Imaging and manipulation of temperature in living single cells

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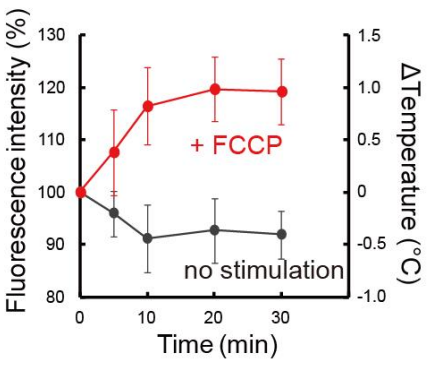
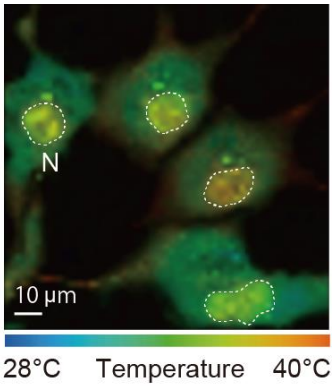
Temperature, a key regulator of biochemical reactions, influences many physiological functions of organisms. Recent progress in intracellular thermometry shows temporal and spatial variation associated with cellular functions, shedding light on an intriguing hypothesis: temperature change inside of a cell is essentially involved in cell biology. Conceiving this idea, we have been investigating intracellular temperature based on a fluorescent polymeric thermometer and quantitative fluorescence imaging.

We first performed the tracking of the averaged temperature of a single cell and showed that the averaged temperature of single COS7 cells increased by 0.98 °C upon mitochondrial uncoupling (left figure). Next, we developed a novel method to visualize intracellular temperature distribution by utilizing fluorescence lifetime imaging microscopy (FLIM) ,which indicated an interesting temperature gradient observed between the nucleus and the cytoplasm of steady-state COS7 cells (right figure). Furthermore, imaging of intracellular thermogenesis was also investigated: we observed the local temperature change provoked by both endogenous heat production from mitochondria and external heating using infrared laser focusing onto a cell. Cellular response including translation reprogramming through RNA granule formation induced by the manipulation of local temperature demonstrates an intrinsic connection between intracellular temperature and cell function. These techniques are indispensable for the advancement of thermal biology, which explores the commitment of temperature to life.





References

1) Gota C., Okabe K. *et al.*, *J. Am. Chem. Soc.*, **131**, 2766–2767 (2009).
2) Okabe K. *et al.*, *Nat. Commun.*, **3**, 705 (2012).