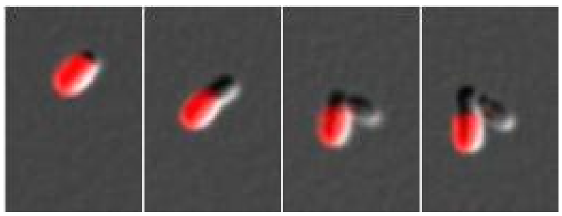
# Polar growth at the bacterial scale reveals potential new targets for antibiotic therapy

January 17 2012



Outer membrane proteins of an *Agrobacterium tumefaciens* cell were labeled in red, with images taken every 50 minutes as the cell grew. In panels three and four it is clear that the cell on the left (red) has kept all the labeled proteins, whereas the other cell has all new surface proteins. Image by Pamela J.B. Brown, Indiana University.

(PhysOrg.com) -- An international team of microbiologists led by Indiana University researchers has identified a new bacterial growth process -- one that occurs at a single end or pole of the cell instead of uniform, dispersed growth along the long axis of the cell -- that could have implications in the development of new antibacterial strategies.

Based on past detailed studies of rod-shaped bacteria such as *Escherichia coli* and Bacillus subtilis, it has been assumed that most bacteria grow by binary fission, a dispersed mode of growth involving insertion of new cell wall material uniformly along the long axis of the cell. Growth requires breaking the cell wall at numerous places along the cylinder to allow insertion of new cell wall material, enabling uniform elongation of the cell, with the process culminated by cleavage at the mid-point of the cell to create two symmetric new cells.

The new research published today, Jan. 17, in Proceedings of the National Academy of Sciences reports on the surprising discovery that cell growth in a large group of rod-shaped bacteria occurs by insertion of new cell wall material only at a single end, or pole, of the cell rather than by the dispersed mode of growth. The cell wall of the progenitor cell remains largely intact, and all of the new cell wall material is partitioned into the new cell.

Polar growth of four bacterial species -- the plant symbiont *Sinorhizobium meliloti*, the plant pathogen Agrobacterium tumefaciens and the human pathogens *Brucella abortus* and *Ochrobactrum anthropi* -- was observed using time-lapse microscopy and transmission electron microscopy. The four related bacteria used in the study are all members of a large and diverse class of bacteria called the Alphaproteobacteria. The results reported suggest that polar growth is broadly distributed among many different bacterial taxa, including groups outside the Alphaproteobacteria.

There could be a number of reasons why polar growth emerged and has remained conserved and persistent in bacteria, the researchers believe. The process may act as an aid in anchoring damaged material to only the aging mother cell; it could serve as a tool for conservation of energy by constraining growth to a single region of the cell; and ensuring that newborn cells are composed of newly synthesized outer membrane proteins may help pathogens avoid detection by host immune systems.

"As a consequence of polar growth, the two bacterial cells are actually markedly different," said lead author Yves Brun, the Clyde Culbertson Professor of Biology in IU Bloomington's College of Arts and Sciences. "One cell contains all of the old cell wall and surface molecules, including those with damage. In contrast, the other cell is composed of newly synthesized, relatively pristine material."

Ensuring that some cells are composed of newly synthesized surface molecules may help bacteria vary their surface composition, and the ability to do so rapidly is thought to be advantageous for adapting to new environments. Since the defense systems of many plant and animal hosts recognize bacterial cell surfaces, rapid modification of the cell surface may allow bacteria like those used in the experiments to evade detection by the host cell's defense systems.

"These findings make it abundantly clear that the widely accepted binary fission model is not a general rule and suggest that polar growth may be broadly distributed," said IU biology professor Clay Fuqua, one of the IU co-authors. "Therefore, future work aimed at understanding the molecular mechanism underlying polar growth should provide attractive targets for the development of new antibacterial strategies."

Understanding the mechanisms of bacterial growth has enabled advances in strategies to limit the proliferation of bacteria that cause disease. Penicillin, for example, targets actively growing cells by directly inhibiting the proteins responsible for the synthesis of the cell wall and that are required for cell growth. New insights into bacterial cell growth have also been utilized to promote growth of certain bacteria used in oil spill remediation and eradicating disease-carrying mosquitoes.

**More information:** "Polar growth in the Alphaproteobacterial order Rhizobiales" *Proceedings of the National Academy of Sciences* Jan 17, 2012.

Provided by Indiana University