

New research provides dynamic visualization of simplest circadian clock

March 13 2008

Scientists have acquired a more dynamic picture of events that underlie the functions of a bacterial biological clock. New research published online March 13th by Cell Press in the journal *Molecular Cell*, shows how the simplest organism known to have a circadian clock keeps time and may enhance our understanding of how other organisms establish and govern chronological rhythms.

A variety of organisms have evolved endogenous timing systems called a circadian clock that allows them to regulate metabolic activities in a day/night cycle. The simplest organisms known to possess a circadian oscillator are the cyanobacteria, better known as blue-green algae. The essential components of the circadian oscillator in cyanobacteria are the three clock proteins KaiA, KaiB and KaiC, all of which are expressed in the cyanobacterium *S. elongatus*.

Considerable research has implicated the phosphorylation cycle of KaiC as the central pacemaker in cyanobacteria and has demonstrated that the Kai proteins are repeatedly assembled and disassembled into heteromultimeric complexes, termed periodosomes. The crystal structure of each clock protein has also been determined and analyzed.

“Despite the substantial progress in structural characterization, the relationship between the assembly/disassembly dynamics and the circadian phosphorylation of KaiC is still poorly understood, mainly because of the difficulty in unraveling the underlying mechanisms solely from the static molecular pictures of individual clock components,”

explains Dr. Akiyama from the Japan Science and Technology Agency.

To obtain a more complete visualization of the cyanobacterial circadian oscillator, Dr. Akiyama and colleagues used small-angle X-ray scattering (SAXS) to follow the assembly/disassembly dynamics of the *S. elongatus* heteromultimeric Kai complexes in real time. The researchers found that the assembly/disassembly processes are crucial for phase entrainment in the early synchronizing stage but are passively driven by the phosphorylation status of KaiC in the late oscillatory stage. Further, KaiA and KaiB are recruited to KaiC in a phosphorylation-dependent manner.

“Our findings demonstrate that the initial phase of the cyanobacterial oscillator is determined predominantly by the assembly/disassembly communication of the clock components, and that the period is essentially resistant to intracellular noise such as collisions, cytoplasmic viscosity and crowding. These resistances are achieved in the binary and ternary complexes by recruiting KaiA homodimers, KaiB homotetramers and KaiC homoexamers in a phosphorylation-dependent manner,” concludes Dr. Akiyama.

Source: Cell Press

Citation: New research provides dynamic visualization of simplest circadian clock (2008, March 13) retrieved 26 April 2024 from <https://phys.org/news/2008-03-dynamic-visualization-simplest-circadian-clock.html>

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