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Press Release

Shedding Light on Bacteria

The tiny cyanobacteria use the principle of the lens in the human eye to perceive light direction

Scientists have been trying to figure out how it is possible for bacteria to perceive light and react to it ever since they started using microscopes 300 years ago. An international team led by the Freiburg biologist Prof. Dr. **Annegret Wilde** has now solved this riddle: In studies on so-called cyanobacteria, the researchers demonstrated that these tiny organisms of only a few micrometers in size move toward a light source using the same principle of the lens in the human eye. The study was published in the journal *eLife*.

Cyanobacteria have populated Earth for 2.5 billion years and can be found anywhere where there's light: in ice, deserts, rivers, and lakes, as well as in the walls of buildings and in aquariums. They use light to produce energy by the process of oxygenicphotosynthesis . In the oceans, which cover roughly 70 percent of Earth's surface, oxygen-producing cyanobacteria are among the most important photosynthetically active organisms and are thus a central component of the biosphere. The Wilde group together with an international team discovered that cyanobacteria, which can move directly and precisely toward a light source, use their micro-optic properties to identify where the light is coming from. The light hits the surface of the round unicellular organisms, where it is focused as if by a microscopically tiny lens. This creates a focal point on the opposite side of the cell. The cells then move away from this point of high light intensity, causing them ultimately to move toward the natural light source.

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Freiburg, 09.02.2016

All previous attempts to explain bacterial phototaxis, the process by which bacteria move toward light, have failed because these organisms, which measure only a few lengths of a light wave, were thought to be too small to perceive differences in light between the front and back side of the cell. Since the entire bacterium functions like a lens, however, the organisms can concentrate light, creating a pronounced light gradient within the cell. “This physical principle is actually hardly different from the way light is focused in the lenses of our eyes,” explains Wilde. “We now want to conduct further joint projects to investigate the concentration of light in microscopic organisms that do not necessarily need to have the shape of a round lens but, for instance, can also concentrate light like an optical fiber.” A better understanding of the microoptic properties could lead to insight on the extent to which the structure and form of cells and biofilms influence the process of light collection. This knowledge could be used in the future to construct custom-made photobioreactors or to improve new types of solar cells.

Annegret Wilde has served since 2012 as professor of molecular genetics at the University of Freiburg. The study included scientists from the Institute of Biology III as well as the university’s Freiburg Institute for Advanced Studies (FRIAS). The team collaborated strongly with researchers from Karlsruhe and London, England. A key participant in the study was Prof. Dr. Conrad Mullineaux from London who visited Freiburg as an FRIAS external fellow.

Original publication:

N. Schuergers, T. Lenn, R. Kampmann, M. V. Meissner, T. Esteves, M. Temerinac-Ott, J. G. Korvink, A. R. Lowe, C. W. Mullineaux, A. Wilde (2016): Cyanobacteria use micro-optics to sense light direction. In: eLife. DOI: 10.7554/eLife.12620

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Caption:
The light hits the round cells of the bacterium, where it is focused by a microscopically tiny lens. This creates a focal point on the opposite side of the cell. Source: Nils Schürgers