A MATHEMATICAL MODEL FOR BACTERIAL CHEMOTAXIS

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ABSTRACT A differential equation describing the chemotactic migration of a bacterial population in a fixed exponential gradient of attractant has been integrated using the appropriate boundary conditions. The solution predicts an initial bacterial accumulation at the concentration "knee" with the final distribution of bacteria approaching a time-independent state. Specific additional experiments to obtain further data for a rigorous test of the theory are suggested.

In the steady state

$$\partial b/\partial t = 0. \tag{8}$$

Then,

$$\mu(\partial^2 b/\partial x^2) = 0, \quad -L_1 \leq x \leq 0, \tag{9}$$

$$\mu(\partial^2 b/\partial x^2) + v(\partial b/\partial x) = 0, \quad 0 \leq x \leq L_2. \tag{10}$$

The boundary conditions are given again by Eqs. 5, 5 *A* and 6, 6 *A*. Eqs. 5–10 have the solution

$$b(x) = b_1, \quad -L_1 \leq x \leq 0, \tag{11}$$

$$b(x) = b_1 \exp(-vx/\mu), \quad 0 \leq x \leq L_2 \tag{11 A}$$

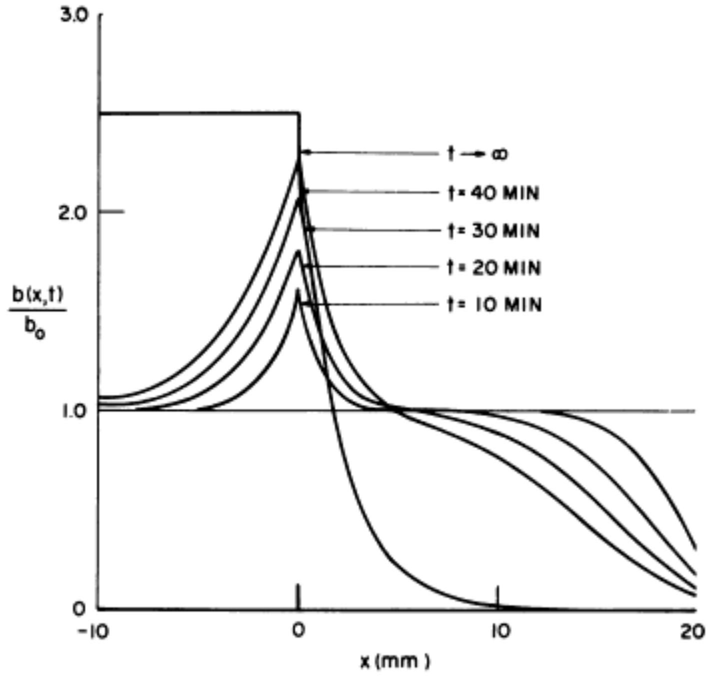

FIGURE 1 Plots of bacterial density distributions at t = 10 min, 20 min, 30 min, 40 min, and $t \to \infty$. The peak of the bacterial density distribution grows with time at the discontinuity in the nutrient (L-serine) gradient located at $x = 0$.

Bacterial chemotaxis