Micro-Particle Transporting System Using Galvanotactically Stimulated Apo-Symbiotic Cells of *Paramecium bursaria*

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It is well known that *Paramecium* species including green paramecia (*Paramecium bursaria*) migrate towards the anode when exposed to an electric field in a medium. This type of a cellular movement is known as galvanotaxis. Our previous study revealed that an electric stimulus given to *P. bursaria* is converted to a galvanotactic cellular movement by involvement of T-type calcium channel on the plasma membrane [Aonuma *et al.* (2007), Z. Naturforsch. **62c**, 93–102]. This phenomenon has attracted the attention of bioengineers in the fields of biorobotics or micro-robotics in order to develop electrically controllable micromachineries. Here, we demonstrate the galvanotactic controls of the cellular migration of *P. bursaria* in capillary tubes (diameter, 1–2 mm; length, 30–240 mm). Since the *Paramecium* cells take up particles of various sizes, we attempted to use the electrically stimulated cells of *P. bursaria* as the vehicle for transportation of micro-particles in the capillary system. By using apo-symbiotic cells of *P. bursaria* obtained after forced removal of symbiotic algae, the uptake of the particles could be maximized and visualized. Then, electrically controlled transportations of particle-filled apo-symbiotic *P. bursaria* cells were manifested. The particles transported by electrically controlled cells (varying in size from nm to εm levels) included re-introduced green algae, fluorescence-labeled polystyrene beads, magnetic microspheres, emerald green fluorescent protein (EmGFP)-labeled cells of *E. coli*, Indian ink, and crystals of zeolite (hydrated aluminosilicate minerals with a micro-porous structure) and some metal oxides. Since the above demonstrations were successful, we concluded that *P. bursaria* has a potential to be employed as one of the micro-biorobotic devices used in BioMEMS (biological micro-electro-mechanical systems).

Key words: BioMEMS, Green Paramecia, Particle Transport