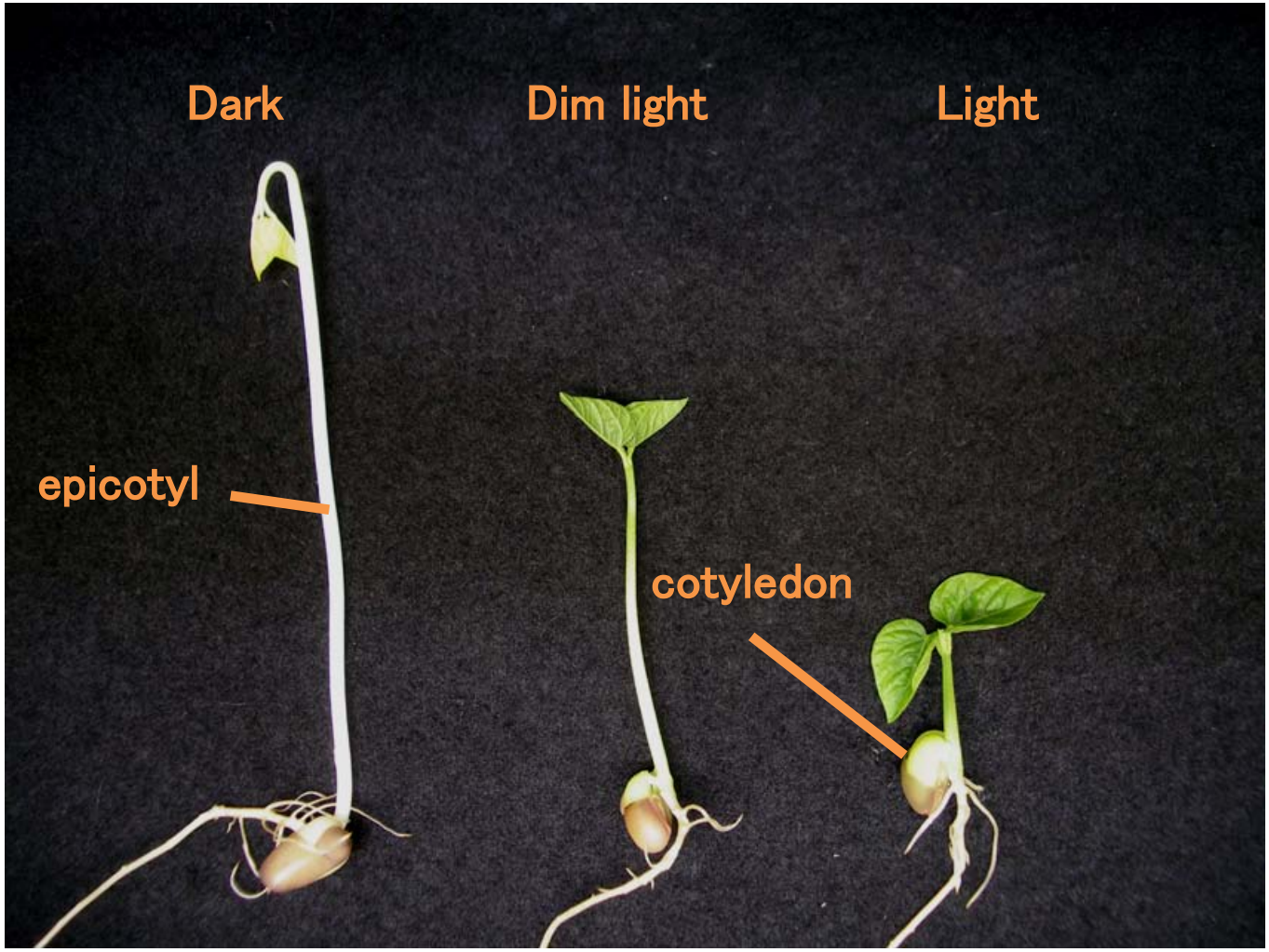
Space Seeds for Asian Future 2013

Kibo Utilization Office for Asia
Human Space Systems and Utilization Mission Directorate
JAXA

SSAF2013 Mission Outline (Asian Seed 2)

- The primary purpose of this mission is **education and outreach** to promote understanding in space biology among people in **Asia-Pacific region**.
- Students will learn how the sprouts of **Azuki bean**, *Vigna angularis*, grow in microgravity environment.
- Students are to nurture their own seedlings on the ground and observe their shape, then compare with the downlinked image of space grown bean sprout to find how plants respond to gravity.
- Thousands of students from the region including **Australia, Indonesia, Japan, Malaysia, Thailand, Vietnam** are expected to participate in this program.

Azuki seedlings under various light conditions

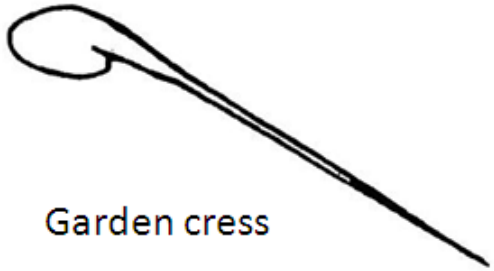


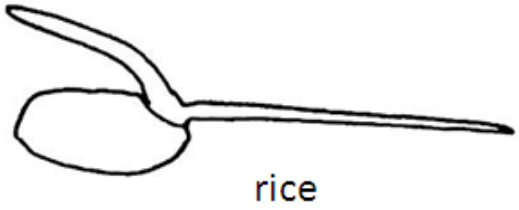
courtesy of Dr. Koichi Soga of Osaka City U.

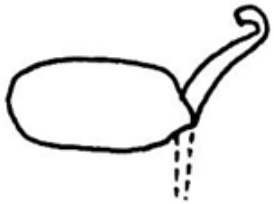
Hypothesis 1

- Living organisms on the earth are thought to modify their shape to adjust the gravitational environment from their inherent plan.
- When the gravity is removed, some organisms may express their inherent.
- The **automorphogenesis** of Azuki bean, *Vigna Angularis,* is expected to be observable, when grown in the dark and microgravity condition for 5 to 7 days, as suggested from preliminary experiment using 3D clinostat.

Automorphogenesis of Various Species







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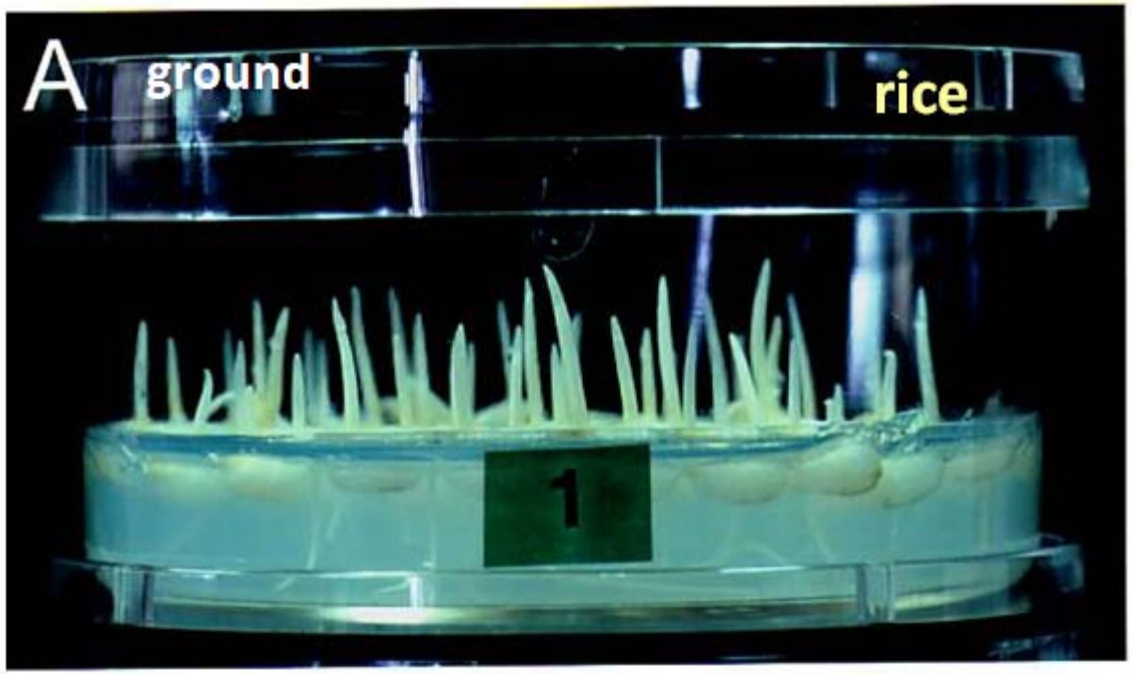

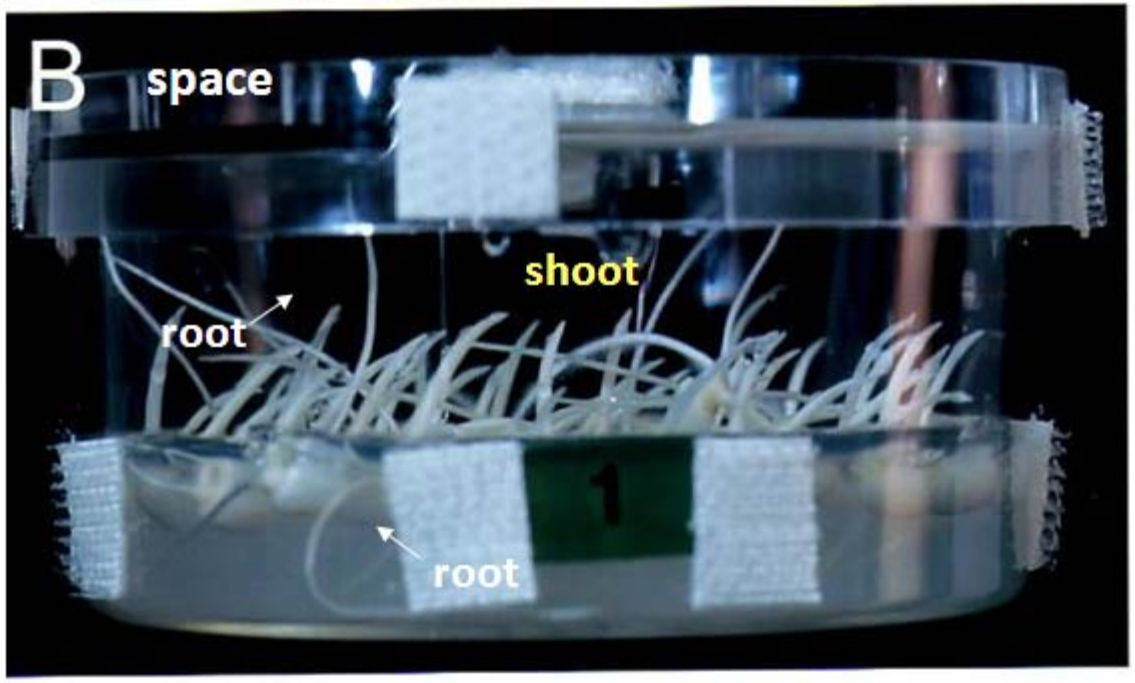

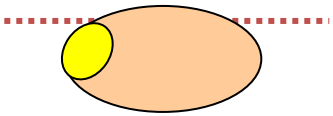

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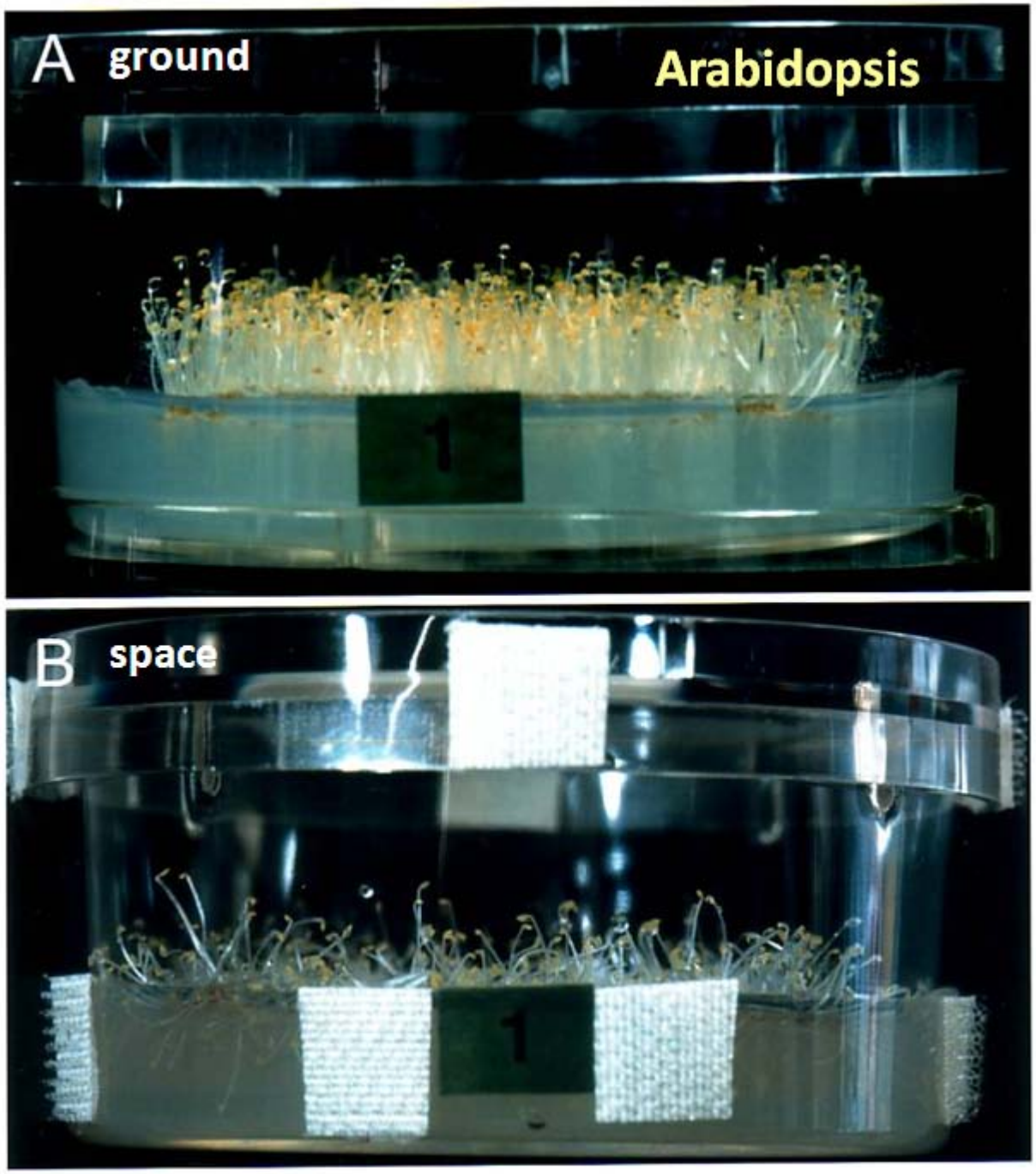

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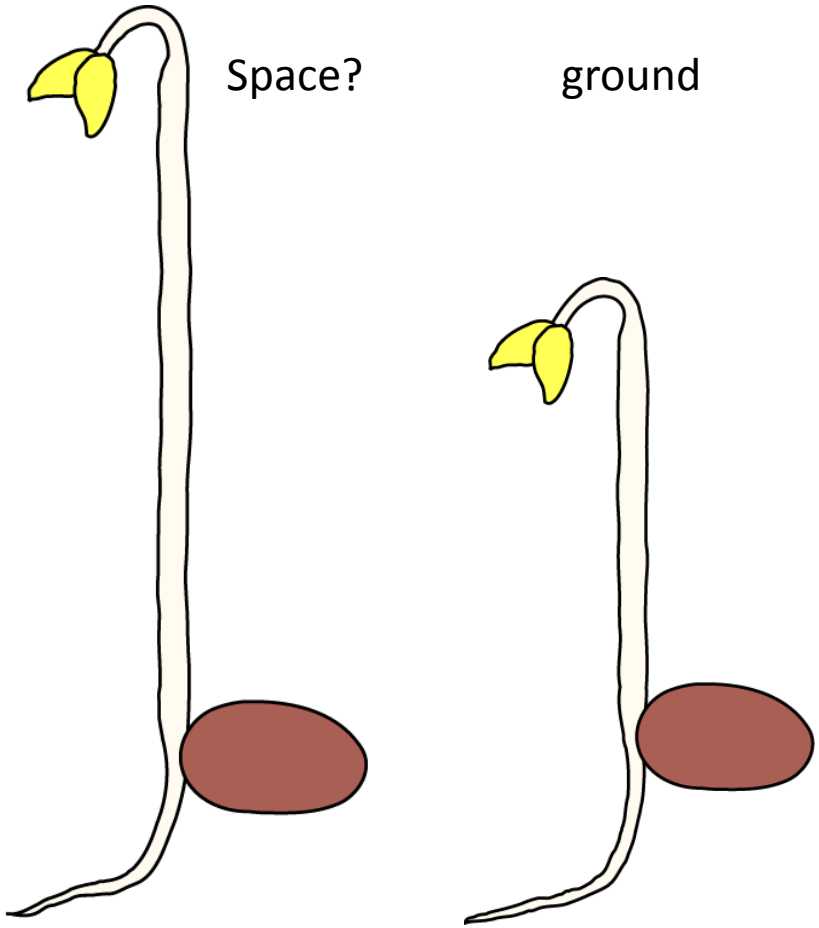
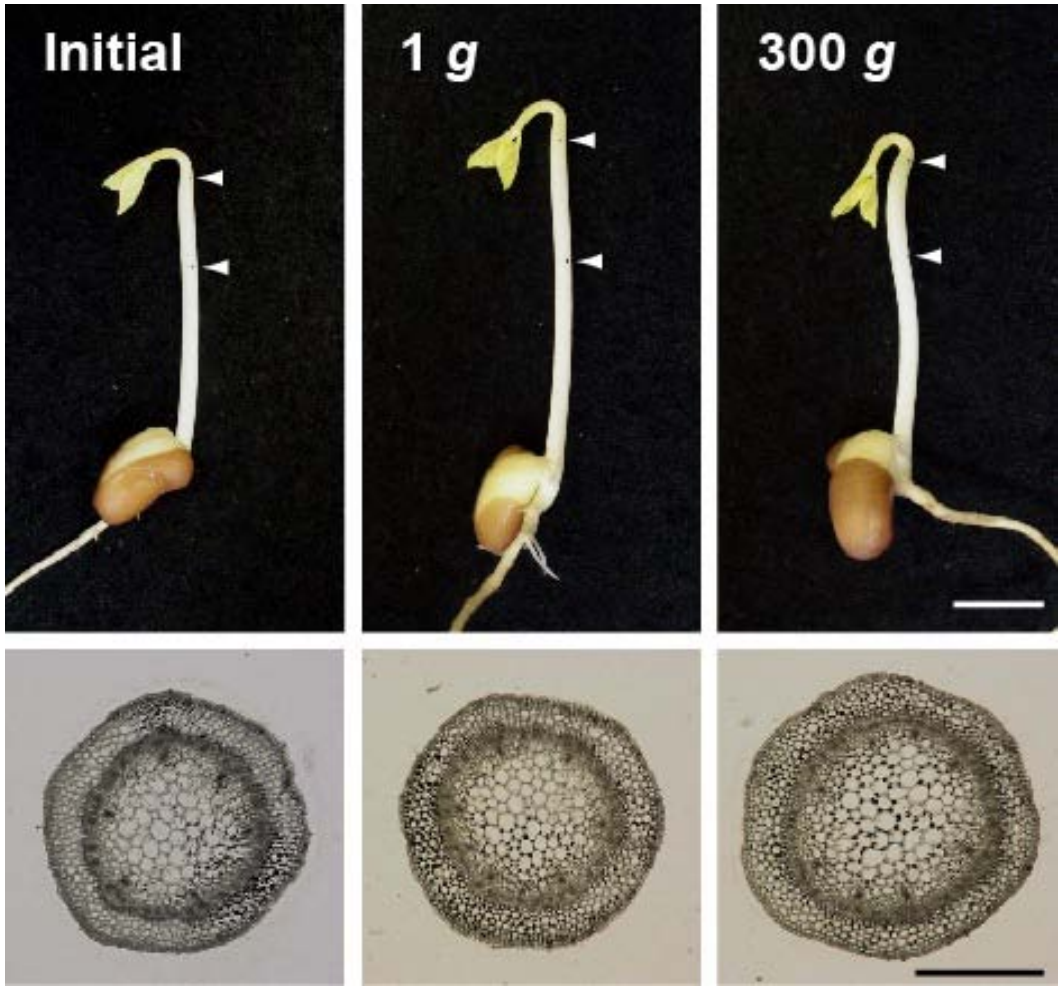
Hypothesis 2



- Observations have been made with Arabidopsis hypocotyl and rice coleoptile, that the tissues become thinner and longer and the cell wall is softer in space than on the ground.
- The question is if such gravity dependent morphogenesis is also observed in space with Azuki?

courtesy of Dr. Koichi Soga of Osaka City U.

Resistance to gravity: New aspect of gravity response by plant cells



courtesy of Dr. Koichi Soga of Osaka City U.

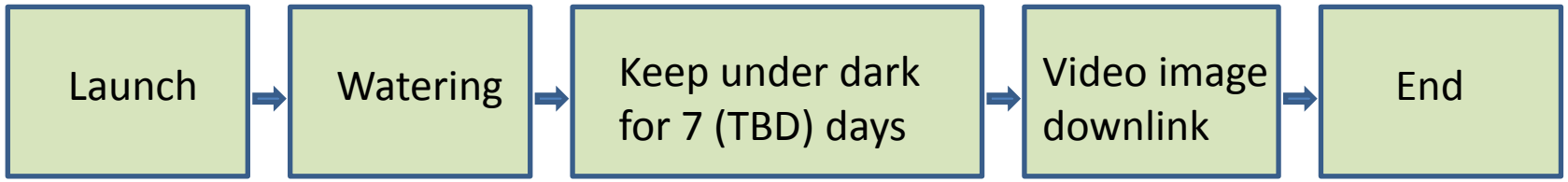
Investigation goals and objectives

- Taking video images of space grown bean sprout in a quality enabling students to compare the shapes with those on the ground.
- Reconfirming that Azuki bean sprouts form their inherent shape, **automorphogenesis**, when gravitational and light signals are removed.
- Provoking scientific interests and space awareness among students, especially those from Asia-Pacific region who formerly thought themselves having no connection with space development.

Azuki seedlings on ground (left)
and in space (right)
courtesy of Prof Junichi Ueda
of Osaka Prefectural University

Measurement approach

- Azuki beans, *Vigna angularis cv.* Erimowase, are implanted into a rockwool block medium under dry condition and sent to the Kibo module of ISS.
- The rockwool is wetted by water to let beans to germinate in orbit. The seeds are put inside an opaque bag and kept in the cabin.
- Seven days (TBD) later, the bag is opened and the growth and the shape of seedlings are observed. Video images are taken and downlinked.
- Downlinked video images are distributed to participating students.
- If extra crew operations are possible, astronauts can pick some sprouts out and touch them to examine its stiffness and other physical properties, ie gravity resistance.



Importance and reason for ISS

- Concurrent operations by students on the ground and ISS crew strongly stimulates space awareness among young participants.
- To investigate cellular mechanosensing process, it is necessary to utilize the condition in which input signal can be switched off. ISS is the best place to provide such condition.
- Although the primary purpose of this mission is education and outreach, observations from this mission can help understanding the biological mechanosensing process, because the precise nature of cellular mechanosensors are still unknown.

Expected results and how they will advance the field

- Azuki bean sprouts will show different form from those grown on ground. The angle between radicule and epicotyl of space grown plants form may fall into small range suggesting that they form their inherent shape, an automorphogenesis.
- Students on the ground will notice the difference between the ground and space, and find that plants change their shape in response to gravitational conditions.
- The results greatly help deepening our understanding to cellular mechanosensing process.
- The biological sensing of mechanical signals, including gravity, is one of the key functions for life. The information about cellular mechanical sensors is essential for many fields of biomedical applications including tissue and organ regeneration technology.

Earth benefits/spin-off applications

- Showing the invaluable merit of the ISS to people in Asia-Pacific region to obtain their material and moral supports.
- Greatest educational benefit.
- Sponsoring space agencies in Asia-Pacific region will build their capability to coordinate space experiments and will become new users of space utilizations.



Malaysian students with their plants they nurtured from the seeds from space in SSAF 2010-2011 program.

- The "Space Seeds for Asian Future" program is one of the activities under the "Kibo-ABC" initiative of the Asia-Pacific Regional Space Agency Forum (APRSAF), intended to promote understanding and gain experience regarding the utilization of Kibo. This program also aims to provide children and students in the Asia-Pacific region with an opportunity to learn about space experiments or the space environment including orbital microgravity.
- Well over one thousand students from four Asian countries (Indonesia, Malaysia, Thailand and Vietnam) participated in the previous program ("Space Seeds for Asian Future 2010-2011"), which gave them a valuable opportunity to grow "space seeds" retuned from the Japanese Experiment Module (JEM) called Kibo on the International Space Station (ISS). In the "Space Seeds for Asian Future 2013" program, there are plans to cultivate indigenous seeds of Asia in Kibo/ISS. Members of the "Kibo-ABC" initiative will collaborate in the preparation, following which many people including children, students and researchers, are expected to participate in the program. Participants can cultivate their own seeds on the ground and join events organized by Kibo-ABC members that include simultaneous control experiments on the ground. We therefore welcome and encourage your participations.
- The logos for 2010-2011 and 2013 were designed by The National Space Agency of Malaysia (ANGKASA) and the National Science and Technology Development Agency of Thailand (NSTDA), respectively.