IQ testing in bacteria

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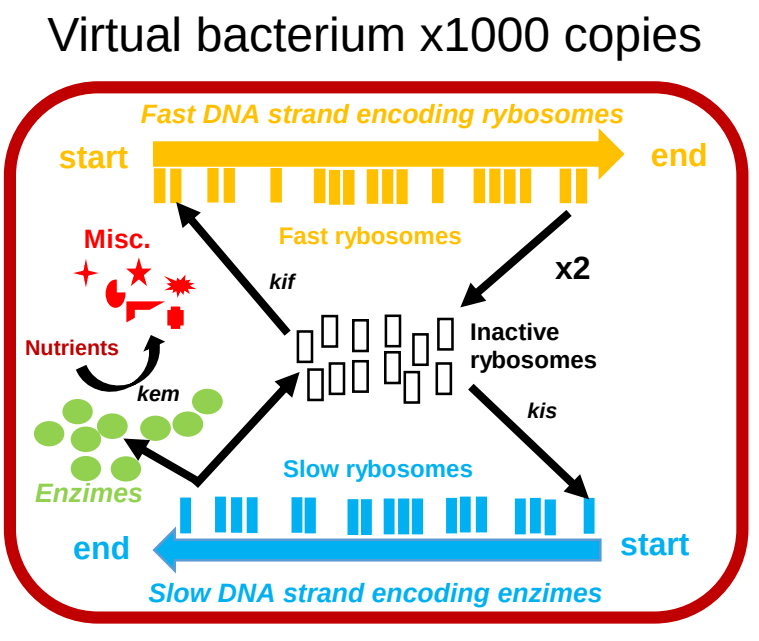
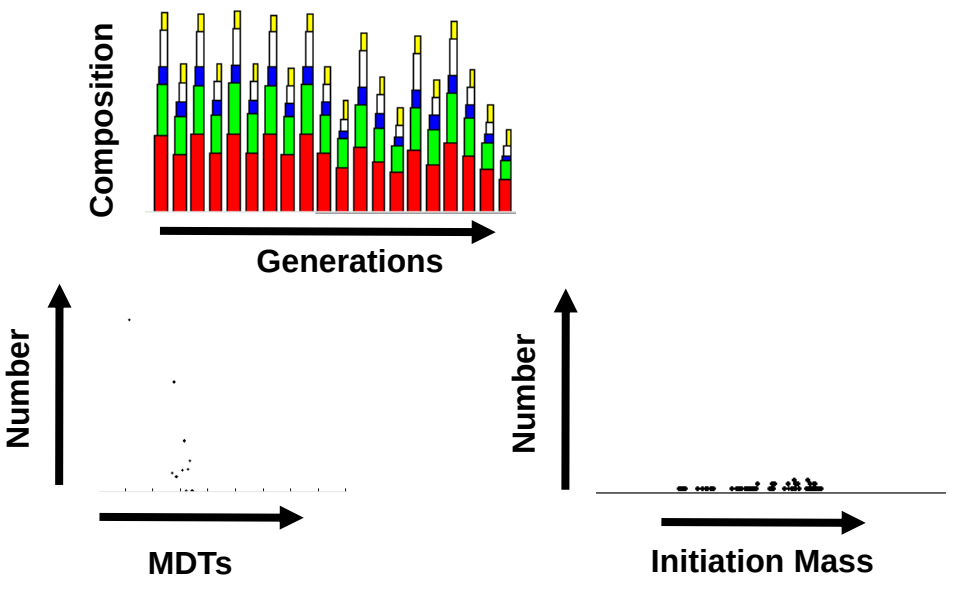
Sensing the intensity of working of constituents, *I,* is important for many biological systems because once a constituent becomes limiting, the system can no longer grow exponentially. The solution is to duplicate this constituent – and perhaps divide – before it becomes limiting (1). Sensing the quantity, Q, of constituents in a system is also important to ensure the viability of the daughter subsystems produced by a division. At the level of the cell, DNA becomes limiting if it is not replicated. We report the results of the simulation of a turbidostat of bacteria written to address the question of how the decision to initiate DNA replication might be made by testing both *I* and *Q*.

If it is assumed that control over the replication of DNA and over cell division developed at some early stage in the evolution of cells, it might then be assumed that the nature of this control was independent of the action of sophisticated enzymes. I have argued that a powerful selection exists for cells (1) to replicate their DNA and their catalytic functions before they become limiting for growth and (2) to divide before they get too big (2). These actions require cells sensing the intensity, ***I***, with which their constituents are working and sensing the quantity, ***Q***, of their mass. To explore this hypothesis, we have simulated the growth of bacteria in a turbidostat. Each bacterium has seven constituents: the two DNA strands, ***m*** *miscellaneous* material (lipids, metabolites, ions etc.), ***e*** *enzimes* (catalysing the production of enzimes), and *rybosomes* (composite RNA polymerases and rybosomes) that can be either ***i*** inactive or ***f*** fast (expressing the strand encoding rybosomes) or ***s*** slow (expressing the strand encoding the enzimes). Each DNA strand is expressed by rybosomes that advance through a fixed number of intervals; each interval can be saturated with rybosomes (i.e., there is a maximum number of rybosomes per interval). Each newborn bacterium has a *NewBornMass* = ***Ni + Nf + Ns + Ne + Nm*** (where ***N*** = number and the mass of each constituent is one unit). Growth rate and composition is calculated via iteration of equations based on kinetic constants ***kif*** (inactive to fast), ***kis*** (inactive to slow), and ***kem*** (enzime catalysing miscellaneous from miscellaneous).

Intensity sensing is used to initiate DNA replication. Each bacterium divides at constant time after initiation of DNA replication. Strand segregation is semi-conservative (3, 4). Every time division occurs, a randomly chosen bacterium is discarded. The program allows the value of many variables to be calculated.





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