

Basic: Diffusion with source

Summary: Diffusion with source is defined by a supply of diffusing molecules from some point(s) within diffusing space. One example is diffusion of proteins molecules in the nucleus that enter continuously through nuclear pores. Another example is a diffusion of ions within the cytoplasm that enter through ion channels on the plasma membrane (Fig.1).

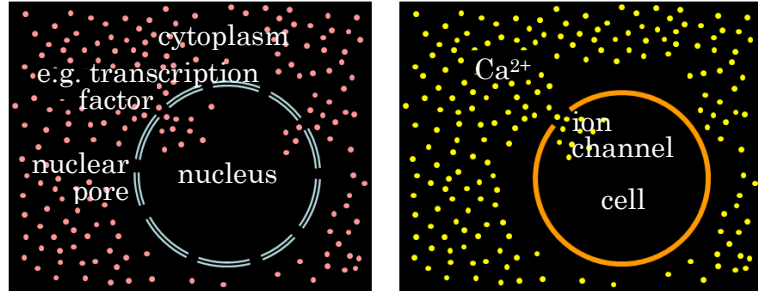
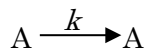


Fig.1 Two examples of diffusion with source.

Cartoon and A-Cell model: As in the model construction of diffusion without source, embed a following dummy reaction to all compartments of the shape.



Any value for k is good. The question is how a source model is constructed. Here we apply “stimulation” function of A-Cell for modeling a source (Fig.2). In the present case, stimulus that describes the concentration of A is

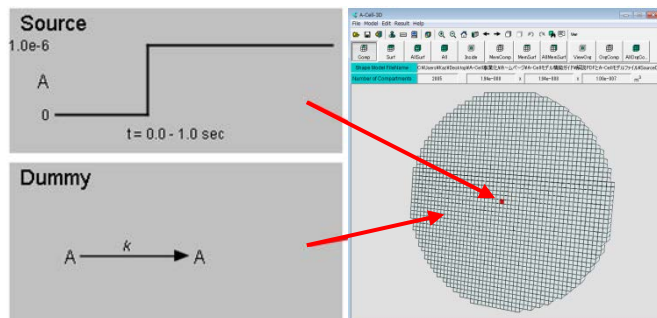


Fig.2 A-Cell model for diffusion with source

embedded to the center compartment of the disk shape of $1 \mu\text{m}$ in diameter with 51 divisions, and the dummy reaction shown above is embedded to all compartments with concentration of $0 \mu\text{M}$ for all compartments. This enables continued supply of A at the center compartment acting as a source. Simulation result with diffusion coefficient of $10^{-11} \text{m}^2/\text{s}$ is shown in Fig.3. Simulation conditions were as follows: calculation time = 0-10 ms; calculation step = $1 \mu\text{s}$; output step = $100 \mu\text{s}$.

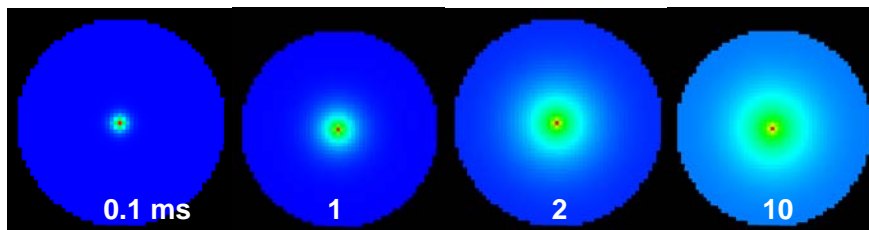


Fig.3 Simulation result of diffusion with source

Simulation result is quite different from diffusion without a source. Here there is no decrease in the concentration because of the continuous supply of molecules at the center compartment. Instead, the concentration at the peripheral compartments is increasing, and it is not homogeneously distributed for a long period of time. Try to see if there are source and sink at the same time.