- Technology Presentation #2 -

“Harnessing synthetic chemistry to hijack plant hormone responses”

Dr. Keiko Torii
University of Washington
Nagoya University

Abstract:
The rise of plant molecular genetics has led an unprecedented advancement in our understanding of plant hormone signaling. Such an approach, however, is facing the limit for manipulation of signaling at cellular precision: virtually every plant cell can produce and perceive plant hormones. Yet, different tissues and cell-types elicit unique physiological and developmental response. Due to genetic redundancies, single or double knockout of hormone receptor genes often do not give any phenotype, whereas eliminating all of them results in severe growth defects or lethality. We aim to overcome such hurdles through synthetic chemistry and structure-guided receptor engineering.

The auxin, indole-3-acetic acid (IAA), regulates nearly all aspects of plant growth and development. Despite substantial progress in our understanding of auxin biology, delineating specific auxin response remains as a major challenge. We created a pair of synthetic, convex IAA (cvxIAA) and a shape-complementary concave TIR1 (ccvTIR1) receptor. The cvxIAA-ccvTIR1 hijacked the downstream auxin signaling in vivo both at the transcriptomic level and in specific developmental contexts. In contrast, cvxIAA elicited no response to natural Arabidopsis plants that do not carry the engineered ccvTIR1. Likewise, ccvTIR1 failed to perceive natural or synthetic auxins, thereby enabling the precisely controlled activation of auxin signaling without interfering the endogenous system. Harnessing the cvxIAA-ccvTIR1 pair, we provide a conclusive evidence for the direct role of TIR1-pathway in acid growth, the auxin-triggered rapid cell elongation initially observed by Charles Darwin in 1880. The cvxIAA-ccvTIR1 system serves as a powerful tool for solving outstanding questions in auxin biology and for precise manipulation of auxin-mediated processes as a controllable switch and for plant horticulture/agriculture.

- Technology Presentation #2 -
(continued)

Biography

Keiko Torii is currently an Investigator of Howard Hughes Medical Institute, an Endowed Professor of Biology at the Department of Biology, University of Washington in Seattle, USA. Since 2013, she is also appointed as an Oversea Principal Investigator of the Institute of Transformative Biomolecules (WPI-ITbM), Nagoya University, Japan. Keiko Torii received BS, MS, and PhD from University of Tsukuba, Japan. Since 2000, she is at the University of Washington where she takes an integrated approach to unravel the underlying principles of cell-cell interactions specifying fate decisions and developmental patterning in plants, with specific focus on stomatal development. Her group in WPI-ITbM harnesses synthetic chemistry to probe and manipulate signaling in plant development. Keiko Torii has received numerous recognitions, including the Elected Fellow of AAAS (2012), Elected member of the Washington State Academy of Sciences (2012), ASPB Fellows Award (2015), and most notably, the Saruhashi Prize (2015), which honors a Japanese female scientist each year for both scientific accomplishments and mentoring junior women scientists to break through obstacles.

Publications (selected)

Perraki et al., Nature, in press, 2018
Fendrych et al., Nature Plants 4 (7):453-459, 2018
Uchida et al., Nature Chem Biol 14(3):299-305, 2018
Han et al., Dev Cell 45(3):303-315, 2018
Hirakawa et al., Nature Commun 6 (8):14318, 2017
Qi et al., eLife 6:e24102, 2017
Nemhauser and Torii, Nature Plants 2;2:16010, 2016
Lee et al., Nature 522(7557):439-443