The 51st Biomechanics Seminar

2026 年 6 月 5 日（金）16:00～17:00

京都大学 医生物学研究所

南部総合研究 1 号館・医生研 1 号館 1 階セミナー室 3

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演　題：**Cellular adaptability and mechanical homeostasis**

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要　旨：Living cells adapt their internal structures to maintain mechanical homeostasis in response to environmental cues. However, the physical principles linking robust macroscopic structural adaptations to the underlying microscopic fluctuations remain elusive. Here, we elucidate the physical basis of cellular adaptability by examining both structural phase transitions and active nonequilibrium fluctuations. We reveal that actin reorganization in response to substrate stiffness, observed even in senescent fibroblasts, arises from a hierarchy of phase transitions dictated by energy and entropy competition. This statistical mechanical framework reveals how physical constraints guide distinct cytoskeletal orders. Furthermore, to understand how cells maintain this adaptability in highly fluctuating environments, we developed a quantitative framework to isolate active functional fluctuations from thermal noise. Integrating fluorescence correlation spectroscopy with theoretical analyses, we reveal that these nonthermal fluctuations are predominantly driven by actomyosin activity. We also show that cellular senescence reshapes the fluctuation landscape, where a reduction in fluctuation diversity mechanistically links to the diminished adaptive capacity of senescent cells. Together, our findings reveal how physical constraints and active regulation collaboratively maintain mechanical homeostasis and govern the physiological state of living cells.

講演言語：日本語

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