**Population dynamics of chemo- and hapto-taxing model cells that have an intrinsic directional persistence in crawling**

Tae Goo Kwon, Kyoung J. Lee

Center for Cell Dynamics and Department of Physics, Korea University, Seoul 136-701, Korea

E-mail: tglkwon@korea.ac.kr

The crawling of a biological cell is a rather complex phenomenon involving various bio-chemical and bio-mechanical processes, many of which are still not well understood. Some of them are intrinsic to individual cells, while many others are either related to the cell population dynamics or attributed to some extrinsically imposed chemical gradients and/or cell-to-substrate interations. Here, we discuss the population dynamics of mathematical model cells that have a built-in directional persistence during their crawling for three different cases: 1) when there is a haptotaxis-mediated social interaction, 2) when there is a chemotaxis following an externally imposed global chemical gradient,
and 3) when both are present. For the case of 1), we show that cells can form intriguing patterns of trails along which they crawl. The trail morphology very much depends on the degree of the directional persistence. For the case of 2) (i.e., chemotaxis only), the model cell density is measured as a function of time and space. Surprisingly, we find the steady-state cell density profile fits rather well to that of a welll-known Keller-Segel population model, in which a chemotatic flux $\mathrm{j}_{chemo} = \kappa\rho \bigtriangledown c$ competes with a diffusive flux $\mathrm{j}_{diff} = -D \bigtriangledown \rho$, where $\kappa$, $c$, and $D$ stand for the strength of chemotaxis, the concentration of chemo-attractant, and the effective diffusion coefficient of the cell population, respectively. In other words, our model cells can be considered as a normal Brownian particle; the time which is relevant for their directional persistence is too small ( $\sim 100$) to be meaningful when it is compared with the much longer time interval ($\sim 10000$) that we have used for the estimation of the diffusive flux. Finally, for the case of 3) (i.e., both chemotaxis and haptotaxis), we find two interesting consequences. First of all, the time it takes for the system to reach its steady-state gets significantly shortened. Second of all, the cell density at the peak chemo-attractant density becomes much higher. We believe that the mixed case of 3) can be a very realistic picture in many different immune responses, such as microglia or neutrophils moving toward and around a site of wound or pathogens.