Aging and imperfect asymmetric division in bacteria


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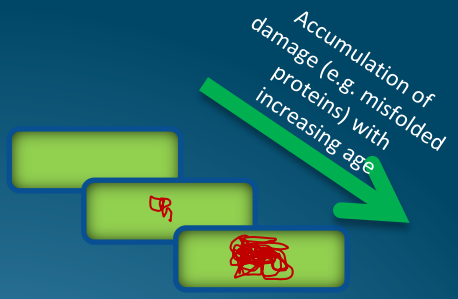
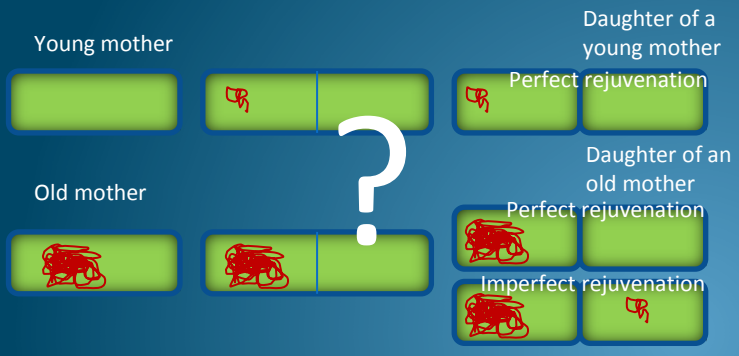
Background

The process of aging is assumed to result from accumulating damage over the lifespan. Evolutionary theory predicts that dividing organisms such as bacteria flee from that process at the population level by asymmetric division. One cell (presumably the mother cell) takes over more of the damage and the other cell (daughter) is perfectly rejuvenated.



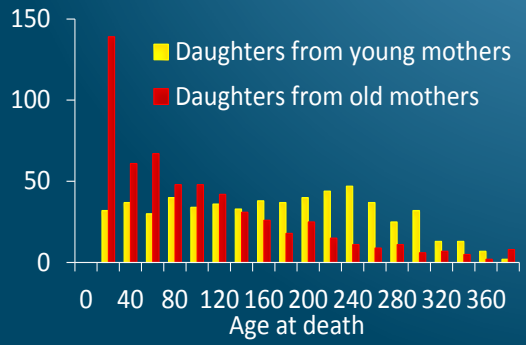


Question

Does asymmetric division remains perfect throughout life and thereby allows old mothers to produce perfect rejuvenated offspring?

Results

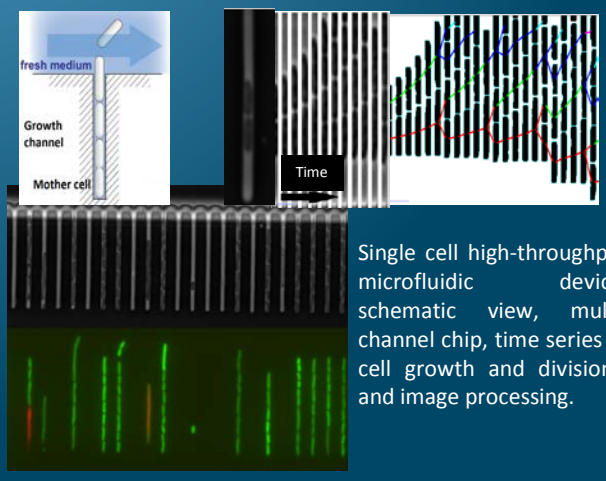
Daughters from young mothers have long lifespan compared to daughters from old mothers. Division rate (reproduction rate) of the daughters does not depend on the age of the mother (young 1.9±0.35 Std/hour; old 1.84±0.53 Std/hour).



Age at death distribution of 1198 single E. coli cells coming from an old mother or from a young mother.

Experiment

We conducted experiments on a single cell microfluidic bacteria system to compare demographic parameters of daughter cells that came from young mothers with daughter cells coming from old mothers.



Single cell high-throughput microfluidic device: schematic view, multi-channel chip, time series of cell growth and divisions, and image processing.

Conclusion

Daughter cells produced early in life prevent the cell lineage from aging through perfect rejuvenation, whereas daughters produced late in life would lead to aging populations. Asymmetric division cannot be maintained perfect across life. The “soma-germ line” division in bacteria happens within a single cell along the age axes. Our results highlight how life-histories and aging has to be considered across generations; not only age matters, also the age of the mother determines the lifespan of daughters.