

Violation of bacterial pattern formation by gene expression

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ある種のバクテリアや培養細胞は美しいパターンを形成する。本研究では、生細胞を外界と相互作用し自身の状態を変化させるソフトマターとみなし、ミクロな細胞状態とマクロなパターン形成の同時測定を試みた。一細胞レベルでべん毛合成遺伝子の発現量をモニターし、遺伝子発現の空間分布を測定した。その結果、コロニー内側の細胞ほどべん毛合成遺伝子の発現活性が高く、淵側では遺伝子発現が見られないことが明らかとなった。このようなべん毛合成遺伝子の発現量の分化は試験管培養下では観察されず、マクロなパターンを形成する自己組織化過程に特有であると考えられる。

1 Introduction

Self-organized pattern formation is observed in bacterial colony growth [1]. Forming stable multicellular structures, individual cells respond to excreted molecules by moving up their local concentration gradients. Over the past years, there has been a significant increase in studying the branching pattern formation as reaction diffusion systems [2]. However, in most studies, bifurcation of a branch is reproduced just as a numerical calculation and the mechanism is still of great interest. In this work, without reference to reaction diffusion systems, I focus on the microscopic feature of pattern formation, e.g., gene expression.

2 Results and Discussion

In this study, I used *E. coli* MG1655 strains that is wild type for motility and chemotaxis. Under the proper conditions, the cells of *E. coli* synthesize multiple flagella, which allow them to swim rapidly. Here, I developed a system for real-time monitoring of the transcriptional activation of the flagellar operons (Figure. 1(a)). By means of reporter plasmids in which green fluorescent protein (GFP) is under the control of one of the flagellar promoters. Therefore, the present system makes it possible to measure accurately gene expression from living cells grown in a semi-solid agar surface.

In the condition that the rich nutrients and semi-solid agar concentration, the cluster of *E. coli* exhibited the branching morphology (Figure. 1(b)). By using the fluorescent microscopy,

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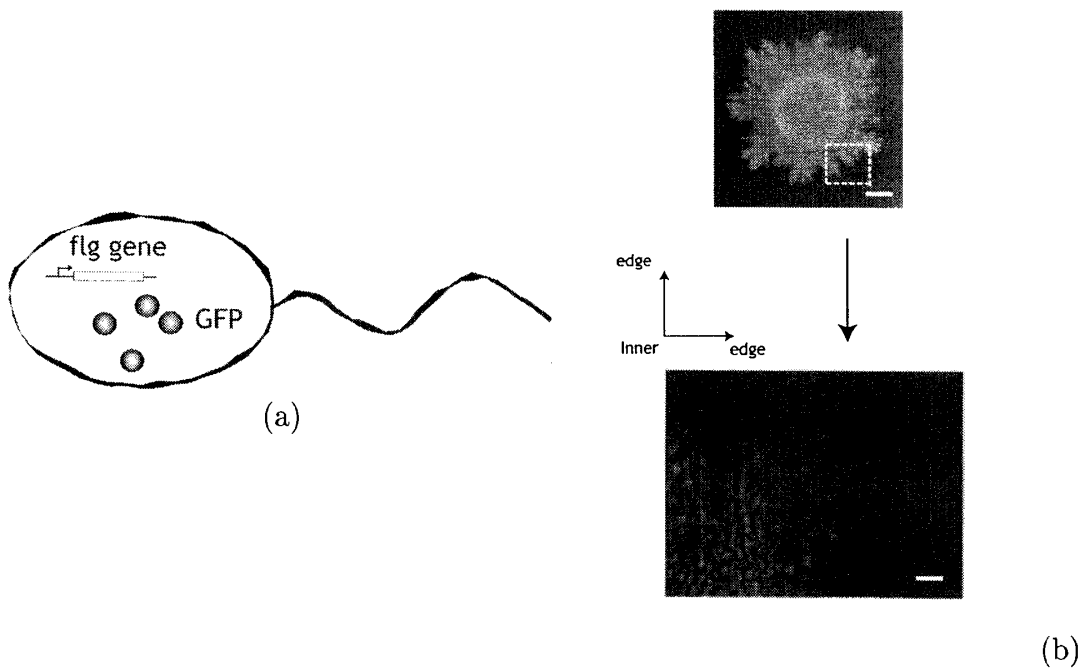


Figure 1: (a) *E. coli* with the reporter plasmid DNA. The level of the flagella gene expression is reported by the fluorescence of GFP. (b) The macroscopic morphology and the microscopic gene expression. Upper: the branching pattern of *E. coli*. The length of the scale bar is 5mm. Lower: the flagellar gene expression in the branching cluster. The length of the scale bar is 5 μm .

I measured the promoter activities of flagellar genes in a single cell. The experiments showed that the two results (Figure. 1(b)). (1) In the central region of branching cluster, the cells had the higher promoter activities and the shorter cell lengths. (2) Near the edge of the branching cluster, the cells had the lower activities and the longer cell lengths. These results suggest that microscopic behavior of individual cells is correlated to the macroscopic spatial inhomogeneity of the cluster. In the workshop, I will present in more details the experiments and discuss about the mechanisms of observed cell differentiations.

Acknowledgment

This work is the collaborative research with Masaki Sano and Mitsugu Matsushita. The author thanks Hanae Suzuki for the encouragement.

References

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