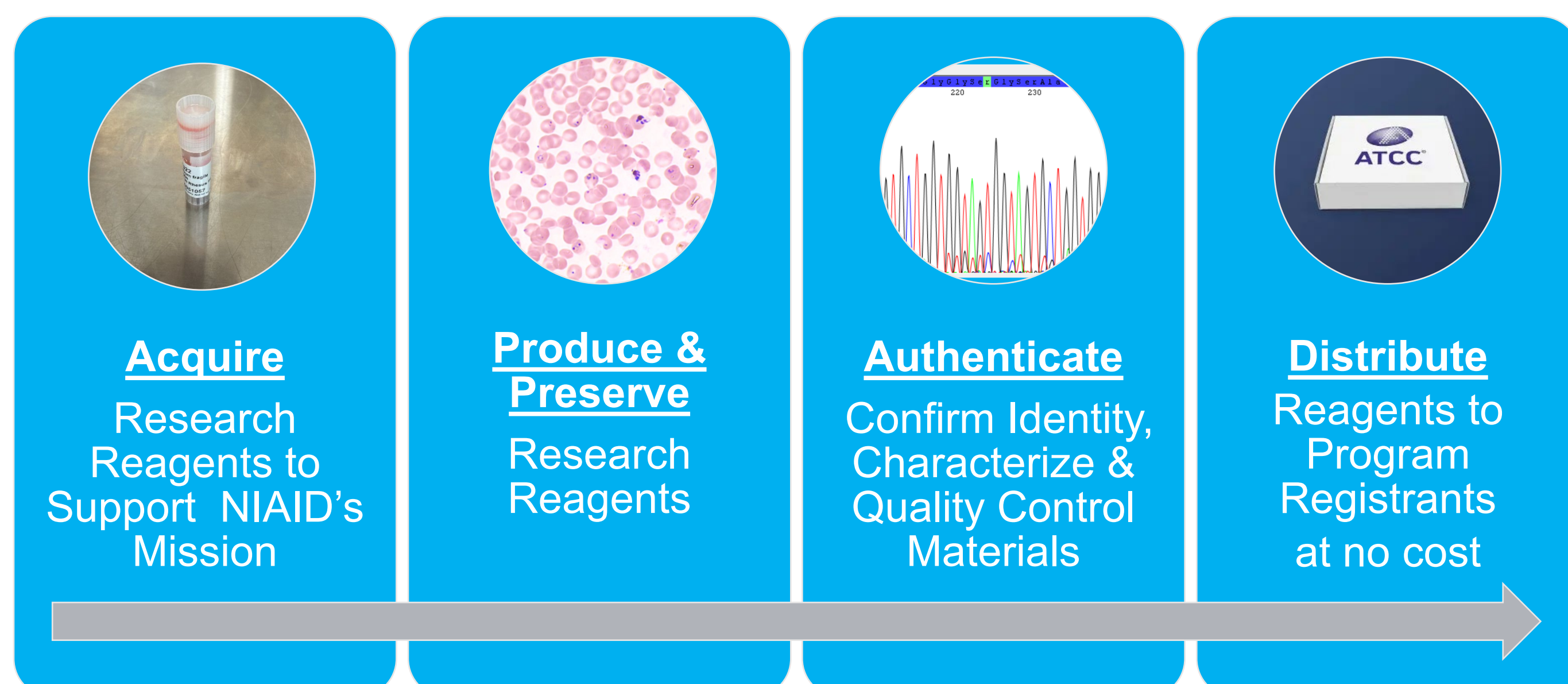


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**Abstract:** BEI Resources (<https://www.beiresources.org>), a program supported the National Institute of Allergy and Infectious Diseases (NIAID) and managed by ATCC, provides NIAID and registered researchers worldwide with a centralized biorepository for the acquisition, production, characterization, preservation, storage, and distribution of unique, scientifically relevant and quality-assured malaria research biomaterials and standardized protocols. These resources aid researchers in the development and evaluation of malaria vaccines, therapeutics, and diagnostics. Research materials deposited into BEI Resources are carefully selected, vetted, and approved by NIAID to ensure that they meet the growing needs of the malaria research community. Resources are available to all BEI Resources-registered researchers and institutions through the Malaria Research and Reference Reagent Resource Center (MR4), a repository for malaria research reagents integrated into BEI Resources in 2010. The biomaterials available include well-characterized reference strains of *Plasmodium falciparum*, rodent malaria parasites, malaria antibodies, live mosquito vectors, mosquito-derived reagents (available through CDC), mosquito cell lines, nucleic acids, and fluorescent reporter parasite lines.

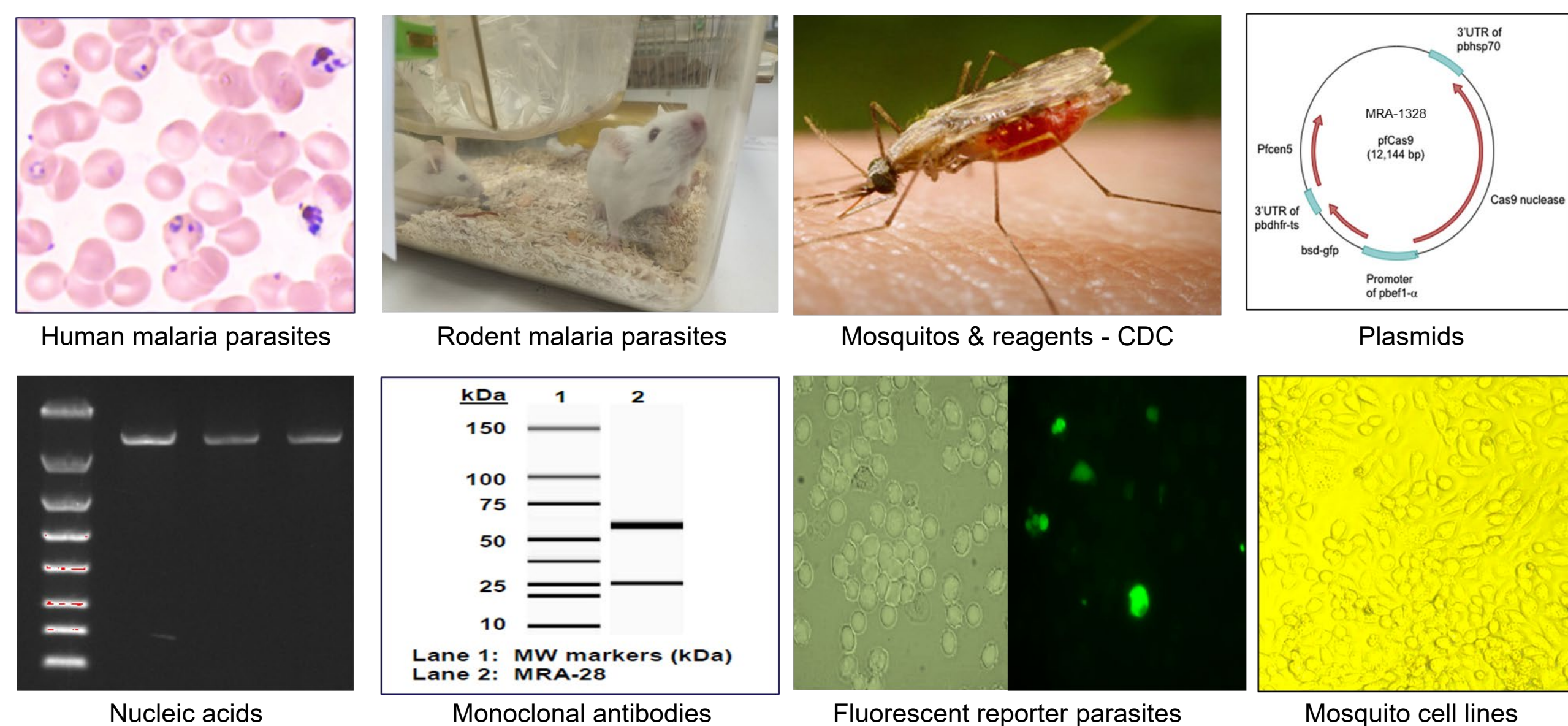
## Background

- BEI Resources provides NIAID and registered researchers worldwide with a central repository for the acquisition, authentication, and distribution of a broad range of unique and quality assured pathogen research materials that aid in the development and evaluation of vaccines, therapeutics, and diagnostics (Figure 1).
- Investigators can register at [www.beiresources.org](http://www.beiresources.org) for free access to the research materials. Institutional review and approval is required for the material transfer agreement and for required material biosafety level classification.
- BEI Resources also offers an opportunity to the scientific community to participate in the program by depositing materials. Advantages of depositing material: (i) Promotes access to the material and use of the material; (ii) Relieves researchers of the burdens of distributing materials; (iii) Protects intellectual property of the depositor; (iv) Ensures quality control of the materials; (v) Offers secure storage of materials; and (v) Ensures regulatory compliance in shipping



**Figure 1: Role of BEI Resources in supporting malaria research.** BEI Resources acquires high-value biomaterials from researchers around the world. It then produces and preserves adequate quantities of each biomaterial based on the projected scientific demand. Biomaterials are authenticated to confirm their identity and then distributed to registered malaria researchers to help accelerate the development of therapeutics, vaccines, and diagnostics. Researchers maintain their intellectual property rights over biomaterials deposited into BEI Resources.

## Research Reagents Available to the Malaria Scientific Community



**Figure 2: Research materials available to the malaria scientific community.** Research biomaterials available through BEI Resources include reference strains of the human malaria parasite, *Plasmodium falciparum*, rodent malaria parasites (*P. berghei*, *chabaudi*, *yoelii*, and *vinckei*), malaria antibodies, live mosquito vectors, mosquito-derived reagents (available through CDC), mosquito cell lines, nucleic acids, and fluorescent reporter parasite lines. Plasmid map for MRA-1328 was adapted from Payungwong *et al.*, *Parasitology International* 67(5), 605–608.

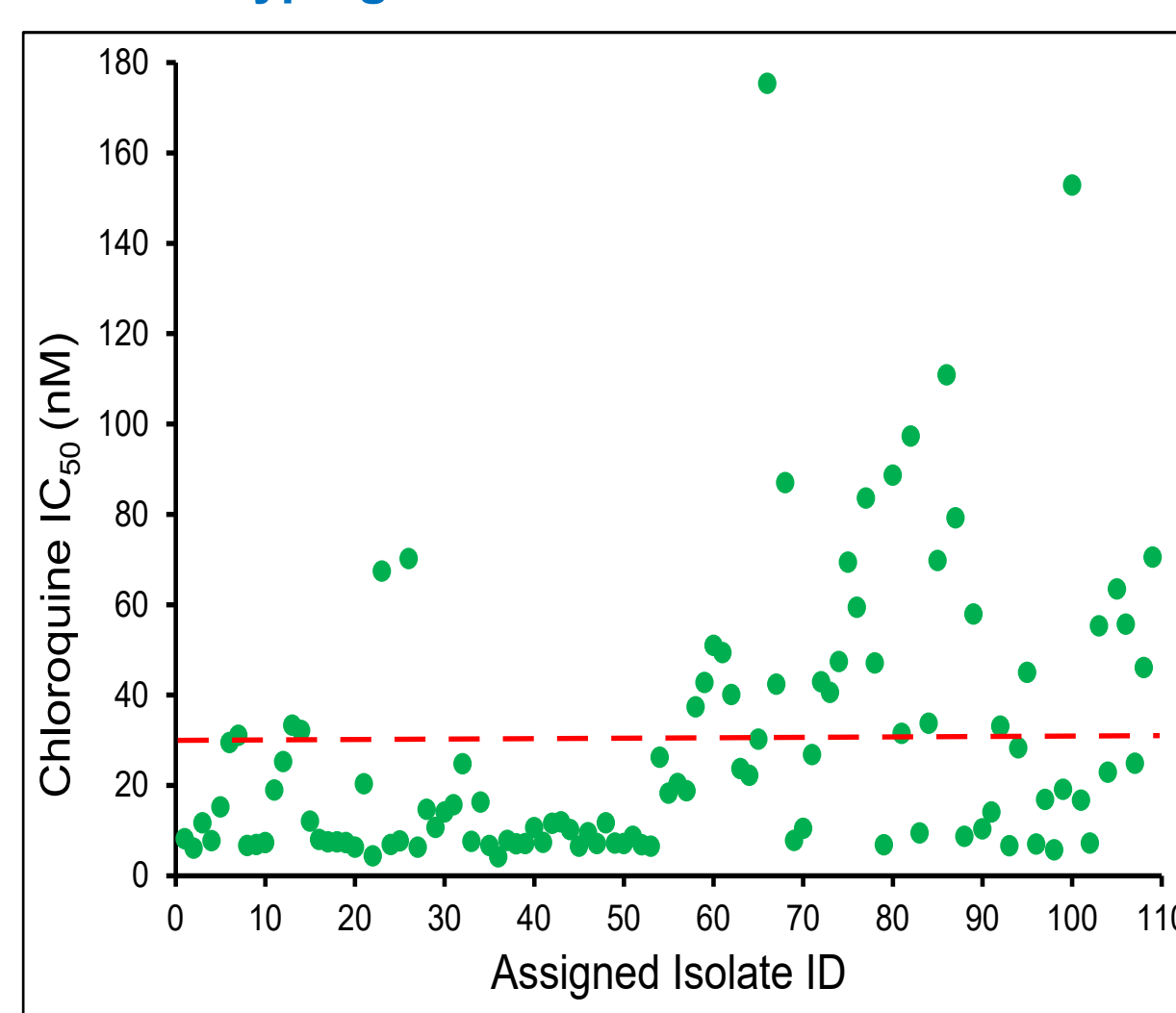
## Malaria Protocols & Training Aids Available to the Scientific Community



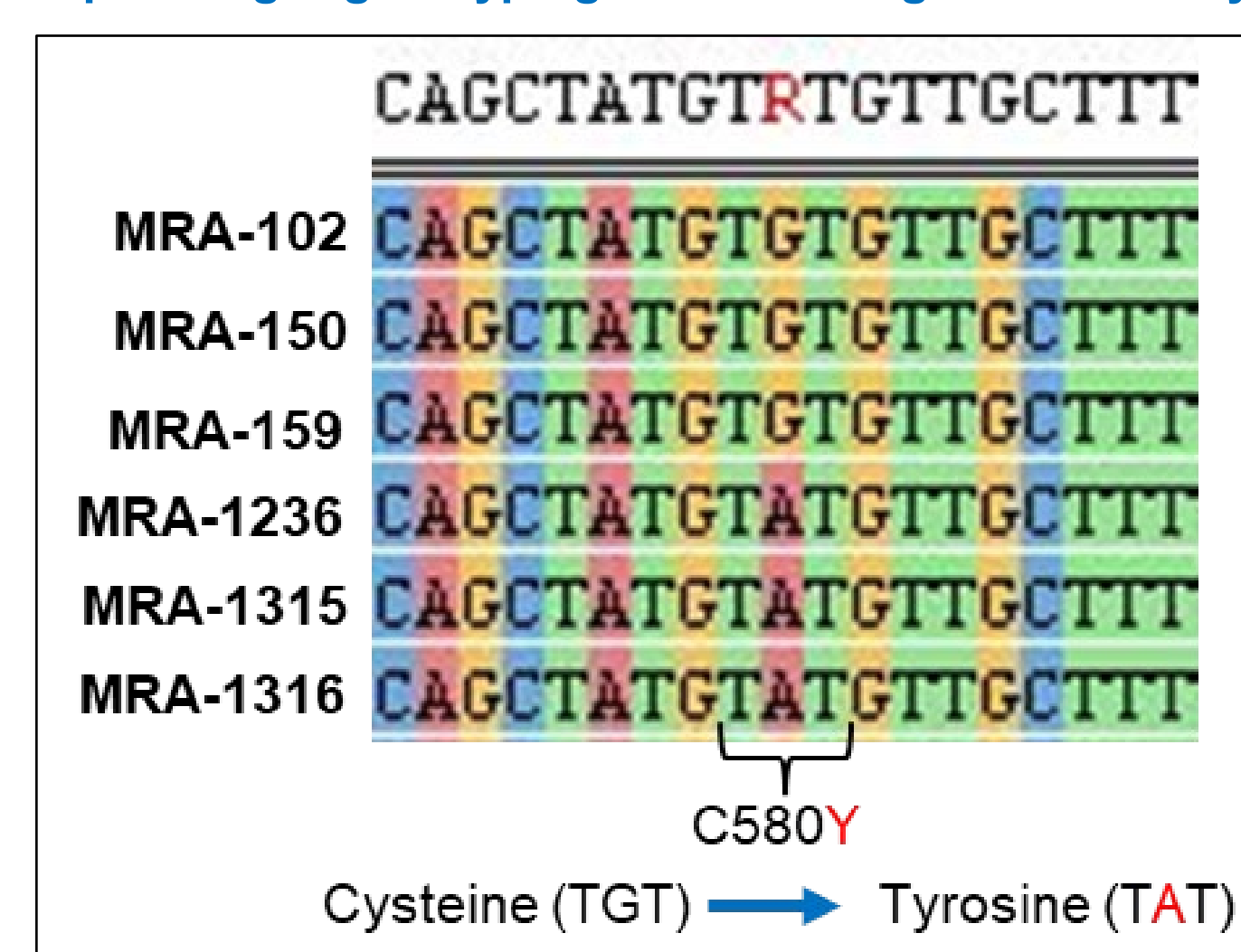
**Figure 3: Research protocols and training aids available to the scientific community.** BEI Resources provides insectary manuals for mosquitoes containing an array of insectary management and experimental protocols for vector biology ([www.beiresources.org/Catalog/VectorResources.aspx](http://www.beiresources.org/Catalog/VectorResources.aspx)). Free protocols for conducting mosquito vector research and malaria parasitology are available in the *Methods in Anopheles Research* and *Methods in Malaria Research*, respectively. BEI also provides reference sets of malaria slides with bench aids, which are distributed to institutions for training purposes.

## What BEI Resources–MR4 Does to Authenticate the Biomaterials Distributed

### A Phenotyping to confirm the trait of interest

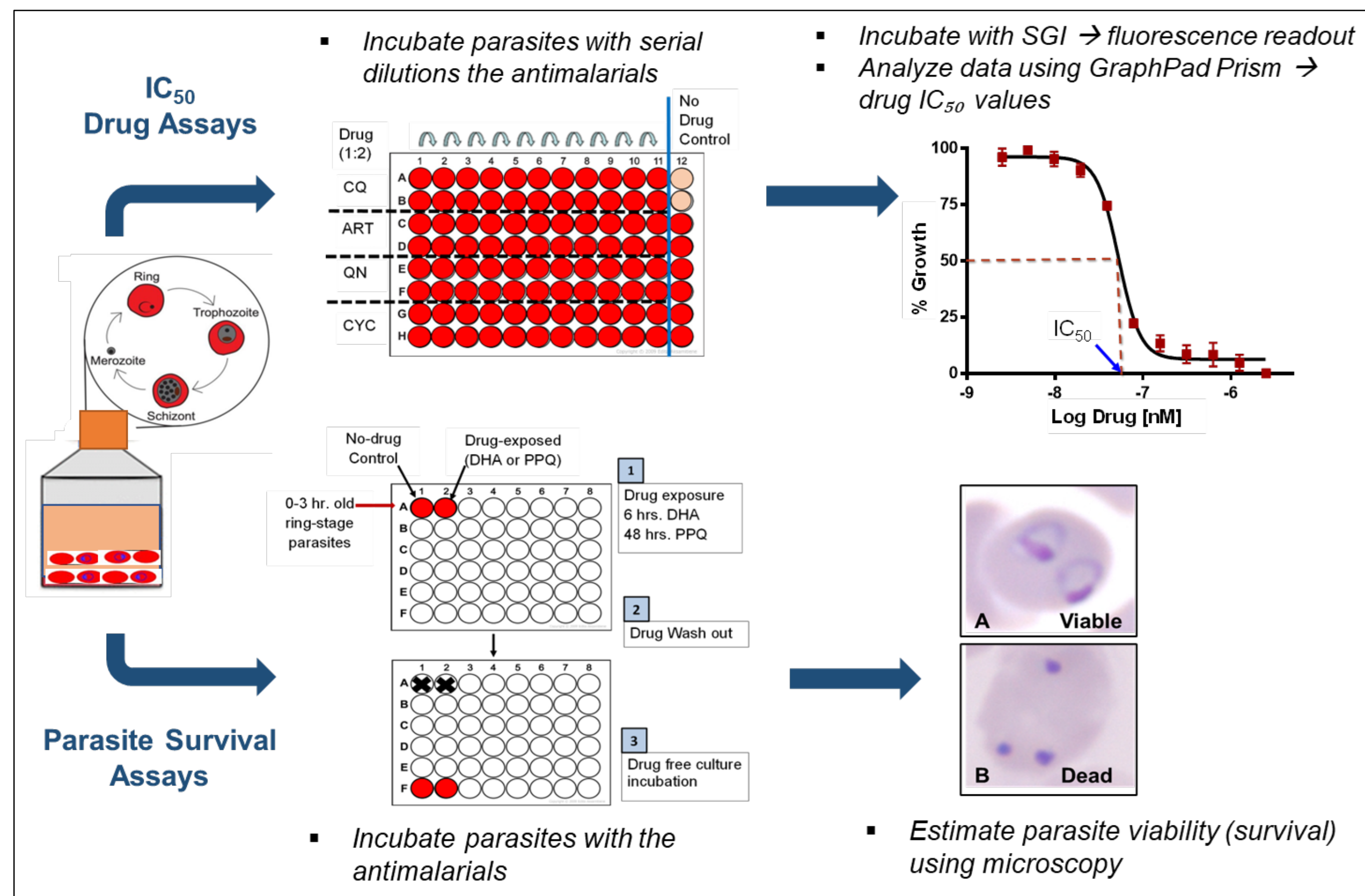


### B Sequencing & genotyping to ascertain genetic identity



**Figure 4: Authentication of BEI malaria strains.** (A) A dot plot depicting *in vitro* chloroquine susceptibility data of 109 malaria strains.  $IC_{50}$  assays measure the drug concentration that inhibits drug-treated parasites by 50% relative to the untreated controls. The red dotted line is a previously threshold for resistance with parasites above the line deemed resistant and those below CQ-susceptible. (B) Results from sequencing the K13 gene that mediates *P. falciparum* resistance to the antimalarial drug artemisinin. While MRA-102, MRA-150, and MRA-159 harbor the wild-type amino acid cysteine, MRA-1236 and its two constituent parasite lineages (MRA-1315 & MRA-1316) bear the resistance-conferring mutant tyrosine at codon 580.

## Authentication Workflow Example: Drug Response Phenotyping



**Figure 5: Schematic representation of antimalarial susceptibility tests for BEI Resources malaria strains.** The drug susceptibility status of each reference strain is determined using standard  $IC_{50}$  assays (top panel) and/or parasite survival assays (bottom panel). Parasite survival assays measure parasite viability upon exposure to a pharmacologically relevant drug dose *in vitro*. Susceptibility data are reported on the Certificate of Analysis for each batch produced and show whether the strain is drug-susceptible or resistant.

## Quality Control Tests

- Assessment of parasite viability:** growth recovery and proliferation to >1.5% parasitemia within 96 hours of initiating the culture from a frozen vial.
- Sterility testing:** Culture purity assessed by screening for microbial contamination using a comprehensive panel of bacterial and fungal media and by molecular screening for mycoplasma contamination using the Universal Mycoplasma Detection Kit (ATCC<sup>®</sup> 30-1012K<sup>™</sup>).

## Summary

- BEI Resources provides the scientific community with a variety of standardized and quality-controlled biomaterials for malaria research.
- Reagents are freely available to registered investigators through the BEI Resources website.

## Acknowledgments

- BEI Resources is funded by the National Institute of Allergy and Infectious Diseases (NIAID) and managed by ATCC under **Contract No. HHSN272201600013C**
- We thank the investigators who have deposited materials into the BEI Resources Program.