When dying, bacteria share some characteristics with higher organisms

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Do bacteria, like higher organisms, have a built-in program that tells them when to die? The process of apoptosis, or cell death, is an important part of normal animal development. In a new study published March 6 in the online, open-access journal *PLoS Biology*, Hanna Engelberg-Kulka and colleagues (at Hadassah Medical School of the Hebrew University, Jerusalem, Israel) have described for the first time a novel cell death pathway in bacteria that is similar to apoptosis in higher organisms. They also found that this newly described apoptotic-like death (ALD) pathway was inhibited by another non-apoptotic programmed cell death (PCD) pathway, mediated through the mazEF toxin-antitoxin system.

Engelberg-Kulka and colleagues were surprised to find two very different death pathways in *E. coli*. The newly-discovered bacterial cell death system was itself surprising because it shared multiple characteristics with apoptosis in multicellular eukaryotes, which is why they named it Apoptotic-Like Death (ALD). In particular, in both eukaryotic apoptosis and in ALD, the cellular DNA becomes fragmented, and the cell membrane becomes depolarized, which can be detected by an influx of fluorescent dye into the cell. They also found that when cellular DNA is severely damaged, the newly described ALD pathway is inhibited by the PCD pathway mediated by the mazEF system of *E. coli*.

Further studies will clarify the similarities between eukaryotic and bacterial apoptosis, and the evolutionary origin of apoptotic death. It

appears that ALD is a non-altruistic back-up death pathway for the traditional mazEF altruistic death pathway: Should one of the components of the mazEF pathway be inactivated, bacterial death would occur through ALD.

What does it matter which way the bacterium dies? The authors suggest that the answer may have implications for the evolution of altruism. They found that the mazEF system is cell-density dependent, and ensures that, in a crisis, enough bacteria die off to ensure a plenitude of bacterial raw materials in the environment for those that survive. The ALD pathway, in contrast, has no density dependence, and may serve as a backup system in the event the mazEF system fails.

Future experiments will help reveal the underlying molecular mechanisms for ALD, and whether this system does in fact influence a "good-for-the-community" population response.

More information: Erental A, Sharon I, Engelberg-Kulka H (2012) Two Programmed Cell Death Systems in Escherichia coli: An Apoptotic-Like Death Is Inhibited by the mazEF-Mediated Death Pathway. *PLoS Biol* 10(3): e1001281. doi:10.1371/journal.pbio.1001281

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