4.3: Yeast growth phases

When yeast are grown in liquid medium, the culture follows a well-established pattern for microbial growth. (Bacteria follow this same general pattern, although they divide much more rapidly.) Cultures are usually started by inoculating media with a small number of cells. A lag phase follows the inoculation, during which cells become acclimated to the new environment and begin to condition the media with their own metabolites. **Lag phase** is followed by an exponential, or **log phase**, when the number of cells increases exponentially.

The exponential growth of yeast can be described by the equation:

\[ N = N_0 e^{kt} \]

where \( N \) represents the number of cells at any time (t), and \( N_0 \) represents the number of cells at the beginning of the interval being analyzed. Scientists often find it convenient to think of the growth constant \( k \) in terms of the doubling time of the culture. In this rendering, \( k = \ln 2 / T \) (\( T \) = the doubling time of the culture). The growth rate of yeast varies with temperature. Yeast grow well at room temperature, but they grow more rapidly at 30°C. Well-aerated cultures grow more
quickly than those that are not, so liquid cultures are usually grown on a rotary shaker or rotating wheel. At 30°C, wild-type yeast strains have a doubling time of ~90 minutes in YPD.

After a few doubling times, cells begin to deplete the nutrients in the culture, their growth rate slows, and the cells enter **stationary phase**. Yeast entering stationary phase adjust their metabolism by altering the transcription of hundreds of genes, leading to many physiological changes, including the accumulation of carbohydrate reserves and the assembly of a more resistant cell wall (reviewed in Werner-Wasburne et al., 1993). In stationary phase, the rate of cell division is similar to the rate of cell death, so the number of cells does not change appreciably. Cells can survive in stationary phase for extended periods of time, resuming growth when conditions are favorable. Eventually, cells enter **death phase** if conditions do not improve.