

## Stop Playing the Cell Differentiation Tune for *Caulobacter*

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### HIGHLIGHT

Since the beginning researchers studying *Caulobacter* have claimed that this asymmetrical bacterium goes through a cell differentiation process so that its asymmetric cell division yields two progenies with different development fates. However, careful literature analysis and new experimental evidence indicate this conclusion is a fiction. Why not stop playing the cell differentiation tune for *Caulobacter*?

### ABSTRACT

Past research on *Caulobacter* has emphasized the role of cell differentiation for creating two different daughter cells from one mother cell. However, based on a new bacterial life model, the two cells formed from one mother *Caulobacter* are the original mother and its new daughter and their developmental fates are essentially the same. Thus, it is a high time to re-evaluate the appropriateness of using "cell differentiation" to characterize the generation and age difference in unicellular organisms.

### KEY WORDS

*Caulobacter*, Cell differentiation, Bacterial life, Bacterial aging, Developmental fate

Editor – I wish to express some different views on the so-called “bacterial differentiation” that was re-emphasized in some recent *Cell* publications (*Cell* 124: 891-893, 1011-1023, and 1025-1037, 2006).

Owing to its obvious body and division asymmetry *Caulobacter* has become a very important model organism for biological studies. Unfortunately, a strong attachment to the dogma has prevented biologists from taking the most important advantages offered by this unique bacterium.

Over the last three centuries microbiology has been dominated by an ill-found view that one mother bacterium divides into two daughter bacteria. This truly eccentric view was based largely on the illusion of a completely equal fission by the so-called “symmetric” bacteria in their reproduction. Thus, while microbiology has enabled us to see another world of microscopic life, it also has created a dichotomy in biology: totally different views on the most fundamental aspects of life. This dichotomy boils down to such a sharp

contrast: all macroorganisms that we have observed on the individual basis show signs of aging and eventually die. Most microorganisms that we have not yet observed on the individual basis are believed to be immortal.

However, careful literature analyses have shown that our microbiological view of life was based on incorrect approaches and fallacious reasoning<sup>1, 2</sup>. Experimental observations on symmetric bacterium, *E. coli*, and logical reasoning has led to a conclusion that bacteria do age and die<sup>3</sup>. A new bacterial life model was proposed and its generality has been extended to include all cell forms of life including tissue cells of multicellular organisms<sup>3-5</sup>.

Using a true sense age-synchronization method<sup>4</sup>, clear reproduction synchrony was obtained for *Caulobacter* in long-term cultivation<sup>6</sup>. Studies on such cell age-synchronized populations also proved that crossband in the stalk of *Caulobacter* can serve as a bacterial aging mark since it is a remnant of bacterial reproduction<sup>7</sup>.

Thus, studies on both morphologically symmetric and asymmetric bacteria have now showed a general picture for prokaryotic microbial life<sup>5</sup>. This generalized view of prokaryotic life is in unity with the established view on eukaryotic life.

When the so-called “different fates” of the so-called “two daughters” formed from one mother *Caulobacter* were aligned by the same developmental stages, there is no essential developmental (or “fate”) difference between the two cells formed from one cell. Sure the two *Caulobacter* cells formed from one cell are different. But these differences can be better explained in terms of the differences between two successive generations with different chronological ages. For the stalked mother cells and the swarming daughter cells, these superficial differences are a result of the temporal lagging (due to the natural generation difference) in the expression of the same genetic program (with some slight variations due to the different living experiences). Typical cell differentiation, as those occurred in the formation of multicellular organism from single germ cell, really does not occur in this unicellular bacterium<sup>8</sup>.

Thus, I strongly suggest that researchers studying *Caulobacter* stop playing the cell differentiation tune for this unicellular prokaryote. Instead, I encourage them to follow the correct ways of studying life and take the new ideas and new methodologies developed for microbiology to study

the true life of this important bacterium and other diverse forms of microbial life.

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