Summary of: The effect of spaceflight on the gravity-sensing auxin gradient of roots: GFP reporter gene microscopy on orbit

Summary:

This study investigates the role of gravity in establishing the auxin-mediated gravity-sensing system in primary roots of Arabidopsis thaliana, using spaceflight experiments on the International Space Station (ISS) to remove unit gravity from the growth conditions. Key findings include:

1. **Distribution of Auxin**: - **GFP Reporter Gene Expression**: The distribution of auxin was indistinguishable between spaceflight and ground control plants over the course of two ISS experiments and several plant ages. The DR5r::GFP reporter gene, which monitors auxin levels, showed no significant difference in expression levels between spaceflight and ground controls. - **TAA1::TAA1–GFP and SCR::SCR–GFP**: These cytokinin and transcription factor reporters also showed no significant difference in their distributions between spaceflight and ground controls.

2. **Cytokinin Distribution**: - **ARR5::GFP**: Plants on orbit displayed a more restricted distribution of ARR5::GFP compared to ground controls. The expression of ARR5::GFP was observed to be limited to the tip of the root in spaceflight plants, whereas it extended shootward in ground controls.

3. **Cellular Resolution**: - Confocal microscopy of preserved samples confirmed the specific cellular localization of GFP signals, showing that the distribution of DR5r::GFP, TAA1::TAA1–GFP, and SCR::SCR–GFP were consistent with the live imaging data.

4. **Discussion**: - The results suggest that the synthesis of auxin within the quiescent center and the distribution of cytokinin are not influenced by gravity. The entire auxin signaling pathway is fully developed in the absence of gravity. - The data indicate that the distribution of auxin in the primary root is not dependent on gravity, even though these distributions are key to the root's response to gravity.

5. **Conclusions**: - The role of gravity in establishing the auxin-mediated gravity-sensing system in primary roots is minimal compared to the inherent developmental cues guided by auxin to define the architecture of the root tip. - The data suggest that the reverse fountain model, which implies a direct role of gravity in establishing the auxin distribution, is not supported by the spaceflight experiments.

The study highlights the importance of removing unit gravity from the environment to examine the role of gravity in fundamental biological processes, particularly in the context of plant growth and development.