

CELL GENERATION TIMES: ANCESTRAL AND INTERNAL CONTROLS

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1. Introduction

In order to develop adequate models for the kinetics of growth of cell populations, it is necessary to know the generation time distribution for the individual cells and the degree to which the generation times of related individuals are associated. In essence, the generation time of a cell is that period between successive cell divisions, that is, the period between the birth of the cell by fission of its parent and the later instant at which its own fission occurs. In practice, the generation times of cells are measured by recording the passage of some particular state during or near fission as the individual cells are observed at successive times. This state must be chosen with some caution since any variability in its passage will cause a corresponding loss of resolution in the measured generation time distribution and will lead to an unduly negative correlation between successive generation times.

Early models proposed to describe generation time distributions, by Rahn [1] and by Kendall [2], assumed that generation times of cells were independent of one another. We now know that the generation times of closely related bacterial cells are not independent since the generation times of sister bacterial cells are consistently observed to be positively correlated (Powell [3], [4], Kubitschek [5], Schaechter, Williamson, Hood, and Koch [6], Powell and Errington [7]), and associations continue to exist for at least three generations [7], [8]. Similar associations may be anticipated for other cells because of the similarity of their generation time distributions to those of bacteria [5], [9].

2. Correlations between the generation times of bacterial cells

2.1. *Lateral correlations.* Powell measured generation times for six species of bacteria that were grown under almost constant conditions [3]. His criterion for cell division (or more precisely, termination of a generation) was cell separation. He observed a significant positive correlation between the generation times of sister cells in all six species. Later, in a study of four of these species [4] he found in each a positive correlation between first cousins (that is, cells

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