Exploring the Biophysics of Bacterial Growth and Division with Time-lapse Optical and Atomic Force Microscopy

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Observing bacterial growth at the single cell level is inherently challenging due to the diffraction limit. We built a dedicated platform for long-term, correlated Atomic Force Microscopy (AFM) and fluorescence microscopy[1] and obtained time-lapses of mycobacterial growth[2] with high resolution. We observed a biphasic growth pattern, where a new cell pole initiates fast growth only after a lag phase of slow growth. Surprisingly, this growth dynamics was different from what was previously reported, resembling instead the growth dynamics of fission yeast (*new end take off* or NETO)[3]. While it is possible to measure NETO dynamics in fission yeast using optical microscopy, AFM was required to capture the subtle variations of elongation for bacteria, which are three orders of magnitude smaller in volume. Using AFM micromanipulation of the cells, we found that pole-to-pole contact forces were not the reason for the initial slow growth at the new poles. On the contrary, we showed, using a combination of AFM and fluorescence photoconversion, that the lag phase corresponds to the relocalization of a molecular factor involved in growth from the old to the new cell pole. AFM shed light on a previously unknown degree of similarity between organisms that are far apart in the evolutionary tree (one is a eukaryote, the other a prokaryote). Our results hints at global biophysical constraints associated with polar growth that remained unexplored so far.

REFERENCES

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FIGURES

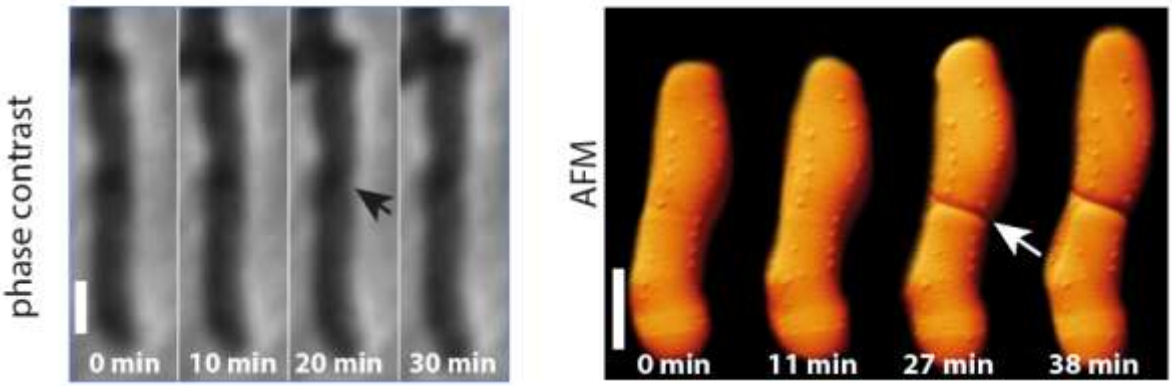

Figure 1: Bacterial division seen with phase contrast optical microscopy and AFM. Scale bar 1um.