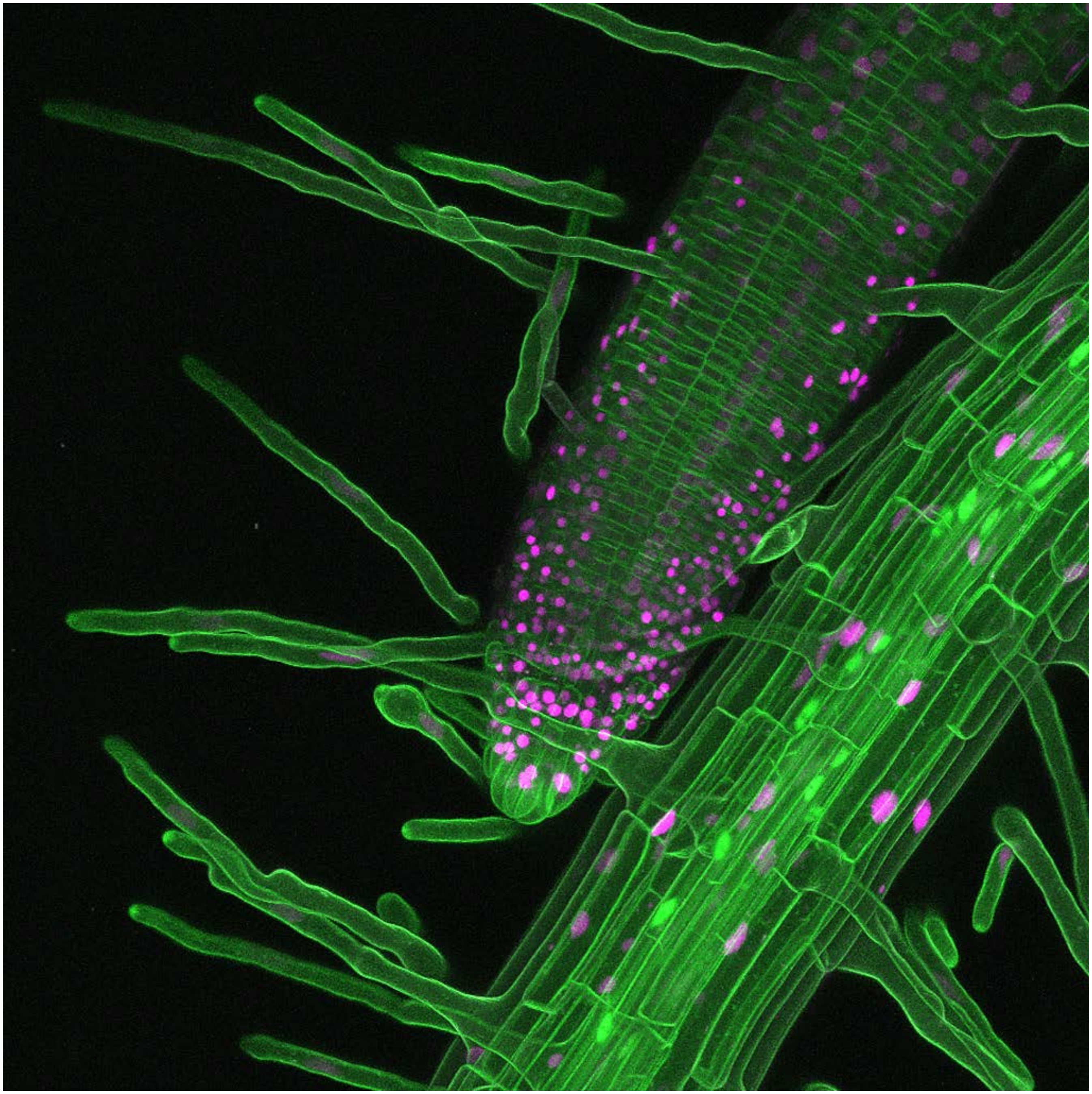
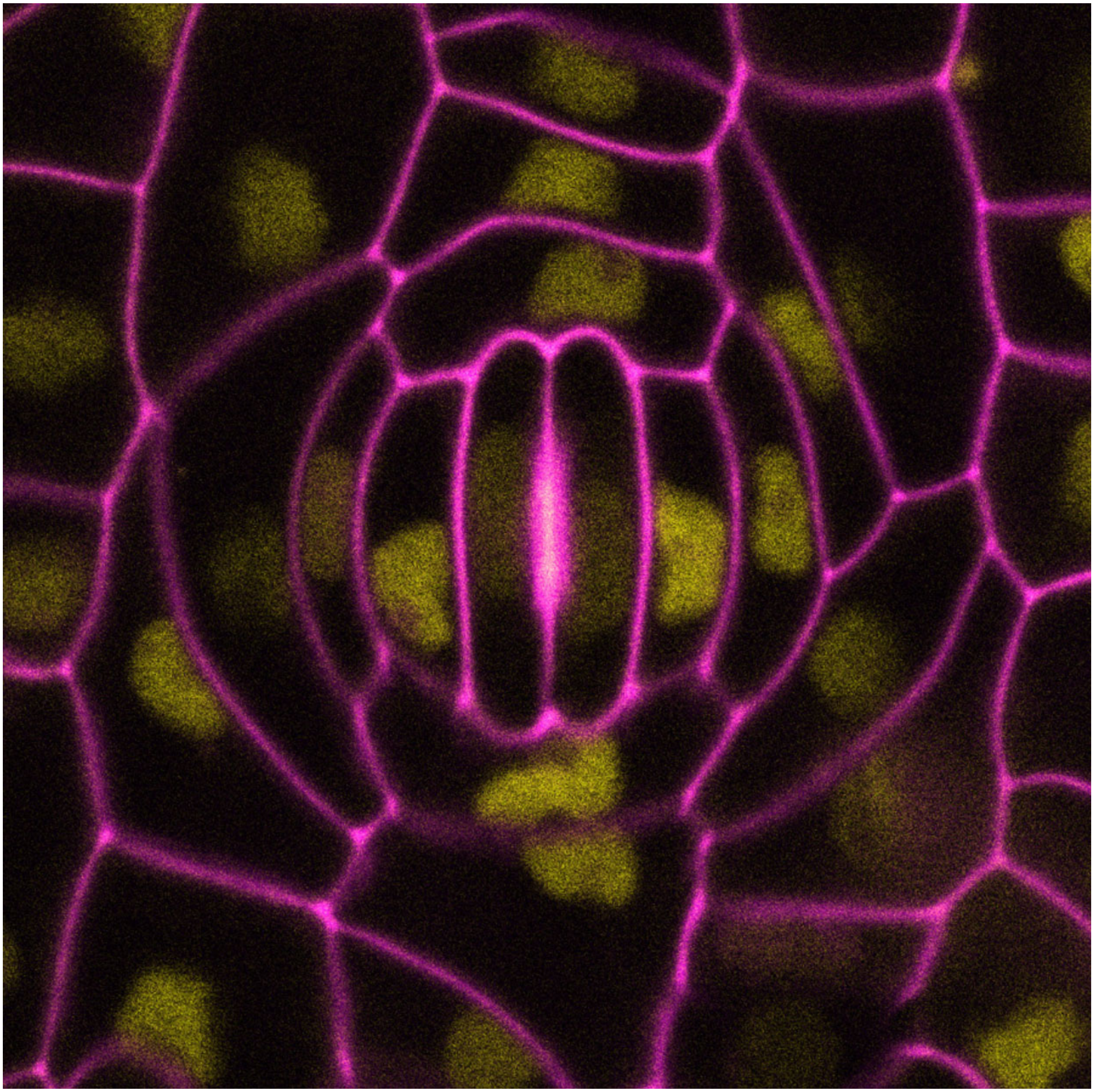
ROOT MOVEMENT



SUPER STOMA



BACKGROUND INFORMATION

Root Movement

Toward the end of his life, Charles Darwin, assisted by his son, Francis, wrote several books on plants including "The Power of Movement in Plants," published in 1880. The father-and-son team performed many experiments on plants and observed that they exhibit a range of behaviors previously only attributed to animals—a controversial conclusion at the time. For example, cells near the end of the root tip (pictured in the lower center of the image) use the movement of organelles and the release of hormones to sense gravity, which affects the timing and location of cell division and root elongation. Such processes enable a root to grow down into the soil.

To generate this image, *Arabidopsis thaliana* plants were genetically labeled with a plasma membrane marker (in green) and a nuclear marker (in purple). The root tips were imaged using time-lapse microscopy in a confocal microscope with a vertical specimen stage. Growing root tips were tracked using the custom-built "TipTracker" MATLAB® program that allows the microscope to follow the growing root tip. The selected image shows one-time point of the root movement, but a gif of the time-lapse video is available at https://www.hhmi.org/biointeractive/root-movement.

Super Stoma

Stomata are openings, or pores, on the surfaces of leaves that allow plants to take in carbon dioxide, which they use to form organic molecules in photosynthesis. They consist of two epidermal guard cells that allow the pore between them to open and close. Every time a stoma is open, carbon dioxide enters a leaf and water and oxygen (one of the byproducts of photosynthesis) escape. Plants regulate the opening and closing of stomata to ensure a balance between carbon dioxide intake and water loss. The basic structure of stomata (two guard cells flanking a central pore) has been conserved throughout the 400-million-year history of land plants with some variations. For example, in members of the grass family, which evolved in the late Cretaceous, the guard cells are flanked by two support cells that help fine-tune the regulation of pore opening and closing. Such fine-tuning may have enabled grasses to more easily adapt to changing environments. Scientists are now exploring the effects of such changes by studying the grass *Brachypodium distachyon*, which has stomata with the usual two guard cells (center of the image) in addition to many support cells (surrounding the guard cells). Such studies may have practical applications for producing crops with improved carbon assimilation and water use, which could more easily adapt to rapidly changing climates.

To generate this image, the grass tissue was stained with a fluorescent dye that reveals cell outlines (in magenta) and a fluorescent protein attached to a factor involved with the control of gene expression (in yellow), and imaged using laser scanning confocal microscopy.