

8. The cell control system

Many of us believe that bacteria are very simple. Now we learn that even the simplest bacterium is not just a sac containing some molecules. It is a very accurate machine controlled by a sophisticated control system.

The internal workings of a cell are not a chaotic, simple process, but precise and complex in which each molecule has its own assigned place and defined functions to perform. Biological components are not randomly distributed in the cell. Their position is determined by the cell's controlled system.

In the last decade Prof Harley McAdams from Stanford University School of Medicine who is himself a physicist published significant discoveries about the cell's control system (Reference 1).

He discovered the control circuitry that directs *Caulobacter* cell life cycle. The cell cycle system consists of many modular subsystems that control the cell growth and reproduction. A control system is using biochemical and genetic logic circuitry. This circuitry control the timing of each of modular functions.

The *Caulobacter* cell cycle control system has been optimized for robust operation. It monitors metabolic reaction rates and nutrient supply. It stops and restarts the reproduction cycle to adjust to nutrient availability. The control system utilizes various sensors which monitor the environment and condition inside the cell.

The cyclic genetic circuit uses changes of concentration of four proteins. These proteins directly control the timing of transcription of over 200 genes. Prof McAdams' main conclusions are that that biological regulatory systems conform to principles that engineers use to design regulatory systems in other engineering domains. The control system is a highly organized machine that is rigorously controlled by a relatively simple biochemically based control logic. And he concludes that "all these observations support the conclusion that it takes a cell to make a cell".

What he means is that proteins used for control are coded by DNA, but the working of this control system is not coded by the cell DNA but is inherited from the mother cell.

Reference:

McAdams H., Shapiro, L., 2009, System-level design of bacterial cell cycle control,

FEBS Letters 583 : 3984–3991.