Motion and Pattern Formation of Micro Bio-Robots

Chih-Ming Ho
Department of Mechanical and Aerospace Engineering
Henry Samueli School of Engineering and Applied Science
University of California, Los Angeles
Los Angeles, CA 90095-1597

Abstract

In biological world, cell is the most fundamental system, which consists of large number of molecules, DNA/RNA and proteins. These building blocks self-organize to form a cellular system which exhibit specific functionalities for performing a physiological function. For many types of cells, motion is an important part of their functional task. For example, a neutrophil can perform an agile motion, like a micron-size robot, by following and attacking foreign particles, e.g. bacteria, as a body defense mechanism.

Many other types of cells, they will move under the influences of local chemical and physical environment and eventual form tissue patterns which lead toward higher level structures of specific shapes. In this presentation, we will discuss an interesting finding that vascular mesenchymal cells (VMCs) can tell left or right and move accordingly to form asymmetric tissue pattern.

When VMCs are dissociated and homogeneously plated in tissue culture, they first reach confluence with no apparent pattern. After 15 to 20 days, the cells proliferate, move and aggregate into regularly spaced ridges in the configuration resemble to the labyrinthine pattern driven by Turing instability.

To probe this system with different initial conditions, we conducted microtechnologies to engineer the substrates with patterns of surface molecular to spatially define the initial settlement of cells. Glass substrates were fabricated with functional surface composed of alternating stripes of fibronectin (FN) and polyethylene glycol (PEG). On such binary surface, cells only attach to fibronectin stripes but not PEG stripes while plating. By day 5, cells proliferated, spreading out from fibronectin stripes and regained the confluence. After 15 to 20 days, instead of forming labyrinthine pattern, cells move and aggregate into regularly spaced and parallel ridges along the diagonal axis. In other words, cells have a preferred direction of motion and accordingly form tissue patterns with left-right asymmetry.

Biography

Chih-Ming Ho holds the Ben Rich-Lockheed Martin Chair Professor and Distinguished Professor in UCLA School of Engineering. He is the Director of Center for Cell Control (NIH Nanomedicine Roadmap program). He served as UCLA Associate Vice Chancellor for Research in 2001-2005.

He is a pioneer in the microfluidics field and has made seminal contributions in micro/nano bio-transducers. He has published 320 papers and 10 patents. He has presented 20 named distinguished lectures and 129 keynote talks in international conferences. He was ranked by ISI as one of the top 250 most cited researchers in all engineering category.

In 1997, Dr. Ho was inducted as a member of the National Academy of Engineering. In the following year, he was elected as an Academician of Academia Sinica. Dr. Ho holds eight honorary chair professorships. Dr. Ho is Fellow of APS and AIAA.