Comparative biophysics and physiology of cell mechanosensing: from passive to active touch

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Cells sense and respond to mechanical forces, by which they regulate their shape, motility, proliferation and differentiation. This presentation will highlight the latest progress in the molecular and biophysical mechanisms of mechanotransduction in bacteria and eukaryotic cells. Mechanosensitive ion channels (MSCs) are the only established molecular class of cell mechanosensors to date, and bacterial MSCs are the best studied ones owing to their resolved 3 D structures. They are activated simply by tension in the membrane, contributing to the cell volume regulation against hypoosmotic challenge. The mechanisms how they sense membrane tension and open their gate are currently unveiling on the atomic scale.

Mechanotransduction in eukaryote MSCs is rather complicated. For example, a Ca^{2+} permeable MSC in endothelial cells is activated primarily by tension in the actin cytoskeleton stress fiber (SF), which gives the MSC force-direction sensitivity. Further association with the focal adhesion (FA) gives the MSC an active-touch capability, where forces actively generated in SFs pull the substrate via FAs and resulting tension/strain in the SF/FA will activate the MSC, inducing a Ca^{2+} influx depending on the substrate rigidity. Mechanosensing machinery might have evolved from the simple bacterial ones passively responding to membrane tension to the elaborated eukaryotic ones that can actively detect the mechanical properties of surrounding physical environments.