The background of the slide is a photograph of the International Space Station (ISS) in orbit above the Earth. The station's complex structure, including its truss, solar panel arrays, and various modules, is clearly visible against the dark space and the blue and white horizon of the planet. The text is overlaid on this image.

ISS/Kibo Utilization Strategy in Japan

ISS Symposium 2012

May 4th, 2012

Makoto Asashima, Ph. D.

**Fellow, National Institute of Advanced Industrial Science and
Technology (AIST)/Fellow and Director, Research Center for
Stem Cell Engineering (SCRC)**

Chairman, the ISS & Kibo Utilization Promotion Committee

Topics

- ❑ “Kibo” Utilization Scenario till 2020
- ❑ Life Science Scenario
- ❑ Space Medicine Scenario
- ❑ Physical/Chemical Science Scenario
- ❑ International Collaboration for Advanced Research Capability on ISS : Enhance onboard Mouse/Rat research Capability
- ❑ Kibo/ISS Utilization Announcement of Opportunity

“Kibo” Utilization Scenario till 2020

- ❑ “Kibo” Utilization Scenario is scoping research areas in Life Science, Space Medicine and Physical/Chemical science performed in JEM-PM till 2020. JAXA President asked an external advisory committee to produce this scenario.
- ❑ Highly-prioritized research areas will be established among three research areas(Life Science, Space Medicine, Physical/Chemical science).
 - 【Category①】 Forefront science & technology research only achieved in ISS & “Kibo”
 - 【Category②】 Fundamental technology development for space activity
- ❑ JAXA will select some large scale research projects in highly-prioritized research areas through AO process by this summer and promote them directly.
- ❑ JAXA will invite some foreign research teams to the selected research projects. JAXA plans to review the proposals by the international peer reviewers.

Categories in Highly-promised Research Area in “Kibo” Utilization Scenario

【Category①】 Forefront science & technology research only enabled by ISS and “Kibo”

(1) Long-term Target (Over 5 yrs)

- Life Science and Physical/Chemical Science

(2) Short-term Target (About 3 yrs)

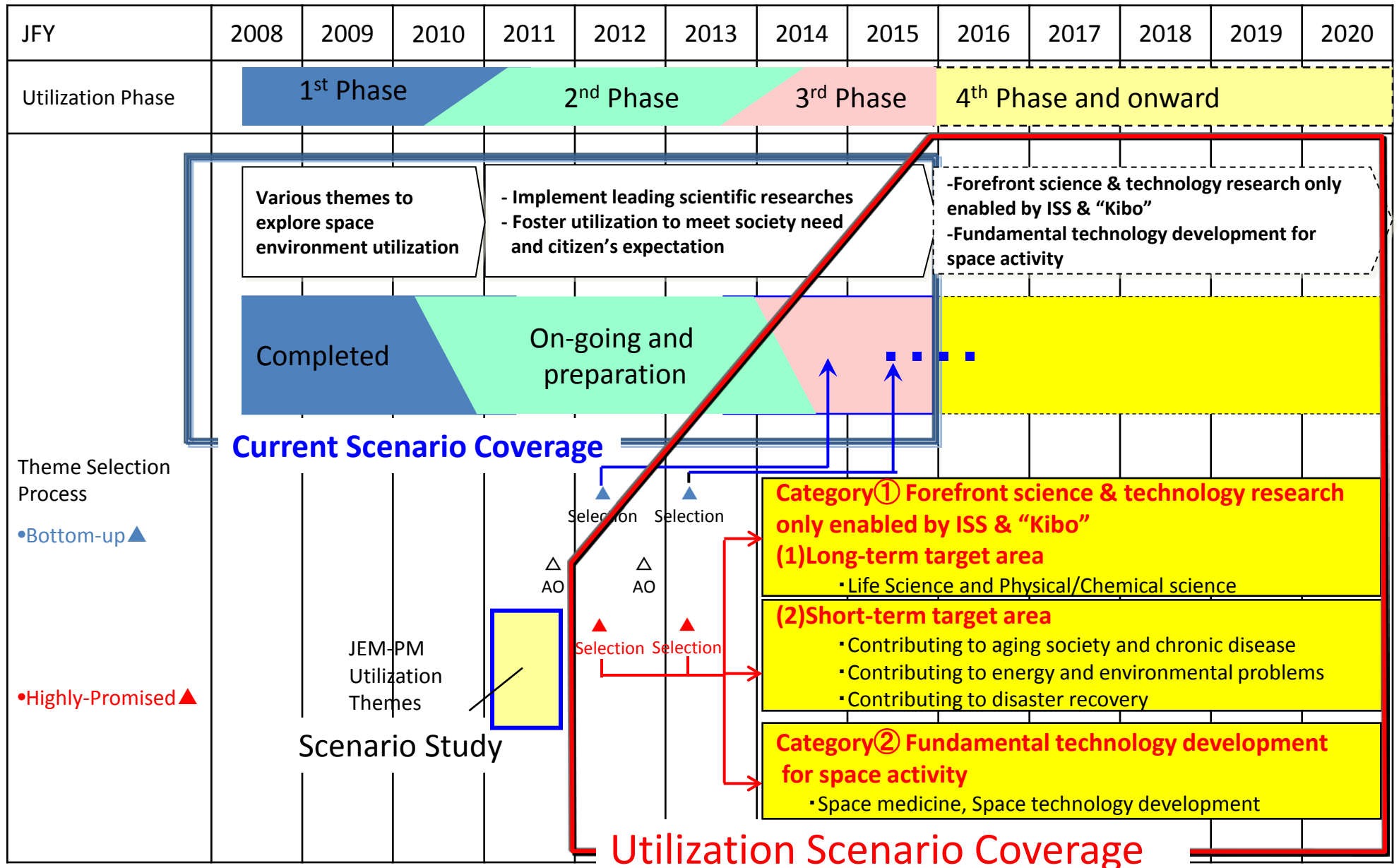
- Contribution to resolving social problems such as aging society and chronic disease
- Contribution to resolving energy and environmental problems
- Contribution to disaster recovery including education and out-reach activities.

【Category②】 Fundamental technology development for space activity

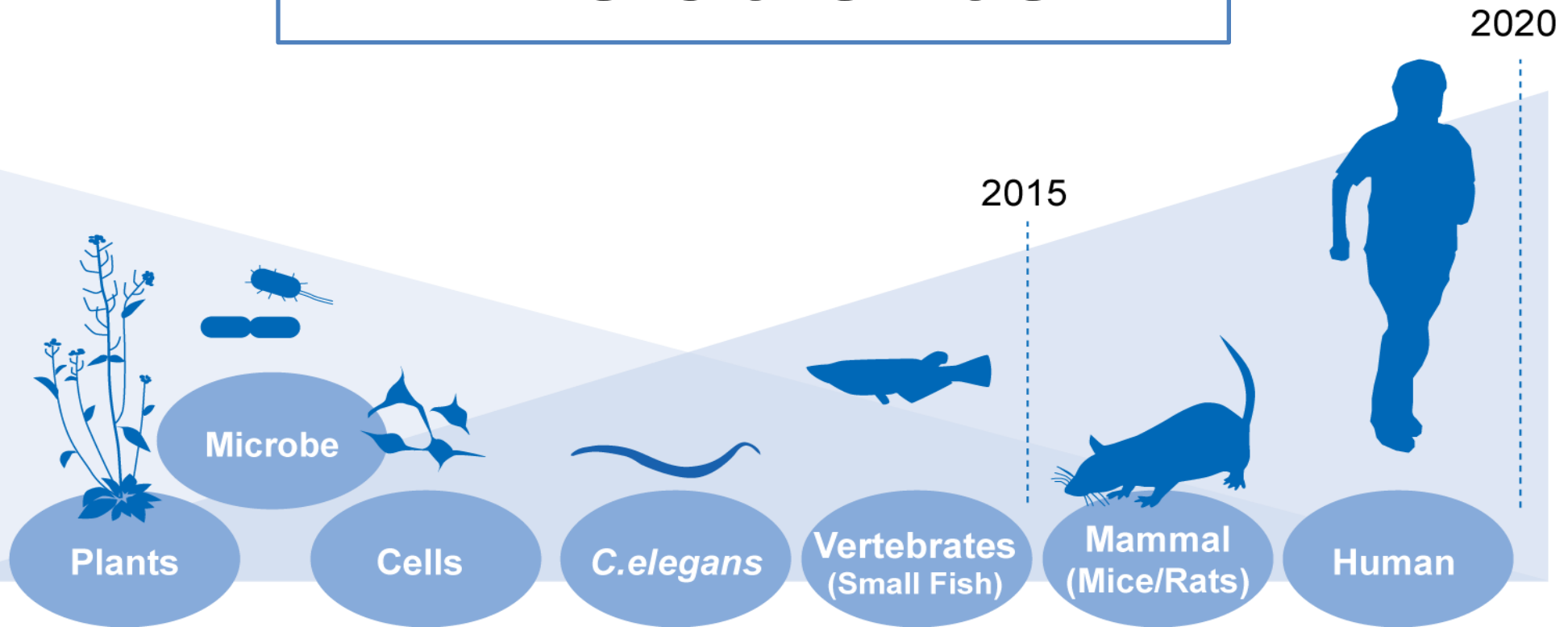
Accumulate key technologies and knowledge for Japan’s future space activities

- Space medicine, Space technology development

“Kibo” Utilization Scenario Coverage



Life Science

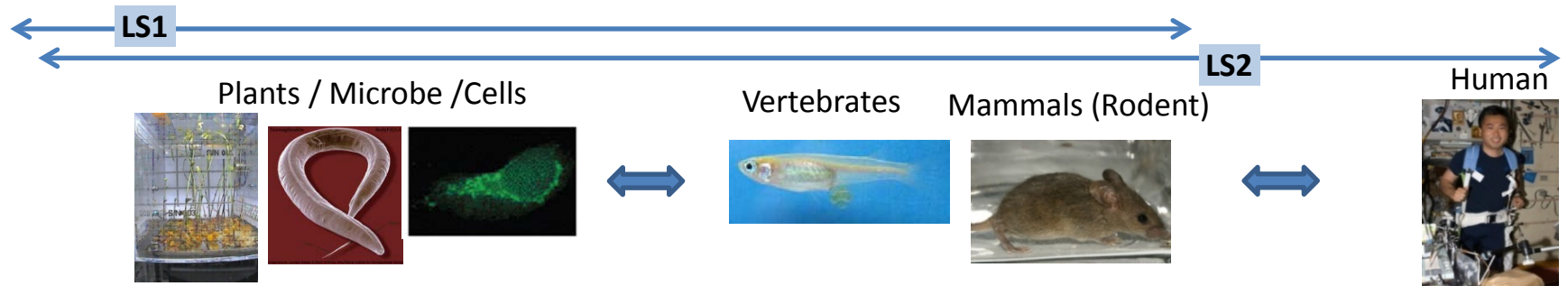


ISS/Kibo utilization scenario in life sciences toward 2020

◆ Highly-promised Research Areas in Life Science

LS1: **“Integrative understanding of biological responding mechanisms to the space environment”** as forefront science & technology research only enabled by ISS and “Kibo”, utilizing cutting-edge analysis technologies to achieve high-quality sciences.

LS2: **“Establishment of scientific foundations to expand human activity to space”** as fundamental technology development for space activity, such as future human space exploration.



Current life sciences experiment facilities onboard Kibo



Habitat for mice, rats, hibernant animals

Contribute to society on earth using pathological animal models



Study necessary experiment facility / devices based on the scenario

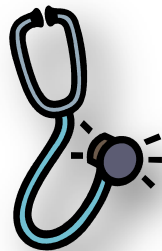
Space Medicine



Medical PC



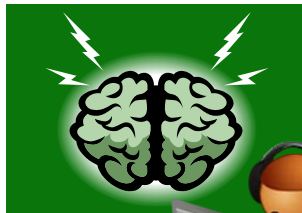
USB camera



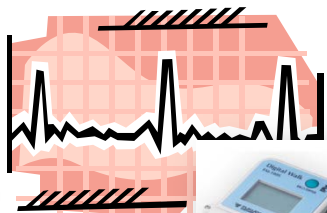
Electronic stethoscope



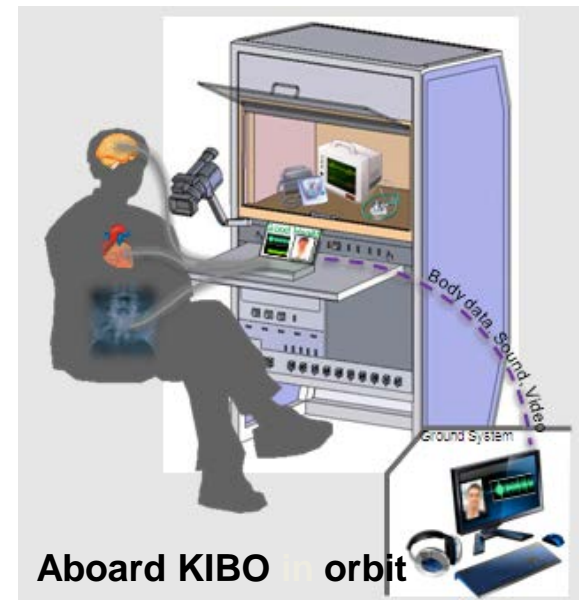
Measuring instrument for blood oxygen saturation level (pulseoximeter)



Electroencephalograph



Holter monitor



Aboard KIBO in orbit

On the ground

ISS/Kibo utilization scenario in Space Medicine toward 2020

◆ Highly-prioritized Research Areas in Space Medicine

SM1: "Space medicine research to improve health care technologies of astronauts" as key technology development for future human space activity.

SM2: "Space biomedical research to elucidate fundamental mechanisms of the effects of space flight on humans and animals" to achieve the goal of SM1, as forefront science & technology research only enabled by ISS and "Kibo",

◆ Highly-prioritized Research Area Candidates (Research Areas and Critical Questions)

(1) Physiological Countermeasure

- Countermeasures to prevent bone loss and metabolic disorder of bone mineral
- Monitoring & countermeasure to sleep and biological rhythms
- Evaluation & preventive countermeasure to muscle atrophy

- Mechanism clarification & preventive measures to bone loss and muscle atrophy
- Space environmental stress responses in Cardio-vascular, neuro-vestibular, and immune systems
- Multi-generation effects of space flight by use of model animals (medaka fish, mouse, rat)

(2) Psychological Support

- Monitoring/ countermeasure of Stress/Fatigue

(4) Space Environmental medicine

- Monitoring of water, air, microorganism. and noise & Work environmental management

(5) Space Telemedicine

- Bio- monitoring & Disease prevention

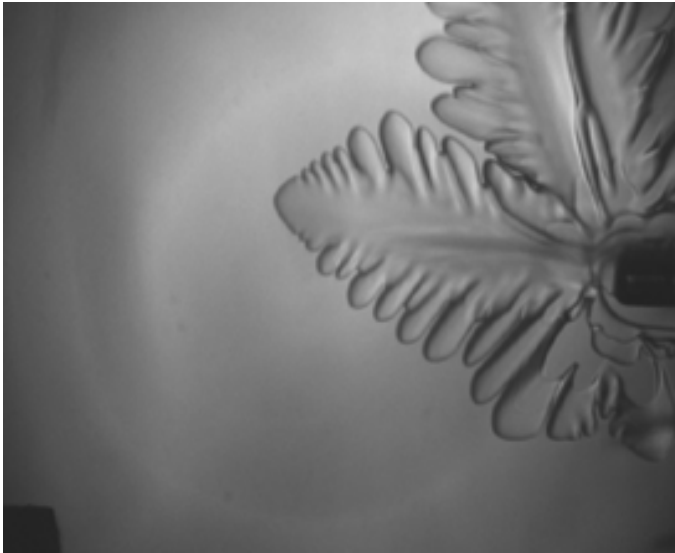
(3) Health Care against Space Radiation

- Advanced space radiation dose monitoring technology

- Dose assessment of low-dose, long-duration space radiation exposure & Development of bio-maker
- Prevention & Protection of biological effects from space radiation exposure



Physical/Chemical science



Ice crystal in ground (not symmetric)



Ice crystal in microgravity (symmetric)

ISS/Kibo utilization scenario in Physical/Chemical science toward 2020

◆ Prioritized policy in Physical/Chemical science

- (1) Systems significantly influenced by gravity, and science areas with great significance and spin-off to the society
- (2) Prioritize new research areas with less former space experiments
- (3) Not limit to research themes utilizing existing experiment payload

◆ Highly-prioritized Research Area Candidates in Physical/Chemical science

PCS1: The forefront science enabled by ISS

【Long term target】

- ✓ “Contribution to New Combustion System for Sustainable Earth”
- ✓ “Science and Technology of Bubbles, Droplets and Films”
- ✓ “Researches on self-organization phenomena in strongly coupled plasmas”

【Short term target】

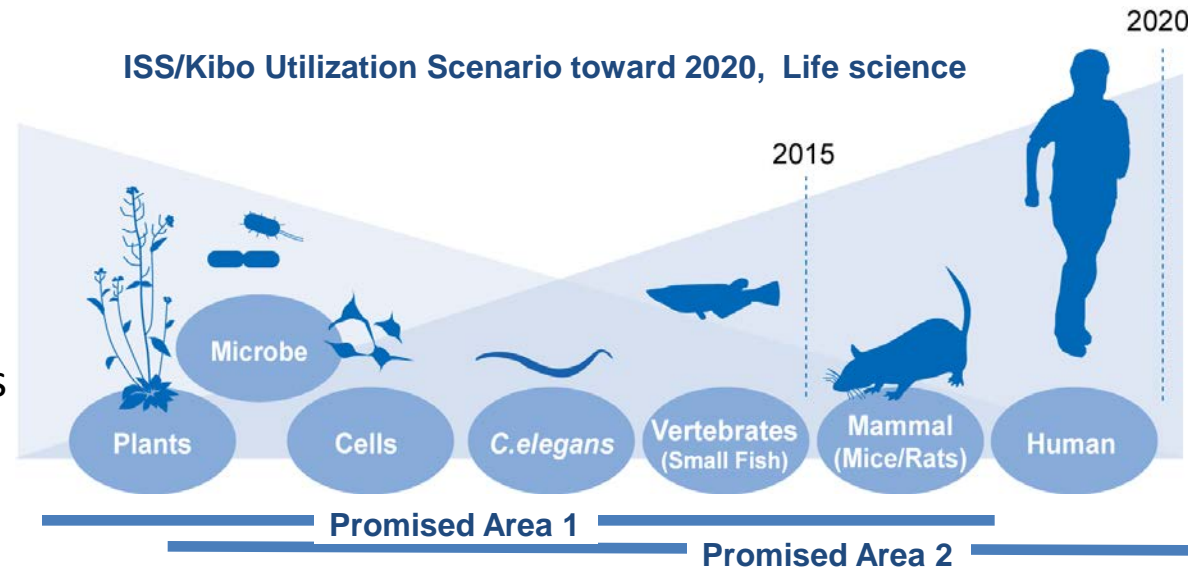
- ✓ “Producing new materials from super cooled phase by container-less processing”
- ✓ “Survey of soft matter useful on the ground”

PCS:2 Basic technology development for space activity

- ✓ “Fundamental research for fire safety standard in space”

International collaboration for advanced research capabilities on ISS: Enhance onboard mouse/rats research capabilities

- 1) In both life sciences and space medicine scenarios, onboard mammal (mice, rats) habitation is strongly recommended as a good animal model for human.
- 2) Some IPs have already conducted mouse/rat experiment in space.
- 3) This research capability in a whole ISS is expected to be enhanced by the International collaboration.



- Candidates for the collaboration
- Development and/or mutual use of IP's unique onboard experiment facilities and analysis devices
 - Launch and retrieval capability
 - Research collaboration & joint experiment (sample share)

Kibo/ISS Utilization Announcement of Opportunity

- ◆ JAXA released Kibo/ISS Utilization Announcement of Opportunity on April 10, 2012.
- ◆ Due date is June 29, 2012.
- ◆ JAXA will select the high priority proposals based on the “Kibo” Utilization Scenario.
- ◆ Annual AO is planned from this year so that the researchers can prepare their proposals based their long term research planning.

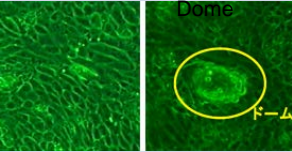




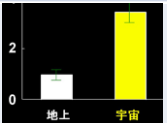

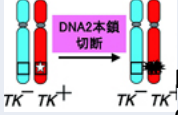
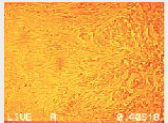
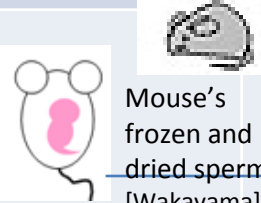


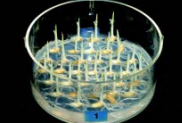



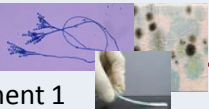
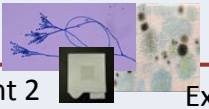

Back up Charts

Status of Life Science Experiments on Kibo

Life science experiments on Kibo began (in Feb. 2009).

Present

Conducting proposed themes and fixing plans based on Kibo utilization scenario

Year	2009	2010	2011	2012	2013 -
Cell & Life	 <p>Frog kidney cell (dome formation) [Asashima]</p>  <p>Nematode (RNA interference) [Higashitani]</p>	 <p>Muscle atrophy (ubiquitin) [Nikawa]</p>  <p>Goldfish scale (bone metabolism) [Suzuki]</p>		 <p>Medaka bone metabolism [Kudo]</p>	<p>Cells: gravity response, muscle atrophy, bone marrow cell: osteogenesis</p> <p>Nematodes: gene effects through aging and alternation of generations in space</p> <p>Aquatic organisms: effects across generations (breeding across 3 generations), muscle atrophy, reproductive function, and stress evaluation</p>
Technology for measuring the effects of radiation	 <p>Human cell p53 influence [Ohnishi]</p>  <p>Silkworm egg [Furusawa]</p>  <p>Mutant human cell [Yatagai]</p>	 <p>Nerve cell (Mitochondria apoptosis) [Majima]</p>		 <p>Mouse's frozen and dried sperm [Wakayama]</p>  <p>Frozen ES cells [Morita]</p>	<p>Effects on life by long-term radiation exposure (max. 3 years), evaluation of effects on reproduction, growth and multiple generations</p> <p>Development of real-time radiation measuring technology</p>
Plants	<p>Arabidopsis thaliana cultivated (long term till 60th day) [Kamisaka]</p> 	 <p>Oryza sativa cell wall (ferulic acid) [Wakabayashi]</p>  <p>Root hydro-tropism (auxin) [Takahashi]</p>  <p>Auxin dynamics [Takahashi]</p>		 <p>Plant's gravity response system [Hoson]</p>	<p>Systems of graviperception and posture control</p> <p>Effective plant production, utilization technology, and life support</p>
Microorganism	 <p>Experiment 1</p>	<p>Monitoring microorganism in the Kibo module [Makimura & Nasu]</p>	 <p>Experiment 2</p>	 <p>Experiment 3</p>	<p>In-orbit analysis and adaptation to monitoring and environment</p>

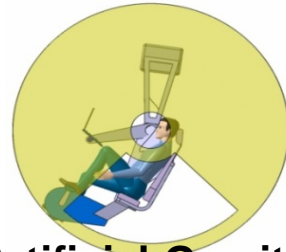
Status of Space Medicine Research onboard the ISS



Health Monitoring System



Study on bone loss prevention with bisphosphonate



Artificial Gravity

- Prepare human exploration of the Moon
- Space medicine supporting Japanese human space activities
- Identify adaptability of living organisms to space environment

- Measures for muscle atrophy and artificial gravity
- Adjustment of dynamic changes of cerebral circulation
- Adjustment of vestibular and blood pressure reactions
- Identification of lives of microbes and analysis of contamination
- Biological studies using killifish

Phase 3 (2016-2020?): Being considered

Late ISS utilization: Sophisticated research and preparation of post-ISS operations

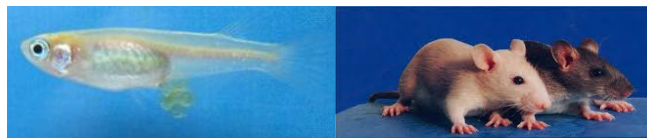
Phase 2 (2012-2015): Being considered

Medium-term utilization of JEM: High-level achievements from research, reducing risks, and identifying mechanisms

- Prevent bone loss and urinary calculi.
- Analyze live body rhythm.
- Analyze effects of space radiation.
- Monitor hair and fungi.
- Health monitoring system

Phase 1 (2008-2011): Complete

Initial Utilization of JEM:
Verify KIBO's utility



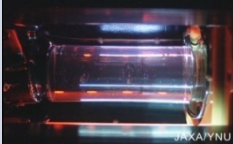
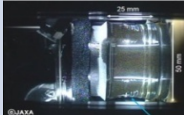
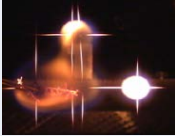
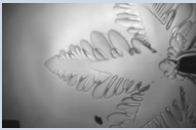
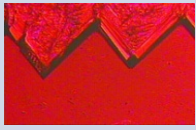
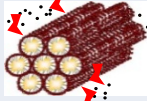


Verification of biological mechanisms in model living organisms

Status of Materials Science Experiments on KIBO

Start of materials science experiments on KIBO (Aug. 2008)

Present

To be scheduled

年	2008	2009	2010	2011	2012	2013 after	
Fluid				Liquid Marangoni Convection Exp. [Yoda]		Atomization Theory verification Exp. [Umemura]	
		1st series	2nd series	3rd series	4th series	5th series	
		Liquid Marangoni Convection Exp. [Kawamura, Nishino]					Boiling/Two Phase Flow Exp. [Ohta]
Combustion					Droplet Combustion Exp. [Mikami]	 Gaseous Combustion Exp. [Maruta]	
						Solid Combustion Exp. [Fujita]	
Crystal Growth					Protein Crystal Observation Exp. [Tsukamoto]	Antifreeze Protein Crystal Observation Exp. [Furukawa]	
		Ice Exp. [Furukawa]	Solidification/Crystallization Exp. [Inatomi]		Single Crystal Semiconductor Exp. [Kinoshita]	Semiconductor Growth Exp. [Inatomi]	
						Electrostatic Levitation Furnace [TBD]	
Soft matter	Protein Crystallization Exp.					Colloid Crystal Observation Exp. [Sogami]	
			Nano-skeleton Exp. [Abe]	Nano-template Exp. [Kinoshita]			
Fundamental physics			Plasma Exp. in collaboration with DLR (Germany)				