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Biologists Discover How Biological Clock Controls Cell Division in Bacteria

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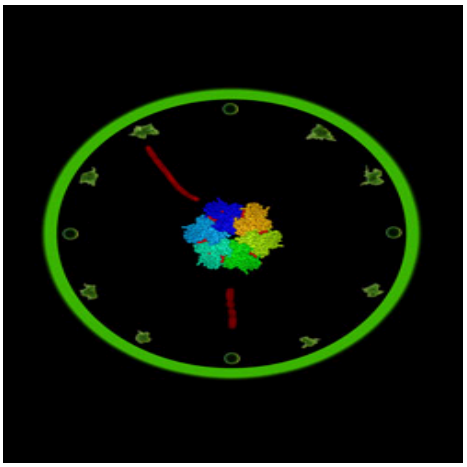
By Kim McDonald



Caption: Circadian clock protein KaiC, at center of clock, controls the timing of cell division in bacterial colonies around the clock's periphery.l

A team of biologists has unraveled the biochemistry of how bacteria so precisely time cell division, a key element in understanding how all organisms from bacteria to humans use their biological clocks to control basic cellular functions.

The discovery, detailed in the February 19 issue of the journal *Cell,* provides important clues to how the biological clocks of bacteria and other "prokaryotic" cells—which lack cell nuclei—evolved differently from that of "eukaryotic" cells with nuclei that comprise most other forms of life, from fungi to plants and animals.

"A major question in biology is how the circadian clock machinery is different in bacteria than it is in plants, animals and fungi," said Susan Golden, a professor of biology at UC San Diego, who headed the study. "We looked at how the biological clock controls when bacterial cells divide—in bacteria, there's a period of four hours where the cells are not allowed to divide—and we identified the structural changes in a key protein that controls this action."

Golden and her colleagues from UCSD, MIT, Michigan State University and Texas A&M University probed cell division in the cyanobacterium *Synechococcus elongatus.* That organism had been studied extensively by the Golden lab and other researchers, who found that the timing of cell division, patterns of gene expression and compaction of the chromosome are controlled by the circadian clock. What was unknown was precisely how the circadian clock in bacteria controlled cell division.

Using time-lapse microscopy, Golden and her colleagues discovered that the clock proteins KaiA, KaiB, and KaiC in bacteria control the action of a key protein called FtsZ, preventing it from going to the middle of the cell and forming a ring necessary for cell division. After four hours has elapsed, the clock proteins allow FtsZ to move toward the center of the cell and change structurally to form this ring.

"This complex of proteins is at the heart of the bacterial clock controlling cell division," said Golden. "There are two cycles, the cell cycle and the circadian cycle, that need to mesh for organisms to function. What we learned from this study is how these two cycles with different timing periods interact, and that the mechanisms that control the timing of cell division in bacteria are different than they are in eukaryotic cells."

Golden added that knowledge of the mechanisms of how organisms from

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bacteria to humans control the timing of their cell division and other processes has application to many human problems resulting from disorders in the circadian clock.

“Understanding the basic mechanisms of the biological clock is vital to our daily lives as many people suffer from some problem in their daily sleep cycle,” said Golden. “The biological clock in humans plays a central role in whether we gain or lose weight, when we fall asleep and wake up, how likely we are to have accidents and how we respond to disease.”

The other co-authors of the paper were Guogang Dong and Yong-Ick Kim of UCSD; Qiong Yang and Alexander van Oudenaarden of MIT; Qiang Wang and Katherine W. Osteryoung of Michigan State; and Thammajun Wood of Texas A&M. Their study was supported by grants from the National Science Foundation, Department of Energy, the National Institutes of Health and the American Recovery and Reinvestment Act.

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