An E. coli System for the Diagnosis of Human African Trypanosomiasis

Aims:
1. To use synthetic biology to engineer systems to detect anti-HAT antibodies in patient blood.
2. To use engineered autotransporters for surface display of two distinct HAT epitopes; mimotopes.
3. Use a quorum sensing AND gate to report E. coli detection of antibodies to both HAT epitopes -> GFP production.
4. Create a device to measure GFP: combine with E. coli into a cheap, simple, thermo-tolerant HAT diagnostic kit.

Aims:

- HAT (Human African Trypanosomiasis) is caused by a parasite transmitted through the bite of the Tsetse fly.
- Stage 1: Infected may be infected for 6 months to 2 years without symptoms.
- Stage 2: Progressive Chorea, Coma & Death – 100% Lethality without treatment.
- Parasite Evades Immune system.
- 30,000 currently infected, ~60,000,000 at risk in Sub-Saharan Africa.
- Current diagnosis relies on refrigerated antibodies.

**BioBrick Engineering for HAT Mimotope Surface Display**

**Ag43 Protein**

- **BBa_K750001 – Hokkaido 2012**
- **BBa_K1352004 – Aberdeen 2014**

**Ice Nucleation Protein**

- **BBa_K523013 – Edinburgh 2011**
- **BBa_K1352006 – Aberdeen 2014**

**Achievements**

- Successfully demonstrated surface display of pathogen mimotopes using bacterial autotransporters (via expression of FLAG tag).
- Created standardised platform technology Ag43 protein and INP BioBricks ready for surface display of any peptide (up to 60 kDa).

**Antibody Detection using a Quorum Sensor AND Gate**

To use engineered autotransporters for surface display of two distinct HAT epitopes; mimotopes.

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**Our Functional $100 GFP Fluorometer**

- As well as tackling the biology of the problem we also created our own detector for GFP.
- It is designed to be small, in keeping with our effort to improve accessibility.
- The detector consists of basic electronic components, controlled by an Arduino and Raspberry Pi.
- Price is suitable for developing countries; less than £100 to make and is small enough to fit in a backpack.

**Achievements**

- Engineered and demonstrated a successful two-antibody detection system based on AND gate quorum sensing.
- Created a cheap and compact GFP detector, to be used with our system which is heat-tolerant up to 40°C.

Daniel R. Headrick – PLOS Neglected Tropical Diseases (2014) (Sleeping Sickness Epidemics and Colonial Responses in East and Central Africa, 1900–1940)