Involvement of membrane sterols in hypergravity-induced modifications of growth and cell wall metabolism in plant stems

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Organisms living on land resist the gravitational force by constructing a tough body. Plants have developed gravity resistance responses after having first went ashore more than 500 million years ago. The mechanisms of gravity resistance responses have been studied under hypergravity conditions, which are easily produced on earth by centrifugation. In *Arabidopsis* hypocotyls, hypergravity treatment greatly increased the expression level of 3-hydroxy-3-methylglutaryl-Coenzyme A reductase (HMGR), which is involved in synthesis of terpenoids such as membrane sterols. In the present study, we examined the role of membrane sterols in gravity resistance in plants by analyzing sterol levels of stem organs grown under hypergravity conditions, and by analyzing responses to hypergravity of the organs, whose sterol level was modulated. Hypergravity inhibited elongation growth but stimulated lateral expansion of *Arabidopsis* hypocotyls and azuki bean epicotyls. Under hypergravity conditions, sterol levels were kept high, as compared with 1 g controls, during incubation. Lovastatin, an inhibitor HMGR, prevented lateral expansion as the gravity resistance response in azuki bean epicotyls. Similar results were obtained in analyses with loss of function mutants of HMGR in Arabidopsis. It has been shown that sterols play a role in cellulose biosynthesis, probably as the primer. In wild type *Arabidopsis* hypocotyls, hypergravity increased the cellulose content, but it did not influence the content in HMGR mutants. These results suggest that hypergravity increases membrane sterol levels, which leads to an increase in cellulose content, thereby inducing gravity resistance response in plant stems.