Interfacing Living Cells via Molecular Communication

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Abstract. Molecular communication provides a direct method for interfacing living cells via transmission of chemical signals. Here we report our recent result of developing a novel molecular communication method based on the cellular event called autophagy. The method currently under investigation uses micrometer-sized objects coated with bio-reactive molecules as information carrying molecules, which are selectively incorporated into and decoded within biological cells. This short paper briefly describes the method, experimental results, and theoretical model for the molecular communication method based on autophagy.

Keywords: Molecular communication, biological machines, autophagy.

1 Introduction

A promising material to design and engineer biological machines for molecular communication is biological cells [1]. The biological cells are by nature capable of recognizing, synthesizing, and processing chemical signals, and they can be genetically modified to implement necessary functionality for molecular communication (e.g., the distance estimation protocol [2]). The approach of using biological cells for specific applications is often employed in synthetic biology; the early work includes the establishment of sender and receiver cells using genetically modified *E. coli* (a bacterium) that collectively perform programmed pattern formation for tissue engineering [3].

Our recent efforts are focused on developing a biologically compatible interface with eukaryotic cells. A key cellular event being studied is *autophagy* in which unwanted molecular components are detected, captured, and degraded within the cells [4]. The process of autophagy can be induced with chemical signals that are externally applied (information carrying molecules in Fig. 1), and thus it can be used to provide an interface between the cell and the outside environment. After the information carrying molecule is captured in the cell, the process of autophagy starts decoding the information, which for instance leads to the formation of a membrane around a specific area in the cell.

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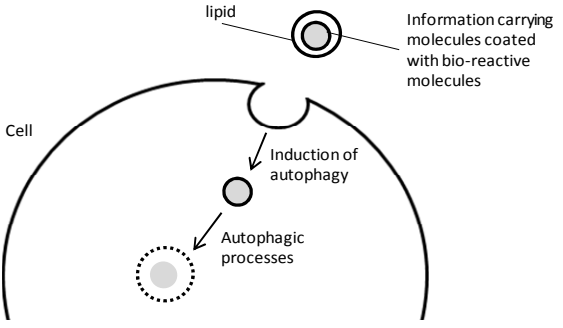

Fig. 1. Molecular communication through autophagy processes

2 Results

Our experiments using eukaryotic (and nonphagocytic) cells have identified the conditions to artificially induce autophagy processes, which have been successfully monitored by live cell imaging [4]. The molecular mechanisms of autophagy processes are now being investigated by further experiments as well as modeling and simulation.

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