Sensing the substrate rigidity: possible roles of stress fibers, focal adhesion and mechanosensitive channel

Takeshi Kobayashi, Mizuna Tanaka, Yoshie Takeda, Gen Ito, and Masahiro Sokabe
Department of Physiology, Nagoya University Graduate School of Medicine, Nagoya, Aichi, Japan

Cell motility, spreading, proliferation and differentiation are critically influenced by the substrate rigidity. Cells adhere to the substrate via adhesion molecules and recognize their mechanical environment at those adhesion sites. To feel the substrate rigidity, cells apply traction force in actin stress fibers (SFs) to the substrate and sense its mechanical responses. However, the underlying mechanism, particularly, how mechanical cues are converted into biochemical signals remains largely unclear. Recent studies have demonstrated that externally applied traction force on an actin SF activates mechano-sensitive (MS) channels located at or near focal adhesions (FAs), inducing an increase in the cytoplasmic Ca^{2+} concentration ($[Ca^{2+}]$cyto). SFs seem to function as a force-generating, -transmitting and-focusing device to FAs (integrins) that bind the substrate and covert the substrate rigidity into passive tension in the linear SF-FA system. Actually, we observed substrate rigidity-dependent spontaneous $[Ca^{2+}]$cyt fluctuations in cultured cells. Therefore we propose that MS channels are involved in the substrate rigidity sensing as intrinsic force measurement system.