STEM BACTERIA
An Asymmetric Cell Differentiation for Maintaining a Stable and Efficient System

1. Overview

We have shown that the progress of unique differentiation of stem cells in bacteria, because bacteria are a mixture of different kinds of cells to do more complex tasks. So we are trying to establish an asymmetric cell differentiation system for bacteria to control differentiation. The priority is to balance two different cell types, which must be controlled by different kinds of bacterial cells. We have developed a new model to control this by combining DNA replication and metabolism. We have found several proteins which can inhibit E. coli cell movement. We also have a new model for asymmetric cell differentiation with a new idea of multifunctional enzymes to guarantee stability.

2. Motivation

Stem cells in E. coli have a capacity of multipotent differentiation. They can change from multipotent cells to special functional cells with different shapes and components to serve their unique functions. But how could the cells take on different functions? Is there any mechanism to regulate this process? There should be a kind of switch to begin the transition, and this can be done by intrinsic (such as cell density) or extrinsic (such as stimuli) factors. Ideally, this initial idea now needs to be proven. We think there is a new way to regulate cell differentiation.

3. Cell Control System

We can regulate bacteria cell cycle by controlling DNA replication, because this is the most intensive period and the least basic aspect of metabolism. It is controlled at the stage of initiation. Bidirectional chromosome replication is restricted by the unique replication origin, O, and the direction is determined by the terminator, t. In order to maintain a constant time at a given temperature and distribution of lots of proteins.

Gene ciaA, dnaA, cagA, cap was cloned from E. coli strain BL21 and linked to RFP. We test the function of these four genes in vector pCS105 respectively.

4. Cell control Performance

Comparing the growth curve of 4 cycle replication genes transformed bacteria with control group, we can see a considerable difference between them and underestimate the cycle replication rate(β) by modeling. The smooth period is quite close, which means that these proteins have no significant effect on maximal environmental capacity.

5. Quorum transform

We used a tunable toggle switch to create a second quorum. Then we build an asymmetric cell differentiation system by using a unique toggle switch. We did construct a toggle switch using S. cerevisiae. It has a unique control system (circuit C: (1) T1; (2) T2; (3) (c) and (d) are proving processes of the promoter by forming the ArpK (N) and S. cerevisiae (C) proteins. The promoters are activated by ArpK in the presence of ArpK and in the absence of S. cerevisiae. In our simulations, we used a similar control system to obtain a maximum of 0.01. We have designs for better toggle switches using this cell model. As Graphene, it can be shown in Figure 6.1.

7. Modeling

Modeling: this model can yield to new function of a toggle switch, it is more stable and robust than an ordinary genetic toggle switch.

8. Applications (New Fermentation Method)

Application on Mixed fermentation
Mixed fermentation produce various products, of which certain kinds of products cannot be manufactured by fermentation. Nowadays, mixed fermentation is a big trend on new era of chemical industry. However, how to make use of this system in the most suitable proportion of different bacteria is still a challenge. In fact, it seems impossible to maintain the efficiency of productivity of every bacterial in a unity media because different kinds of bacteria have different optimal conditions. By using cycle control and quorum transformation, we can monitor and control the growth and differentiation of bacteria in one system, and we can design the optimal module by controlling the different kinds of bacteria in one module.

9. Cycle control

Cycle control includes the use of DNA replication as a prime mover for cell division, and the use of protein synthesis for cell growth. The model is designed to show the relationship between the two processes. By using cycle control and quorum transformation, we can control these processes in the same fermentation tank from the beginning. In addition, this can be used for metabolites producing producing processes.

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