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Spatiotemporal Dynamics of Glycolysis and Cellular Metabolism: Toward Intelligence by Nonlinear Chemical Processes

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Spatiotemporal dynamics both in intracellular chemicals accompanying cell behavior of a giant amoeboid cell and in the cell-free glycolytic system are studied. Spatial patterns vary, accompanying various cell behaviors, and phases of oscillation shift and new waves propagate in response to external stimuli. Thus, the global spatiotemporal dynamics in the cell is a basis for intelligent cell behavior. These characteristics are simulated by the oscillating glycolytic system. Hence, it should be possible to achieve intelligence by using nonlinear chemical processes far from equilibrium.

1. Introduction

It is the dream of material scientists to develop new-functionality materials which are able to sense environmental conditions, make judgments based on this information and act appropriately.[1] However, we do not know at present the principle of how to construct these "smart" or "intelligent" materials.

Cell behavior is a good example for studying the basic mechanism of "intelligence" in terms of chemical dynamics. Single-celled organisms, having neither nervous systems nor brains, are able to sense changes in environmental conditions, make judgments based on this information and move away from or toward the stimulant. Thus, the cell is nothing but an "intelligent" micromachine, and by studying it, we may learn the molecular mechanism of such higher information processes as perception.

Amoeboid cells are one of the most primitive forms of life because these cells have no