MALARIA ELIMINATION: SCIENCE & TECHNOLOGY

NEWS: *Understanding the challenges of malaria vaccination, as elimination becomes achievable*

WHAT'S IN THE NEWS?

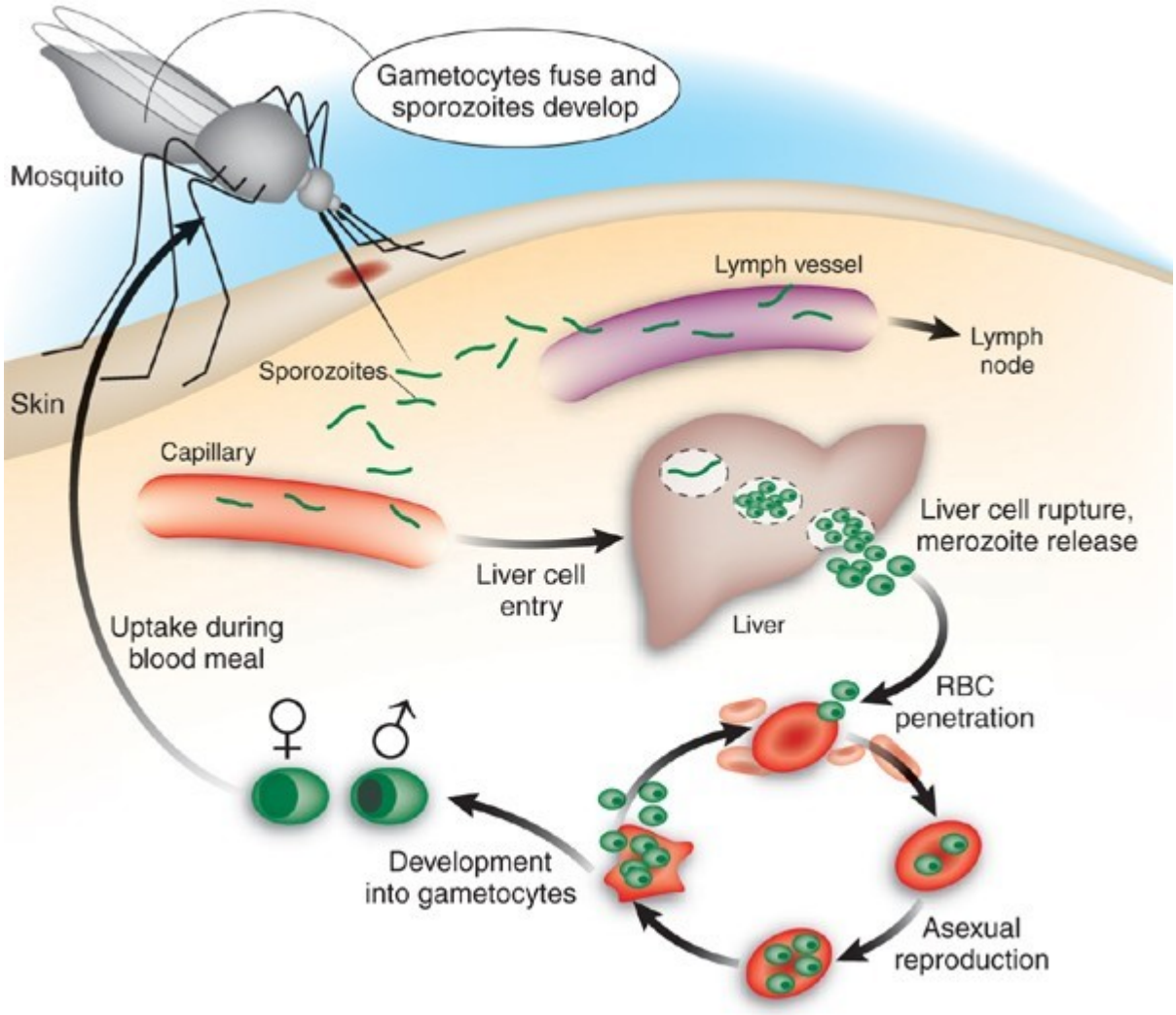
Malaria remains one of the most significant public health challenges globally, particularly in tropical regions where it continues to cause substantial morbidity and mortality. The disease's complexity, the parasite's lifecycle, and the socioeconomic environments in which it thrives make eradication a challenging goal. Here's a more detailed elaboration on the efforts to control and eradicate malaria:

Malaria Parasite and Transmission Complexity:

- **Life Cycle**: The malaria parasite, Plasmodium, has a complex life cycle involving two hosts—humans and Anopheles mosquitoes. In humans, the parasite undergoes several stages: it enters as sporozoites, develops in the liver, and then affects red blood cells, leading to the symptoms of malaria.
- **Transmission Modes**: While the primary mode of malaria transmission is through the bite of infected female Anopheles mosquitoes, the disease can also spread through blood transfusions, organ transplants, and the use of contaminated needles and syringes.

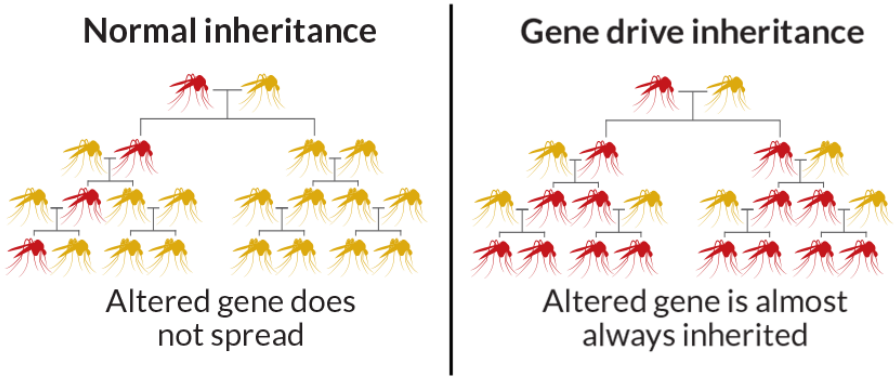
Current Strategies in Vaccine Development:

- **First-Generation Vaccine (RTS,S/AS01 - Mosquirix)**: This vaccine targets the liver stage of the parasite before it can infect red blood cells and cause symptoms. It's the first malaria vaccine to receive WHO approval for pilot introductions in several African countries. However, its partial efficacy (about 36% reduction in malaria cases among children) means it must be part of a broader integrated malaria control strategy.
- **Second-Generation Vaccines**:
    - **R21/Matrix-M**: This promising vaccine has shown up to 77% efficacy in early trials and represents a significant improvement in malaria vaccine technology.
    - **PfSPZ**: Another approach involves using attenuated (weakened) sporozoites to stimulate immunity against the liver stage of the parasite's lifecycle.
    - **RH5-based vaccines**: Target the stage when the parasite invades red blood cells, aiming to block this critical step in the parasite's development.
    - **Transmission-blocking vaccines**: These are designed to interrupt malaria transmission by preventing the development of the parasite within the mosquito, thereby stopping the spread of the disease to other humans.



Genetic Control Strategies:

- **CRISPR/Cas9 and Gene Drive Technology**: These revolutionary genetic engineering tools are being used to modify mosquito populations. By altering genes related to disease transmission or mosquito reproduction, scientists aim to reduce or potentially eliminate the mosquitoes' ability to transmit malaria.
    - **'Doublesex' Gene Modification**: This specific application of gene drive technology targets a gene essential for female development. Modified mosquitoes produce female offspring that are either sterile or develop male characteristics, effectively reducing the population of biting females over several generations.



Challenges to Malaria Eradication:

- **Antigenic Variation**: The malaria parasite's ability to change its surface proteins complicates the immune response, making vaccine development challenging.
- **Drug Resistance**: There is an ongoing battle against the parasite's resistance to antimalarial drugs, which necessitates continuous research and development of new therapeutics.
- **Socioeconomic Factors**: The highest burden of malaria is in impoverished areas where healthcare infrastructure is limited. Effective malaria control requires not only medical solutions but also improvements in living conditions, education, and public health infrastructure.

Global and National Goals:

- **World Health Organization (WHO)**: Targets a 75% reduction in case incidence by 2025 and a 90% reduction by 2030 compared to 2015 levels.
- **National Goals (India)**: Aims to eliminate malaria by 2030, with interim goals to become malaria-free in certain regions by 2027.

Conclusion:

Eradicating malaria requires a multifaceted approach that combines effective vaccines, advanced genetic strategies, improved antimalarial treatments, and sustained public health efforts. While progress is being made, the path to eradication is complex and requires global cooperation and innovation.

Source: https://www.thehindu.com/sci-tech/health/understanding-challenges-of-malaria-vaccination-as-elimination-becomes-achievable/article69207277.ece#:~:text=Malaria%20vaccine%20research%20has%20long,healthcare%20infrastructure%20has%20remained%20limited.