

The age of the inoculum culture has a strong effect on the length of lag phase. The age refers to how long a culture has been maintained in a batch culture. Usually, the lag period increases with the age of the inoculum. In some cases, there is an optimal inoculum age resulting in minimum lag period. To minimize the duration of the lag phase, cells should be adapted to the growth medium and conditions before inoculation, and cells should be young (or exponential phase cells) and active, and the inoculum size should be large (5% to 10% by volume). The nutrient medium may need to be optimized and certain growth factors included to minimize the lag phase. Figure 6.4 shows an example of variation of the lag phase with $MgSO_4$ concentration. Many commercial fermentation plants rely on batch culture; to obtain high productivity from a fixed plant size, the lag phase must be as short as possible.

Multiple lag phases may be observed when the medium contains more than one carbon source. This phenomenon, known as *diauxic growth*, is caused by a shift in metabolic pathways in the middle of a growth cycle (see Example 4.1). After one carbon source is exhausted, the cells adapt their metabolic activities to utilize the second carbon source. The first carbon source is more readily utilized than the second, and the presence of more readily available carbon source represses the synthesis of the enzymes required for the metabolism of the second substrate.

The *exponential growth phase* is also known as the *logarithmic growth phase*. In this phase, the cells have adjusted to their new environment. After this adaptation period, cells can multiply rapidly, and cell mass and cell number density increase exponentially with time. This is a period of *balanced growth*, in which all components of a cell grow at the same rate. That is, the average composition of a single cell remains approximately constant during this phase of growth. During balanced growth, the net specific growth rate

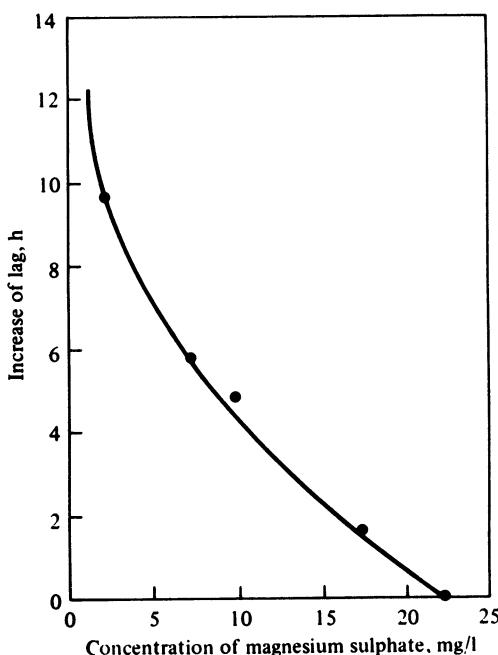


Figure 6.4. Influence of Mg^{2+} concentration on the lag phase in *E. aerogenes* culture. (With permission, from A. C. R. Dean and C. Hinshelwood, *Growth, Function, and Regulation in Bacterial Cells*. Oxford Press, London, 1966, p. 55.)