Hello, this is Kevin O'Donovan, and I'd like to welcome you to the National Institute of Environmental Health Sciences Superfund Research Program monthly Research Brief podcast.

This month, we're discussing the identification of mechanisms for regulating gas exchange in plants.

The Research Brief, Number 260, was released on August 3, 2016, and was written by SRP contractor Sara Mishamandani in conjunction with SRP-supported researcher Julian Schroeder.

Superfund Research Program researchers at the University of California, San Diego are identifying important mechanisms that plants use to respond to changes in the environment. They recently discovered molecular mechanisms that enhance the activity of proteins essential to closing stomata, or pores found on the surface of leaves, in response to environmental stressors.

When high concentrations of carbon dioxide or ozone are present in the atmosphere, or during drought conditions, the stomata on the surface of leaves close to control the plant's water loss, ozone sensitivity, and carbon dioxide supply.

The new study, led by Dr. Julian Schroeder, shows that elevated levels of bicarbonate in guard cells, which is produced with an influx of carbon dioxide, can enhance the activity of the slow anion channel-associated 1 (or SLAC1) plasma membrane protein. SLAC1 is essential for closure of stomata in response to high carbon dioxide concentration or stressors. The researchers also found that an enzyme that boosts production of bicarbonate also interacts with PIP2;1 aquaporin, which are small proteins that form pores in cell membranes.

Based on their findings, the researchers suggest that when carbon dioxide concentration in leaves is elevated, carbon dioxide influx across the plasma membrane is enhanced through PIP2;1 aquaporins. PIP2;1 aquaporins then interact with enzymes that enhance the production of bicarbonate, boosting the activity of SLAC1. The increase in SLAC1 activity then contributes to the closure of stomatal pores in response to elevated levels of carbon dioxide.

The researchers also found that enhancement of SLAC1 activity requires the presence of specific protein kinases, which are enzymes that modify other proteins and are key regulators of cell function. Although they found that bicarbonate increases the activity of SLAC1, significant SLAC1 activity still occurs without bicarbonate, suggesting that a second pathway activates protein kinases to increase SLAC1.

The study also provided insight on how carbon dioxide and water move through plants. Carbon dioxide and water are transported across membranes in plant cells via aquaporins. However, it isn't known whether water and carbon dioxide are transported by the same channel pores or whether there are different mechanisms. Because a mutation in the PIP2;1 aquaporin disrupted both water and carbon dioxide transport, the researchers propose that both are transported through common pores, but more research is needed to confirm this finding. This research is identifying mechanisms by which plants can use water more efficiently, which is of relevance when using plants to remove toxicants from soils in regions of limited water availability.

The UCSD Superfund Research Program work to identify molecular and biological systems in plant cells has also led to the parallel discoveries of genes encoding the central heavy metal detoxification enzymes in plants. Based on this ongoing work, UCSD Superfund Research Program investigators are determining the molecular mechanisms by which plants accumulate toxicants. These advances provide key tools for avoiding toxic heavy metal and arsenic accumulation in edible plant tissues and can contribute to engineering plants for environmental remediation. By understanding how plants respond to different environmental stressors, Schroeder and his research team are providing important information about how plants grow and upload nutrients and toxicants in the environment.

If you'd like to learn more about this research, visit the Superfund Research Program website at www.niehs.nih.gov/srp. From there, click on "Who We Fund" and follow the links to the University of California, San Diego research summary. If you have any questions or comments about this month's podcast or if you have ideas for future podcasts, contact Maureen Avakian at avakian@niehs.nih.gov.

Join us next month as we discuss more exciting research and technology developments from the Superfund Research Program.