengthening local research infrastructures, funding grants and scholarships, and offering educational opportunities to train scientists and researchers, particularly in developing countries. Promoting international partnerships, knowledge transfer, and shared research initiatives are also ways to enable countries to better participate in and benefit from global scientific advancements.

However, capacity-building alone is insufficient; public receptivity is equally important for successfully integrating and using genetic tools. Despite stringent regulations and ethical guidelines ensuring the responsible development and utilization of genetic tools, mistrust from potential beneficiaries often stems from a lack of understanding or reliable information about the research process, technology, and its applications. Concerns about transparency, intertwining science with private interests, rapid scientific advancements, and historical mistreatment in scientific research further fuel this mistrust. Educational and informational initiatives are some of the ways to make accurate information more widely available and demystify genetic technologies.

There is a critical need for a better understanding of genetic technologies by the general public and for capacity-building to bolster research and development, particularly for developing countries.

Investing in these areas can help overcome barriers to adoption and effective use of genetic tools and ensure that their benefits are widely distributed and understood. Through sustained efforts in capacity-building and encouraging the acceptance of these tools, countries can better harness them to address pressing challenges in health, conservation and beyond more effectively.

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