New insights into plant cell organelle and molecule movement

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Credit: Rémi Walle

Michigan State University scientists have identified a new protein, called TGNap1 (TGN associated protein 1), that they found at a poorly understood plant cell organelle, the Trans-Golgi Network (TGN).

The TGN is at the intersection of pathways that control molecule traffic into (endocytosis) and out of (exocytosis) the plant cell. The TGN and its network of supporting expand iconproteins are essential to proper metabolism many organisms. But their function remains a mystery to scientists.

We do know that the TGN contributes to building up expand iconplant biomass, which is important for plant-based products, like fuels, food, and animal feed. In humans, TGN defects cause neurodegenerative diseases and hereditary neuromuscular disorders.

The new study provides insights into how the TGNap1 protein supports the TGN in structure and function. It then describes how the protein assists with TGN movement, through an interaction with microtubules, which impacts the TGN's biogenesis. The research is published in *Nature Communications*.

Plant mutants defective in trafficking

Luciana Renna, a research associate in the lab of Dr. Federica Brandizzi, identified TGNap1 in a plant mutant defective for expand iconsecretion.

"In the absence of the protein, a subclass of TGN seems to mature poorly during its formative stages," Luciana says. "The TGN grows larger and has an aberrant morphology. As a result, we see defects in one of its functions, secretion. In other words, cargo that should be delivered outside of the cell is partially retained in the endoplasmic reticulum, which is part of the exocytic secretion pathway. This defect in secretion leads to malforming of this organelle as well."

The mutant plant is also defective in endocytosis, the opposite process that allows cells to import molecules.

"It is important to note that TGNap1 only targets that specific subclass of TGN," Luciana adds. "This supports evidence that plant cells contain different types of TGN, where each subpopulation might specialize in different functions. But scientists have found it difficult to classify and characterize these subpopulations."

Microtubules: A new model of organelle movement

The N-terminal of TGNap1 has a domain that links it to the TGN and binds it to microtubules, which are like railroad tracks that organelles use to move inside a cell.

"We think the microtubules position the TGN in the right places," Luciana says. "The protein connects both components (see model above). Without it, the link is gone, and movement is hampered. We think this disruption causes the defects we observed in our mutant."

Microtubule-driven movement is a new line of thought in plant science. Scientists have tended to think that movement relies on another component called actin.

Moving forward, the researchers will further study the protein. Luciana says that the trafficking defects in the absence of TGNap1 were partial. That hints at a larger picture including more factors that impact the TGN. Or, perhaps the protein works under specific developmental conditions.

"We are excited to have found this new component that ties together TGN movement, biogenesis, and function," Luciana says. "We are showing that various processes, like membrane transport, cytoskeleton interactions, membrane architecture, and dynamics are interdependent. Our field has tended to study each process in isolation."

More information: Luciana Renna et al. TGNap1 is required for microtubule-dependent homeostasis of a subpopulation of the plant trans-Golgi network, *Nature Communications* (2018). DOI: 10.1038/s41467-018-07662-4