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Improvement and Evaluation of a Mathematical Model for Fertilization Calcium Waves in *Caenorhabditis elegans*

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Abstract: Ca^{2+} waves propagate through the oocyte during fertilization, activate the oocyte and induce embryonic development. Ca^{2+}-induced Ca^{2+}-release (CICR) is a mechanism of Ca^{2+} wave formation. We previously quantified the Ca^{2+} waves in the nematode *Caenorhabditis elegans* by using high-speed imaging and image analysis. We found that the waves consist of a rapid local rise at the point of sperm entry and a slow global wave. We demonstrated that the Nagumo model, which models the CICR by a reaction–diffusion equation, can produce a similar biphasic waveform. However, the model cannot represent the observed gradual decrease in maximum Ca^{2+} concentration with increasing distance from the point of sperm entry. In this study, we introduced a linear monotonically decreasing function into the reaction part of the Nagumo model. We demonstrated that our new model can produce the gradual decrease in maximum Ca^{2+} concentration with increasing distance from the point of sperm entry and a biphasic waveform simultaneously.

Keywords: calcium wave, reaction–diffusion model, computer simulation, fertilization

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