# Nasty bacteria need sunlight to do their worst

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Certain types of bacteria have sunlight-sensing molecules similar to those found in plants, according to a new study. Surprisingly, at least one species—responsible for causing the flu-like disorder Brucellosis—needs light to maximize its virulence. The work suggests an entirely new model for bacterial virulence based on light sensitivity.

The paper was authored by an international team* of collaborators including Trevor Swartz, lead author who was a former postdoctoral and visiting investigator at Carnegie's Department of Plant Biology at the time of the study, and Winslow Briggs and Tong-Seung Tseng currently at the department. The research appears in the August 24 issue of the journal *Science*. It is the first detailed study into the function of plant-like light-sensing molecules in bacteria.

"The central message is that many bacteria have signaling proteins that contain the same light-absorbing domain as those found in the higher plants," Briggs explains. "One of these is a vicious pathogen called Brucella. A species of Brucella is a serious pathogen of cattle that causes abortion of calves, and another species is a nasty pathogen of humans."

The bacterial sensors are closely related to phototropins—the light receptor molecules that cause a plant to grow toward a light source. They share a protein sequence called a LOV (pronounced "love") domain, so named because it can detect light, oxygen, and/or voltage. Briggs and his colleagues were the first to discover and describe plant LOV domains in 1998.

LOV-domain proteins have been found in more than 100 different bacteria. For the purposes of this study, the researchers narrowed the field to a handful of candidates with well-known LOV sequences that closely resemble those in plants. They eventually settled on four species: Brucella melitensis, Brucella abortus, Erythrobacter litoralis and Pseudomonas syringae.

In the case of B. abortus, and possibly others, the presence of a LOV domain is more than mere coincidence. When the researchers disabled the LOV-domain protein gene in this species, its virulence—measured as the ability to reproduce efficiently enough to cause disease—dropped to less than 10% of normal, “wild-type” bacteria.

In a simple experiment involving two layers of light-blocking aluminum foil, they achieved a similar drop in virulence, demonstrating that B. abortus depends on sunlight to do its dirty work.

“Brucella has been extensively studied for years because of its threat to livestock and the effect it has on our food supply—one of the key reasons we pasteurize milk is to prevent infection by Brucella,” explained Swartz. “But no one has previously demonstrated any type of light response in Brucella’s lifecycle. This is an exciting result that could possibly provide for a novel therapeutic avenue to treat and prevent infection.”

“People studying non-photosynthetic bacteria, whether the bugs are pathogenic or not, pay no attention to light conditions and are completely unaware that light might play some essential role in their physiology,” Briggs added.

When it is in the dark, a LOV domain uses weak chemical bonds to hold onto a small molecular group known as a chromophore. When it absorbs light, however, the LOV domain temporarily tightens its grip on the chromophore by forming a more stable bond. This reaction is essentially a biochemical switch, and when the light source is blocked or removed, the LOV domain relaxes its grip on the chromophore once again. Activated LOV domains can switch on yet another signaling molecule, known as a kinase, forming a coupled biochemical pathway referred to as a "two-component system."

The function of LOV proteins is fairly well documented in plants. Although researchers had previously documented LOV proteins in bacteria, Briggs, Tseng, Swartz, and their colleagues are the first to examine their function in detail. They found that bacterial LOV domains activate a common signaling pathway that begins with a specific type of kinase known as histidine kinase.

“Bacteria have a large collection of these so-called histidine kinases that are activated by nutrients such as sugar and amino acids, or toxic substances,” Briggs said. “Our work is the first ever to demonstrate a light-activated histidine kinase in a bacterium and demonstrate that it plays an essential role in bacterial virulence.”

Source: Carnegie Institution