Seedling Growth: New insights into phototropism in microgravity and fractional gravity on the ISS

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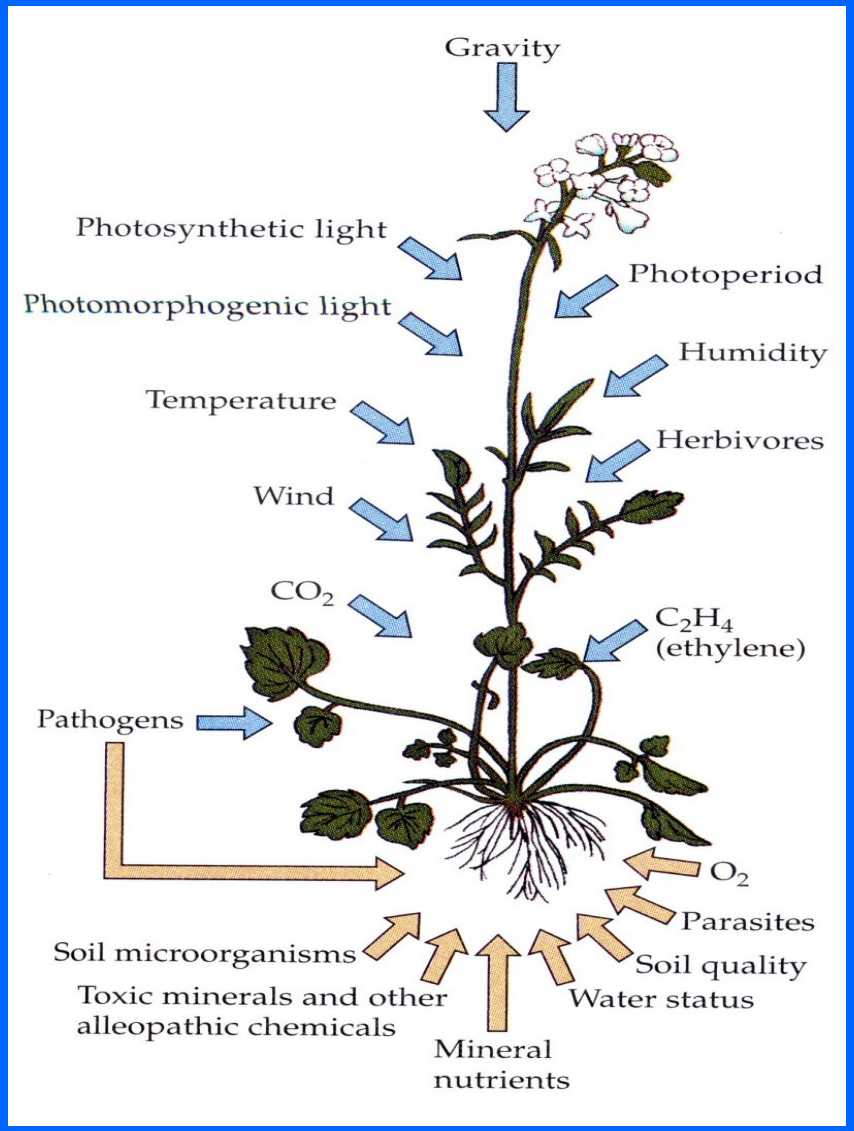
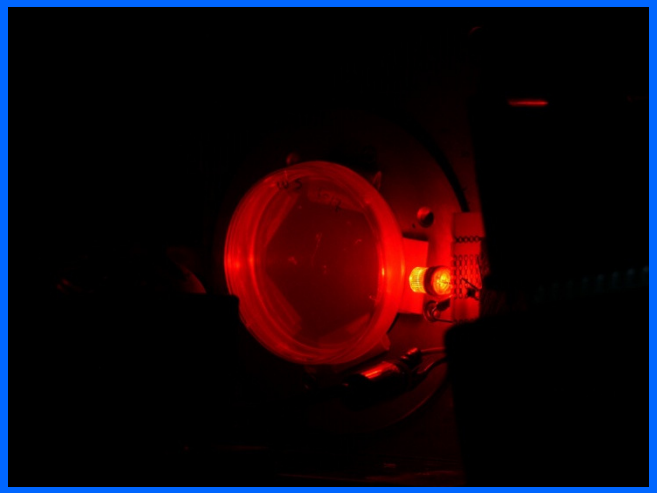
phototropism

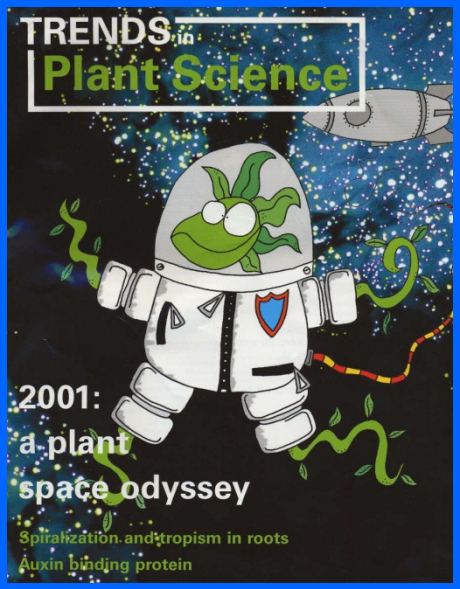
gravitropism



TROPISMS-directed growth in response to stimulus

Significance





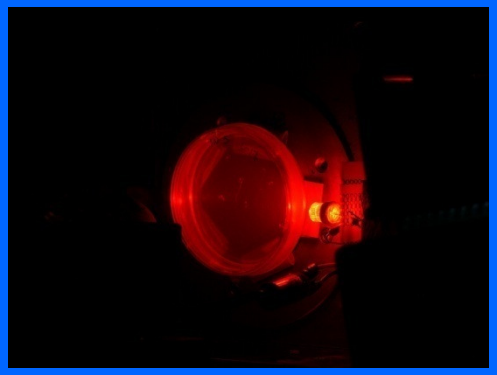
1. Basic questions in sensory physiology

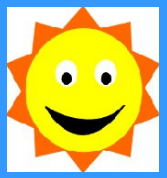
2. Bioregenerative life support

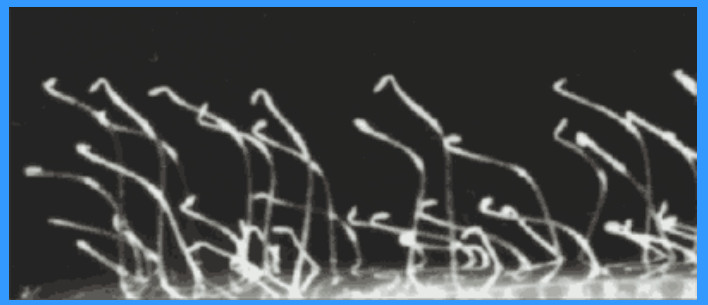
3. Exploration

Objectives

1. Characterize phototropism without the “complications” of gravity.
2. Better understand signal transduction pathways in gravity & light in plants.
3. Improve knowledge about fractional gravity.







Preplastid--Biorack
STS-81 (1997)

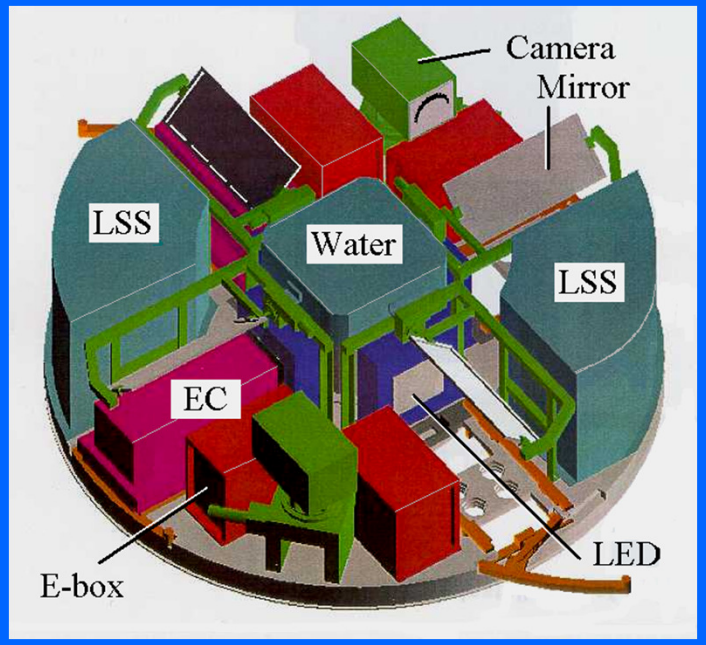
Plastid--Biorack
STS-84 (1997)

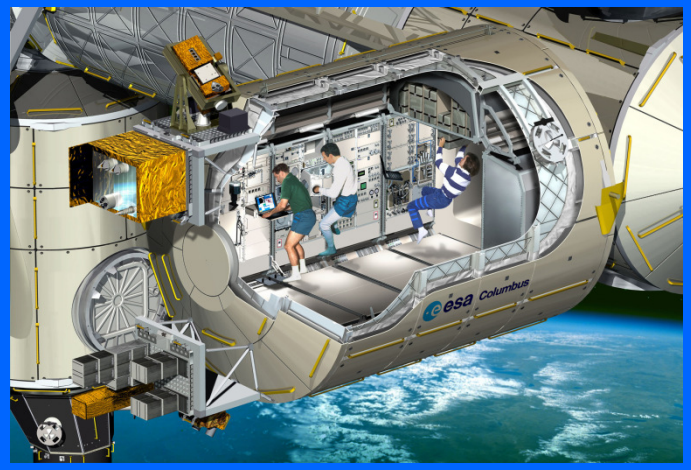
TROPI-1-EMCS
STS-121 (2006)
STS-115
STS-116 (2007)
STS-117
STS-120

TROPI-2--EMCS
STS-130 (2010)
STS-131

BRIC-16
STS-131 (2010)

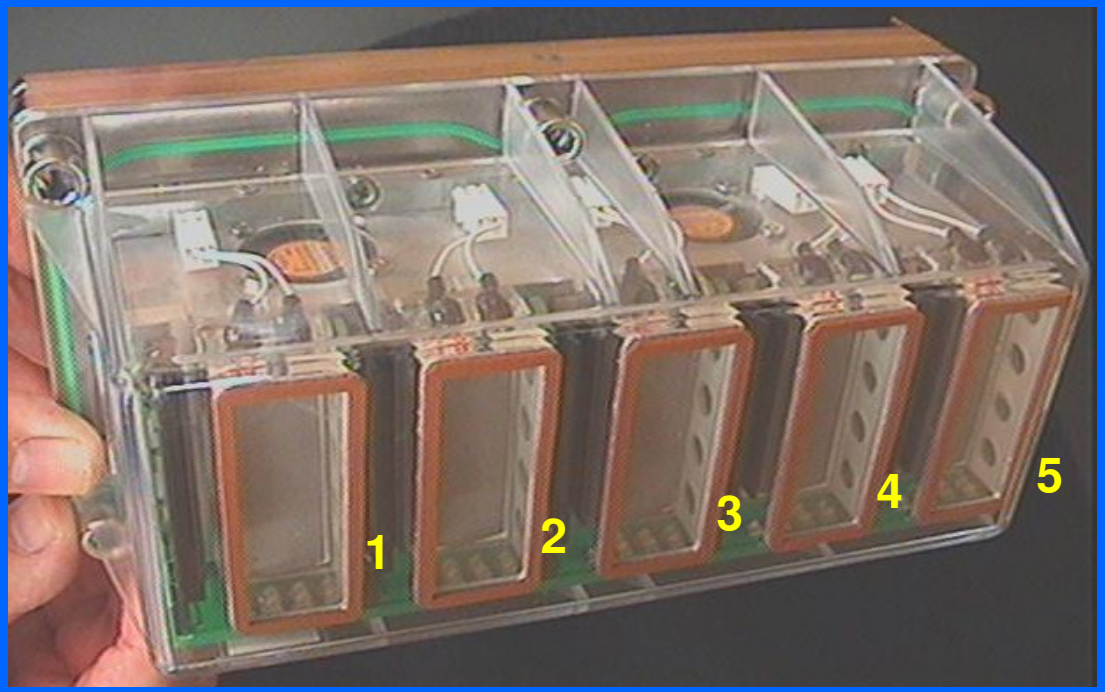
European Modular Cultivation System

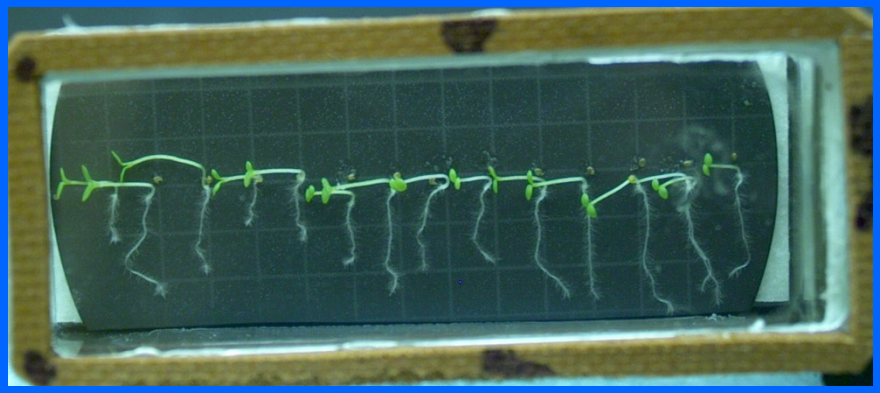


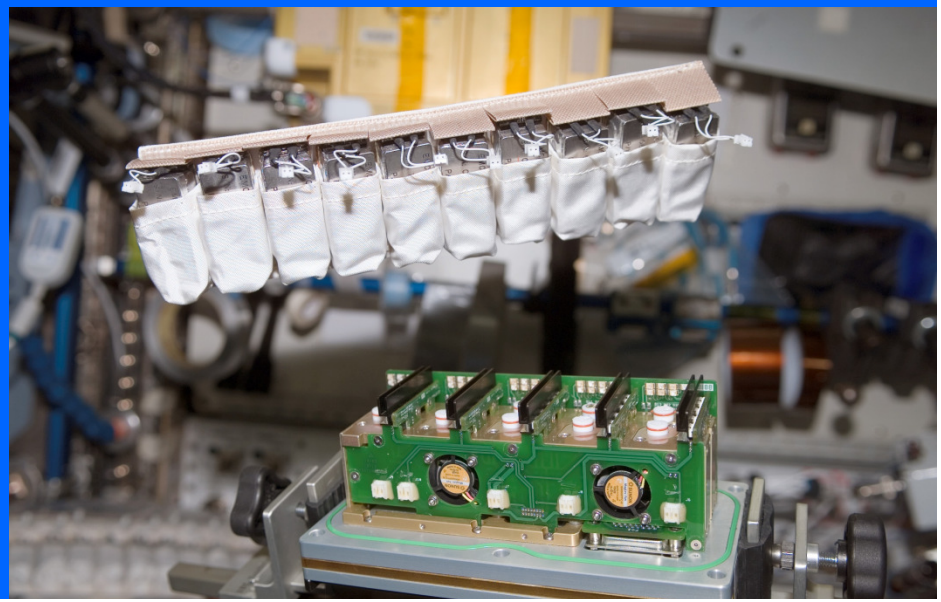


- We were first group to use this facility.

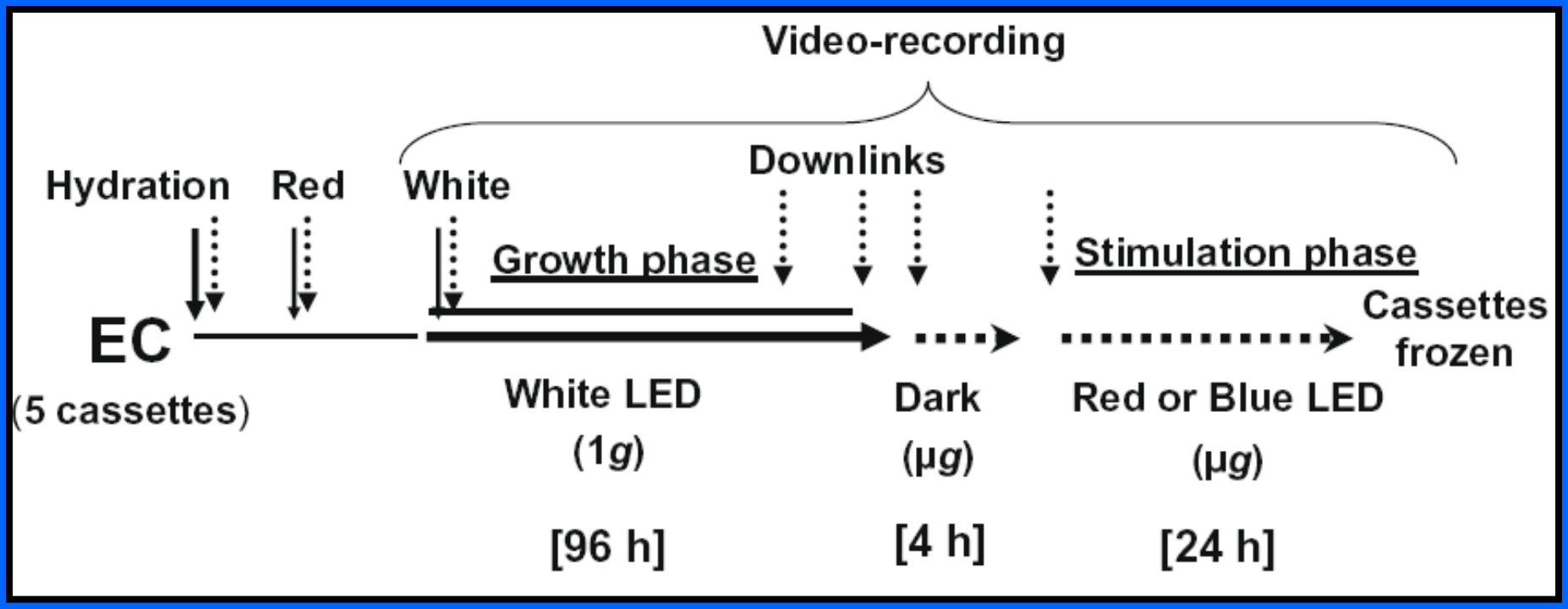
Experiment Unique Equipment (EUE)







Timeline



1*g*, 0.1*g*, 0.3*g*

Start of experiment: http://www.youtube.com/watch?v=w7l3CnRdTCQ

Post-flight Procedures

1. Video Analysis

- Video downlinks (improved from TROPI-1)
- Analysis of germination, growth, curvature

2. Frozen samples.

- Analyze how various light & gravity treatments affect gene expression. This will involve DNA microarrays.

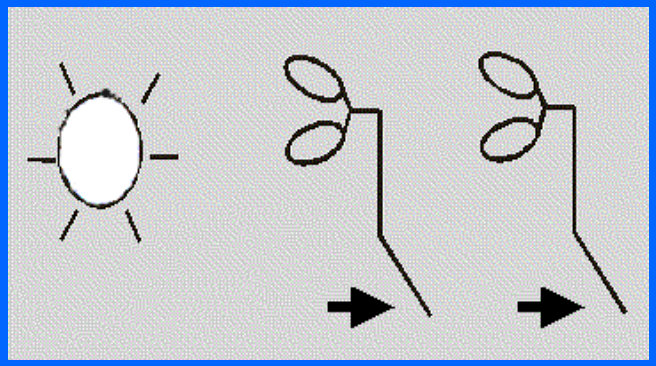
Video Downlinks from ISS

TROPI-1

TROPI-2

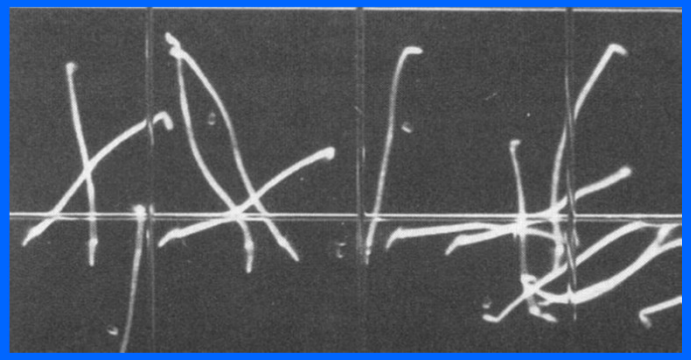
- Improved seed germination & seedling growth in TROPI-2!

Phototropism



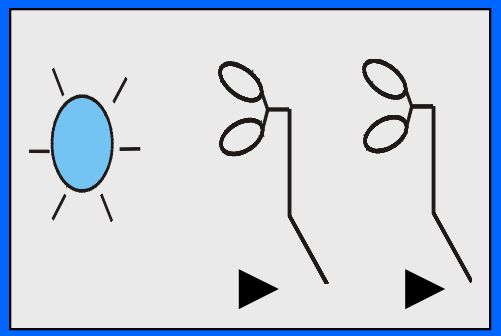
White light:

- Shoot: Positive phototropism
- Root: Negative phototropism



Red light:

- No phototropic response



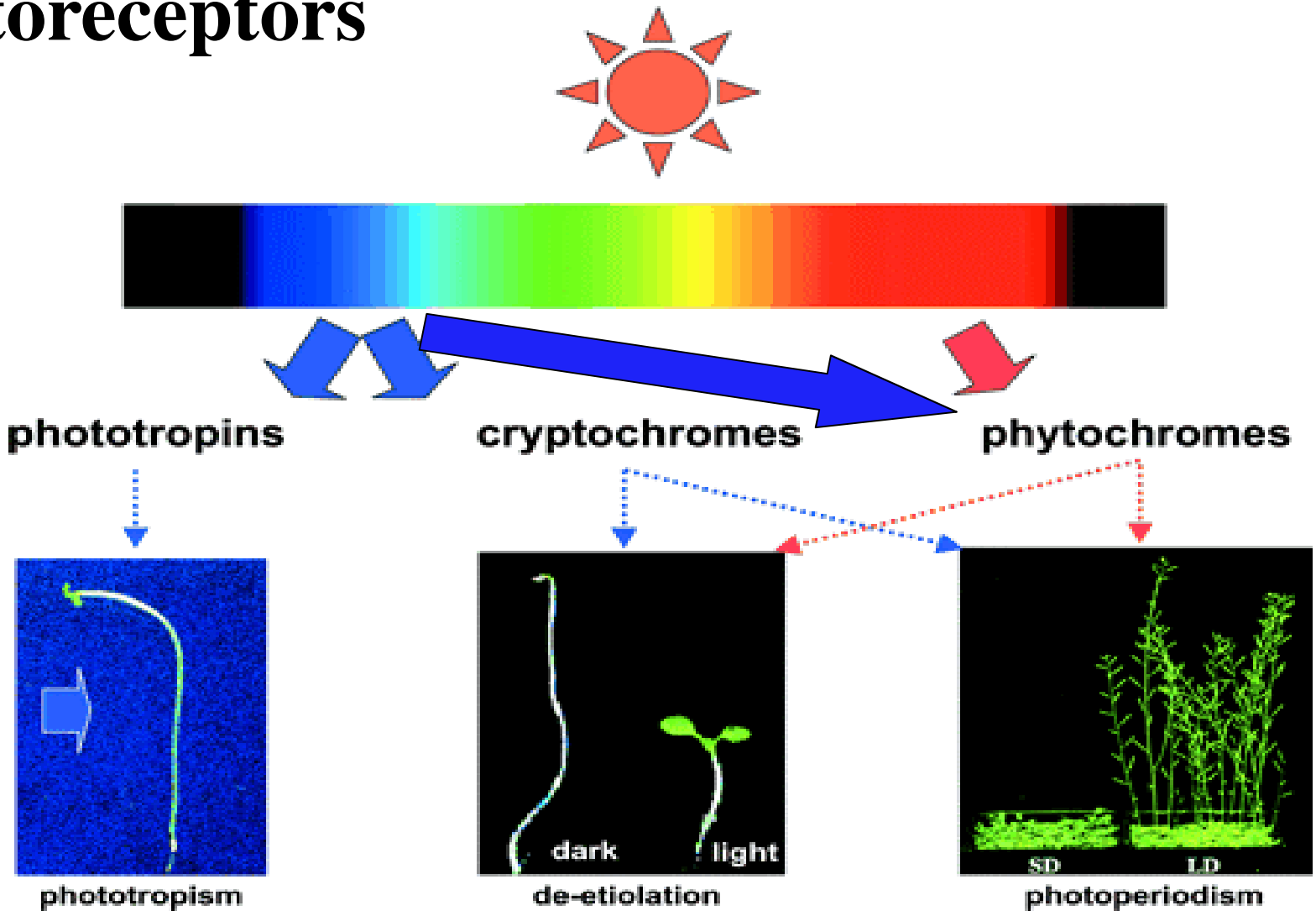
Blue light:

- Shoot: Positive phototropism
- Root: Negative phototropism

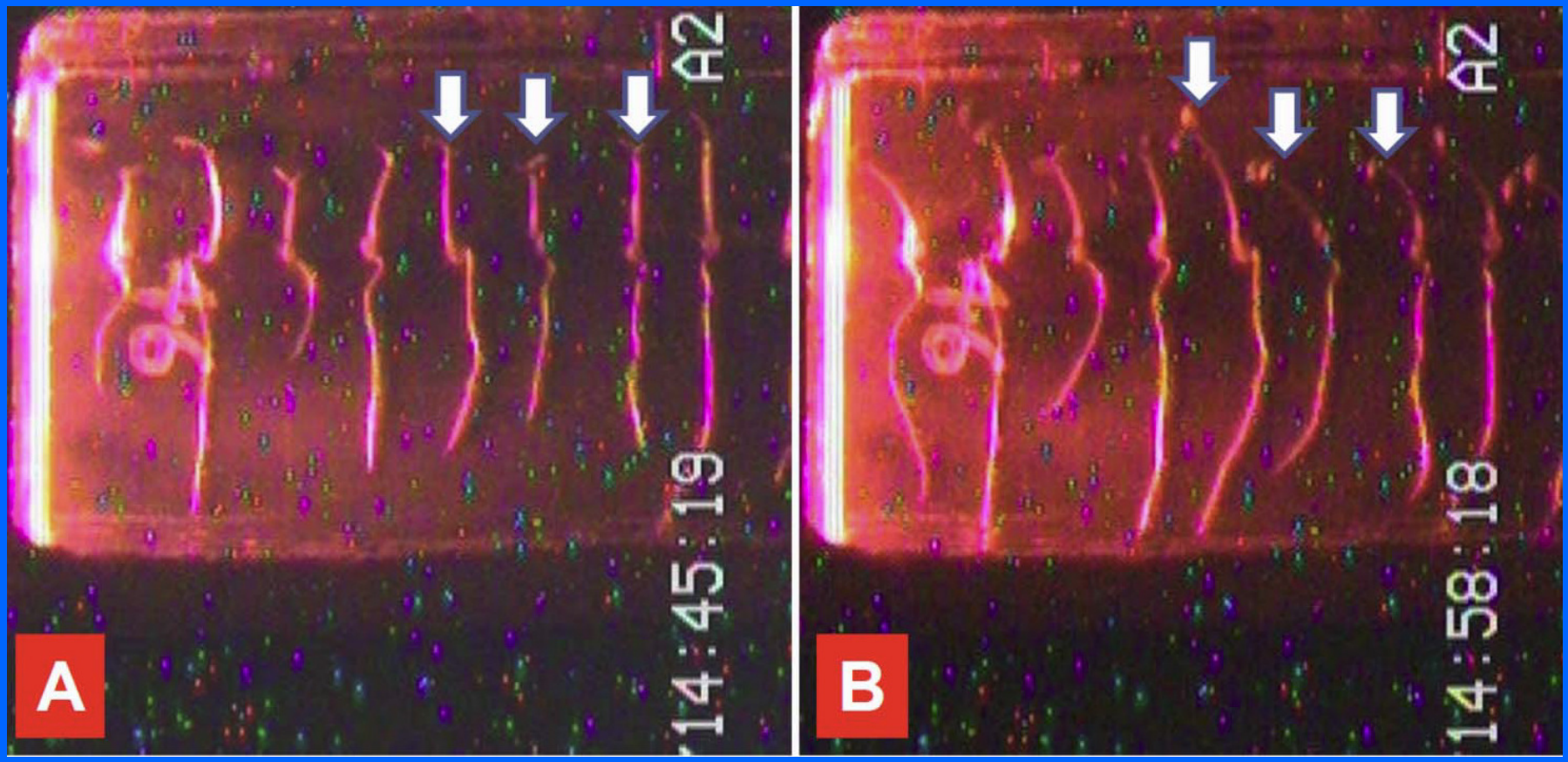
[phot1 & phot2]

Phototropism: How do plants perceive light?

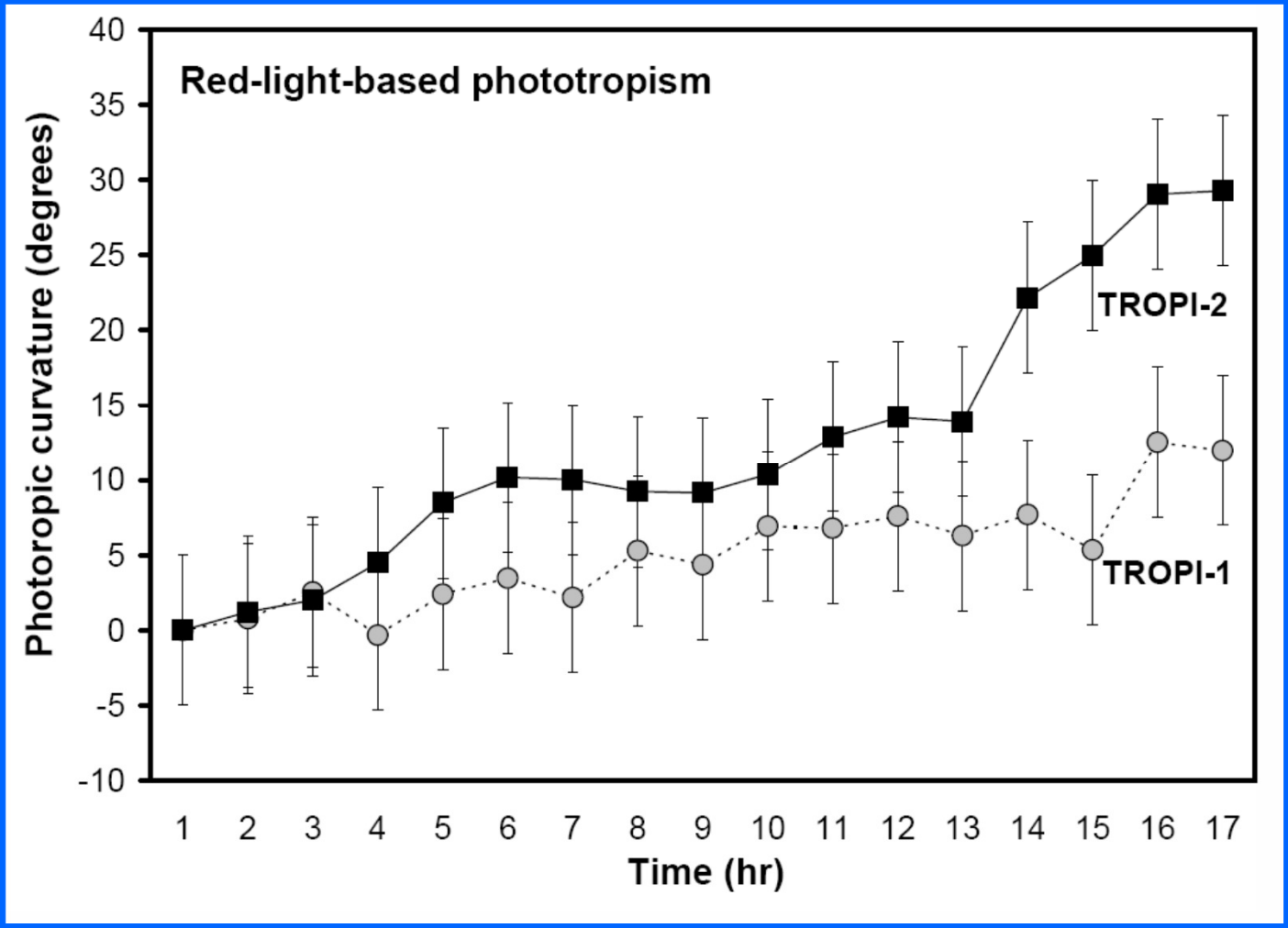
Photoreceptors



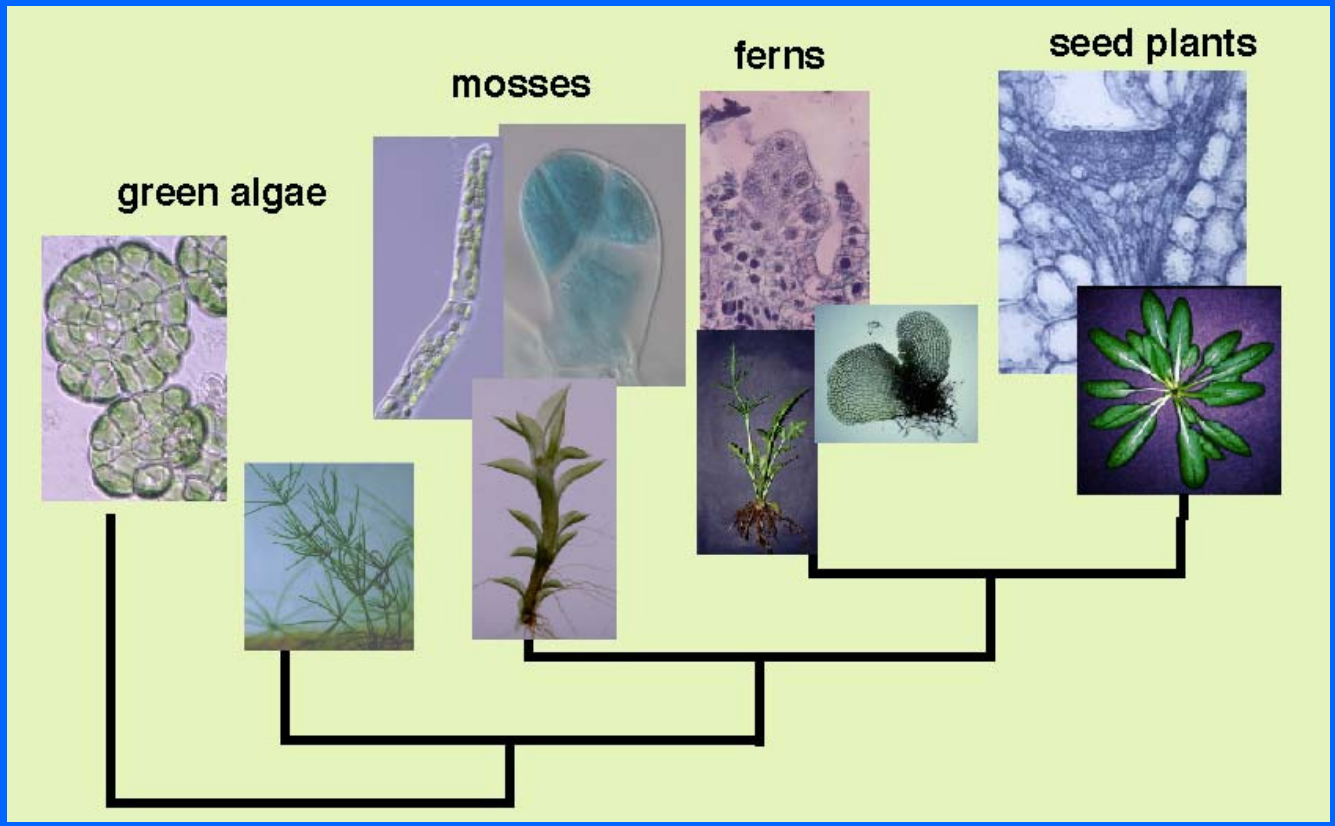
Positive Curvature in Response to Red Light in Microgravity



Red-based phototropic curvature in µg in hypocotyls confirmed in TROPI-2



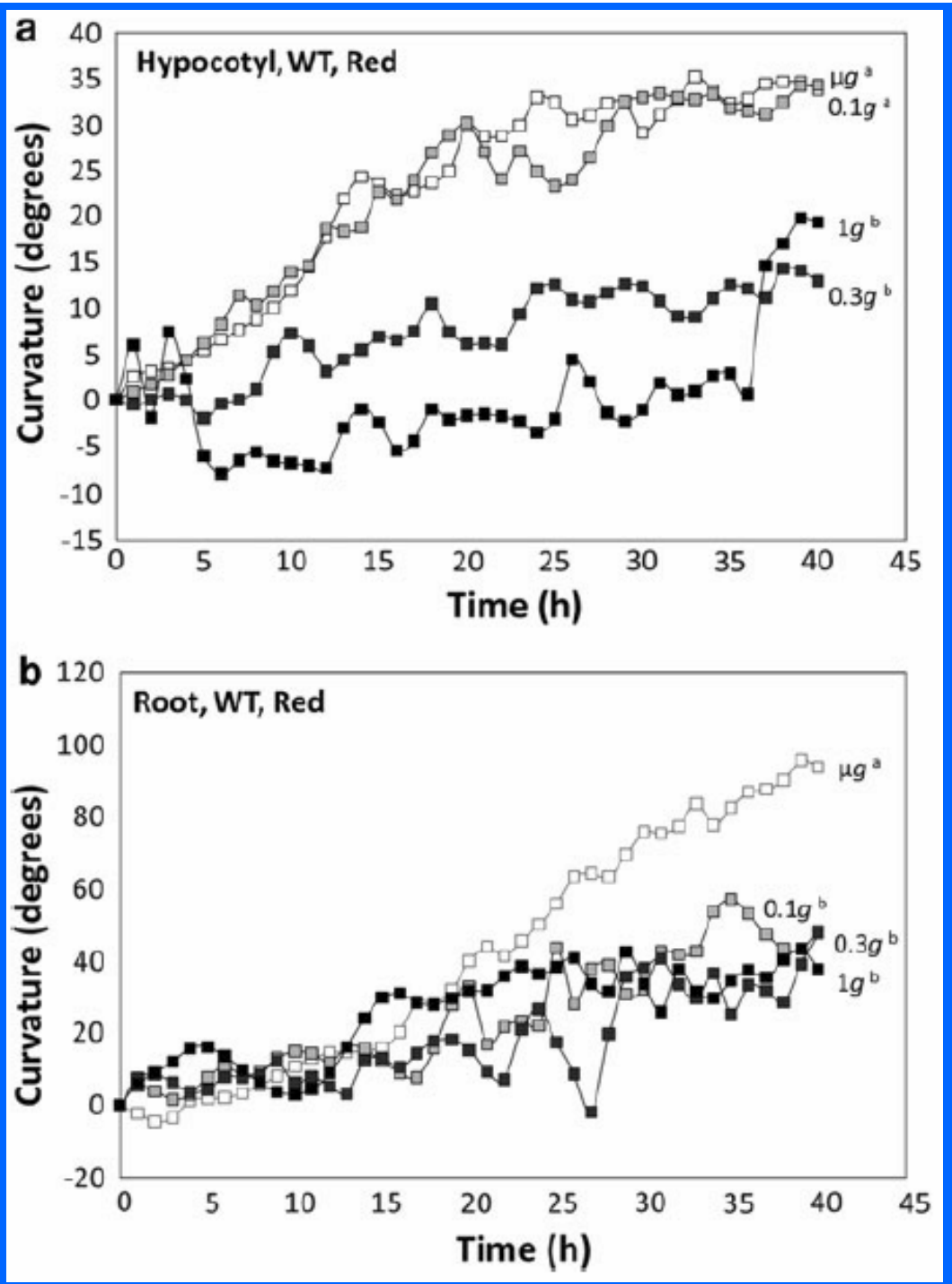
Hypothesis: Red-light-induced phototropism, normally found in ancient plant lineages, is masked by 1-g conditions but also occurs in flowering plants.



http://www.nibb.ac.jp/~evodevo/

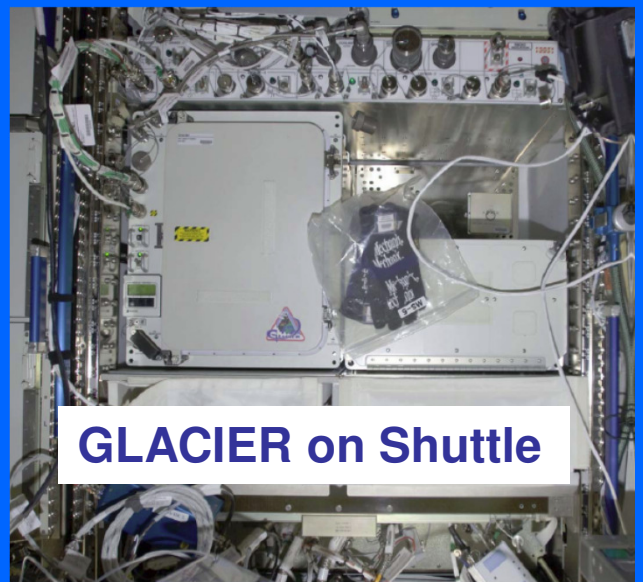
Hypocotyls:
Response is attenuated at 0.3 *g*

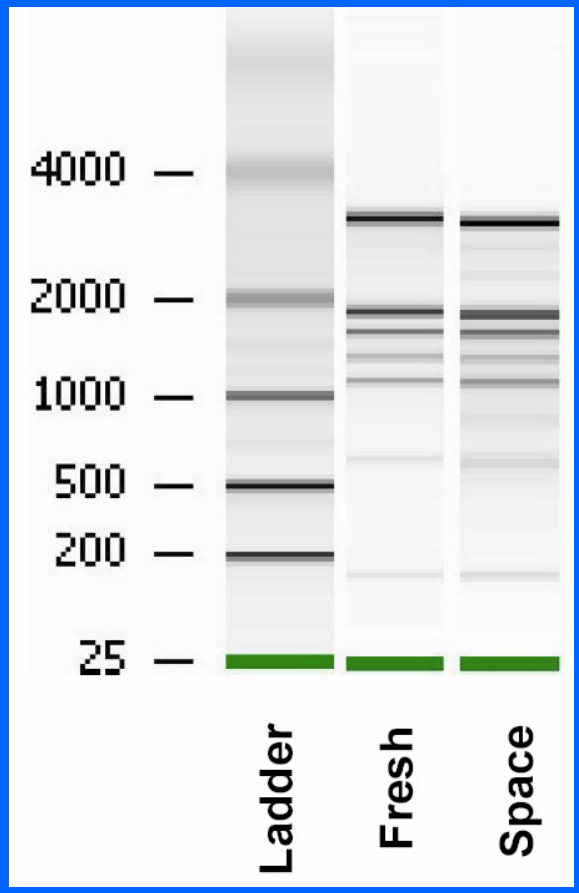
Roots:
Response is attenuated at 0.1 *g*



Frozen Samples:
Good quality RNA for Microarray Analysis

MELFI on ISS





In Progress:
Microarray Analysis

Summary

- **Hypothesis: directional red-light-sensing, found in ancient plant lineages, is masked by normal 1*g* conditions in the more recently evolved lineages.**

- **Red-light phototropism in hypocotyls and blue-light phototropism in roots is attenuated at 0.3*g*. In contrast, red-light phototropism in roots is attenuated at 0.1*g*.**

- **Phytochromes are involved in red-light phototropism i both roots and hypocotyls.**

- **These studies are the first to examine plant behavior in fractional gravity, and in the long term, may provide basic knowledge towards growing plants on Moon/Mars.**

TROPI
EMCS 0-2g in 60 sec

Thanks to: