A SynBio Oscillation Signal Converter

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### Background
Oscillation is a hot topic in synthetic biology and attracts our eyes by its wide distribution from alternative current (AC) power to circadian clocks inside living cells. To create an oscillation in single E. coli is relatively easy, however, to create a synchronized oscillation between bacteria colonies for signal conversion has to overcome noise of gene expression in biological systems first (Figure 1).

To solve this problem, synthetic biologists designed a circuit which can synchronize bacteria within a colony via quorum sensing and among colonies by gas-phase redox signal (mainly H2, Figure 2).

### Microfluidic

(A) Swimming Pool Model

- **Swimming pool size:** 1000x100x10 µm
- **Temperature:** around 30°C
- **Initial conditions:**
  - E.coli: Initially in LB, return to LB after 5-6 hours
  - H2: Initially off, turn on after 5-6 hours

(B) Passage Model

- **Swimming pool size:** 1000x100x10 µm
- **Temperature:** around 30°C
- **Initial conditions:**
  - E.coli: Initially in LB, return to LB after 5-6 hours
  - H2: Initially off, turn on after 5-6 hours

Passage is extremely thin w/ running LB to provide a single cell population as well as the best growing condition.

### Application
Nowadays cancer has become one of the greatest enemies of humanity. At the molecular level, ROS is used to diagnose cancer and modern physics and chemistry. Moreover, cancer diagnosis and treatment are still relatively independent. A trend in this area is trying to combine these two related aspects together to manipulate cell death in cancer. Our project may be a potential biological method to develop cancer diagnosis and treatment.

#### Step 1: ROS biosensing
In the recent decade, scientists have found that the cause of cancer is closely related to the level of ROS. ROS is a reactive oxygen species in cells. The concentration of ROS reflects the level of cell metabolism and antioxidant stress. From these pictures we can get to know it clearly. As we can see, normal cell may mutate to cancer cell if the ROS concentration meets a critical value.

#### Step 2: Protein synthesis periodically
Oscillatory system works owing to the periodic variation of GFP concentration.

### Result & Conclusion

To present synchronized oscillation, we made efforts in following aspects.

**Host:**
1. **BL21 (DE3)**
   - The slight oscillation with more than 200 minutes long period of double plasmid (pBAD-LacI and pBAD-TetR) in E. coli BL21 (DE3) strain. The microfluidic swimming-pool-like array (Figure 8-A) in static culture without antibiotics and passage array (Figure 8-B) with LB-medium inoculating, respectively.

**ImageMe**
- Background
  - We need to analyze the fluorescence strength change of each trap in the microfluidic images to get the data. However, we haven’t found suitable software so far we designed our own named “ImageMe”. Coding in matlab
  - We used MATLAB coding the script and also designed the user interface for easy use.

**References**