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MICRO-ECOLOGICAL LIFE SUPPORT SYSTEM ALTERNATIVE

2022 MELISSA CONFERENCE
7-8-9 NOVEMBER 2022

CREATING A CIRCULAR FUTURE

Light stimuli to guide roots of agriculturally-important plants in extra-terrestrial environments

Luigi Gennaro Izzo, Leone Ermes Romano, Maurizio Iovane, Aranzazu Manzano, Raúl Herranz, F. Javier Medina, John Z. Kiss, Jack J.W.A. van Loon, Giovanna Aronne

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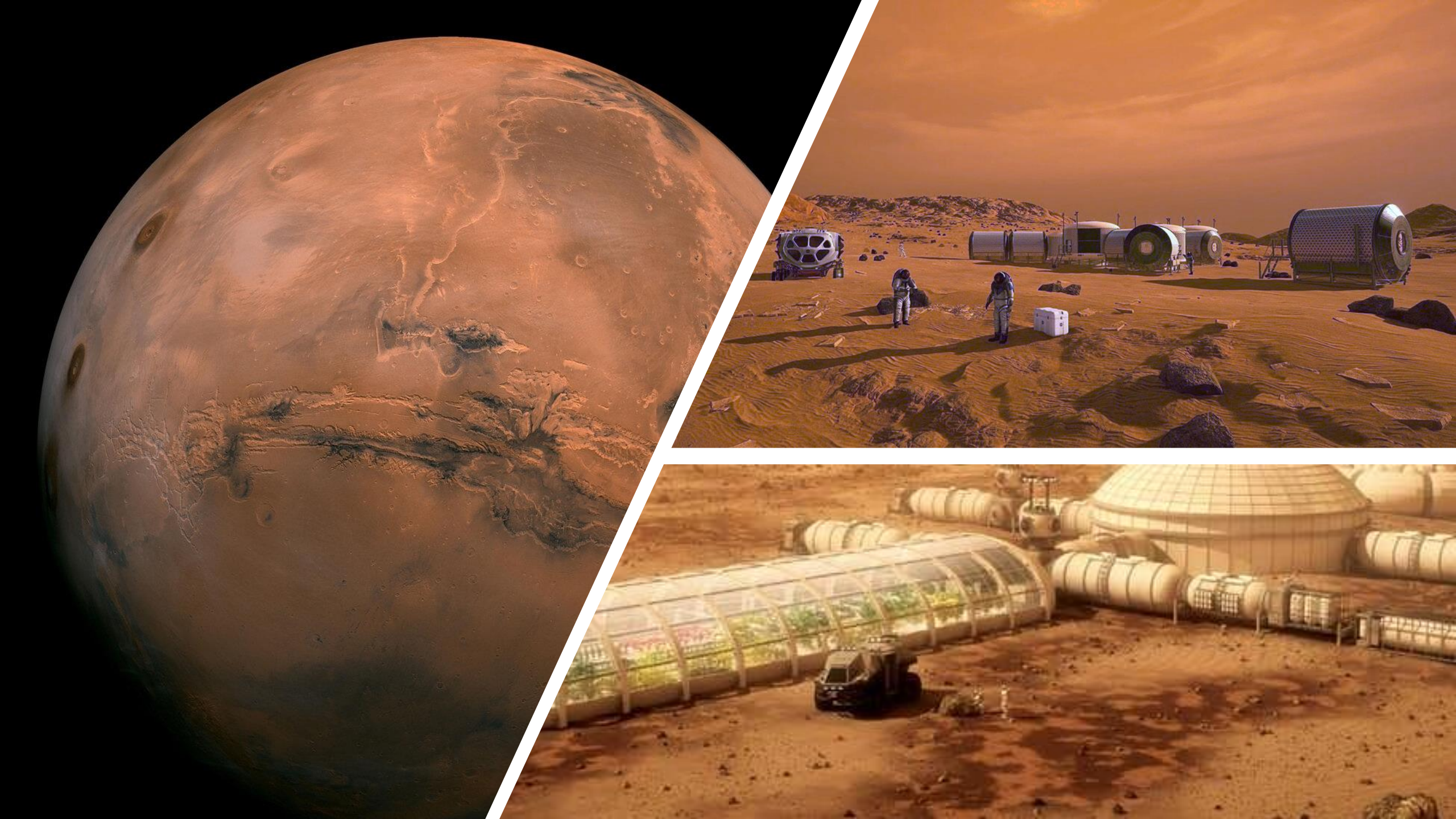
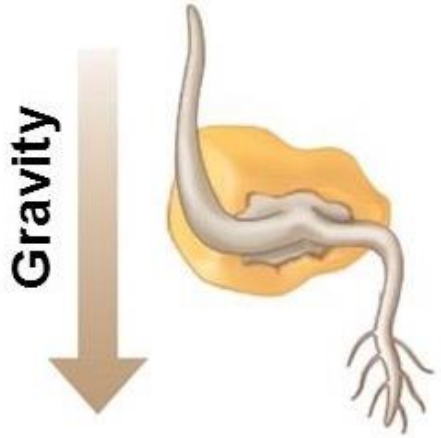


TROPISM: *"A directional growth response to a directional stimulus"* (Gilroy, 2008)

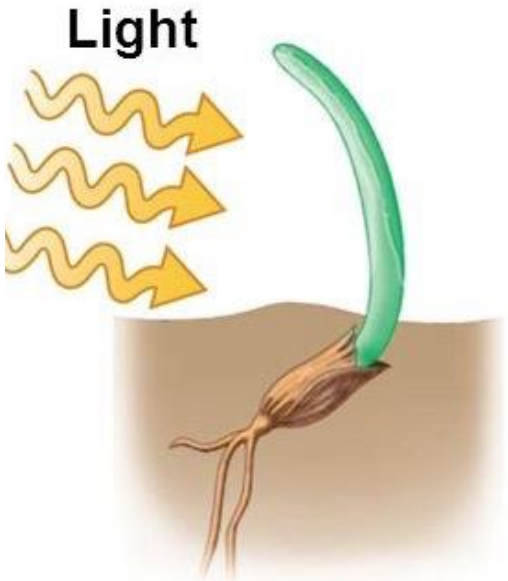
Tropisms allow plants to adjust their growth in response to environmental stimuli

- Gravitropism
- Phototropism

...many others

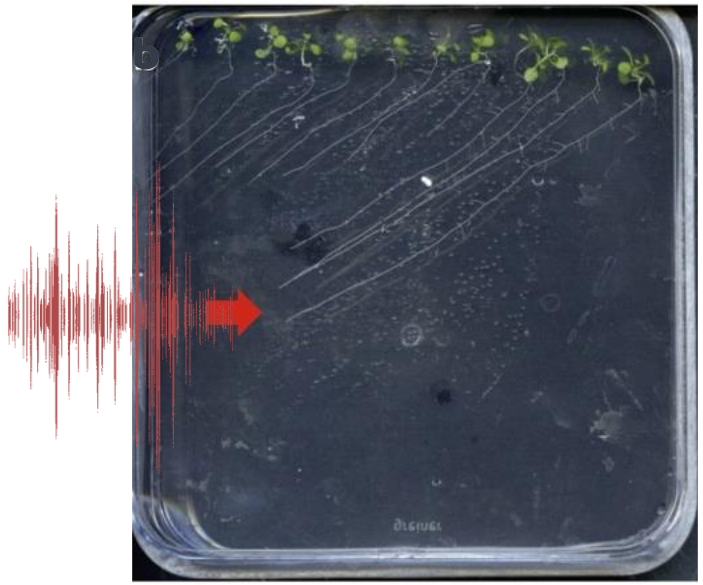


Gravitropism



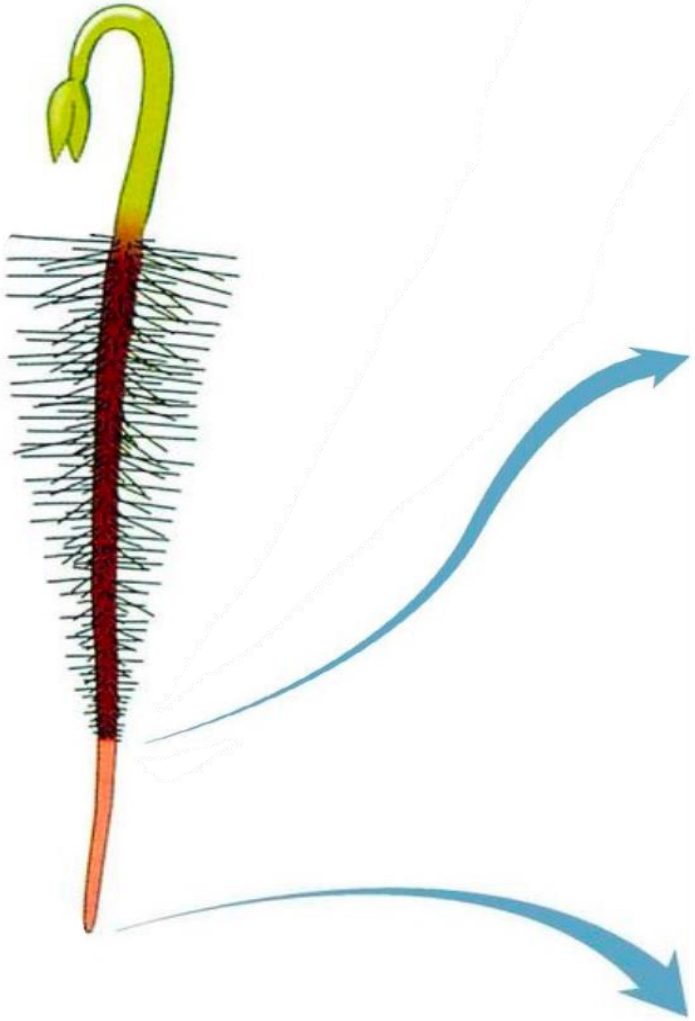
Phototropism

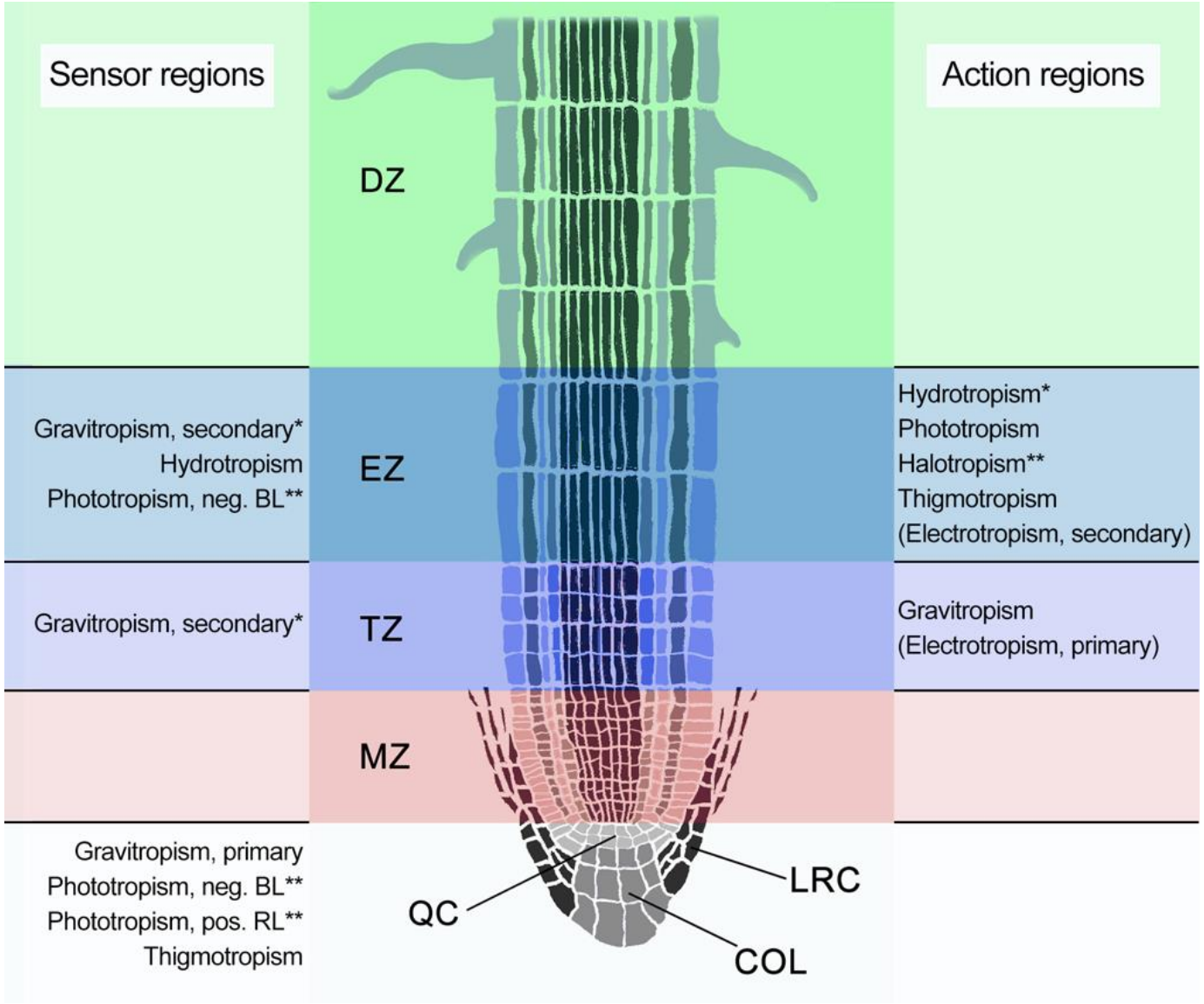
Thigmotropism



Phonotropism

The Root Apex

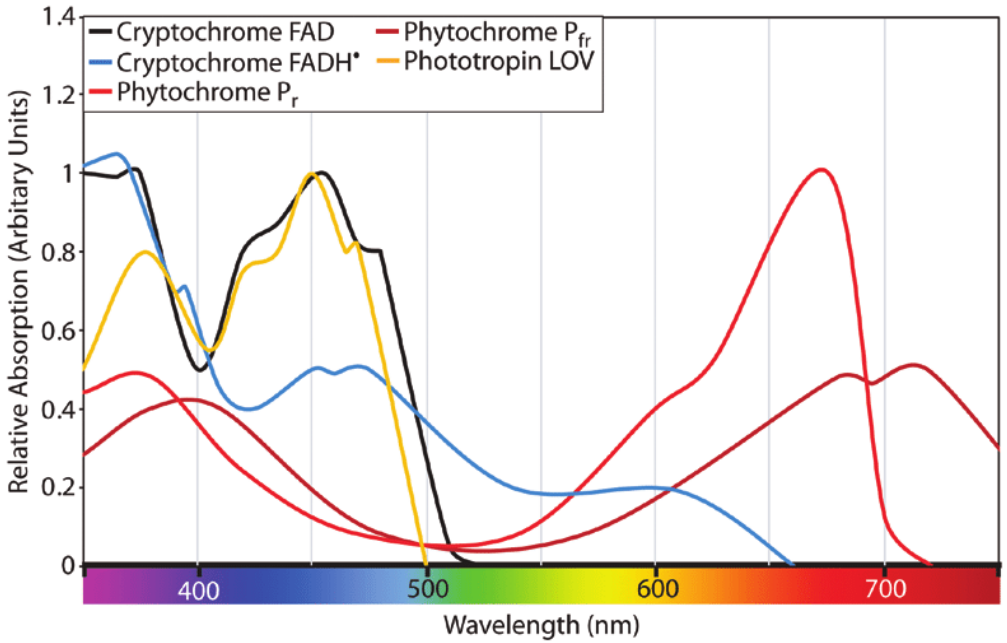


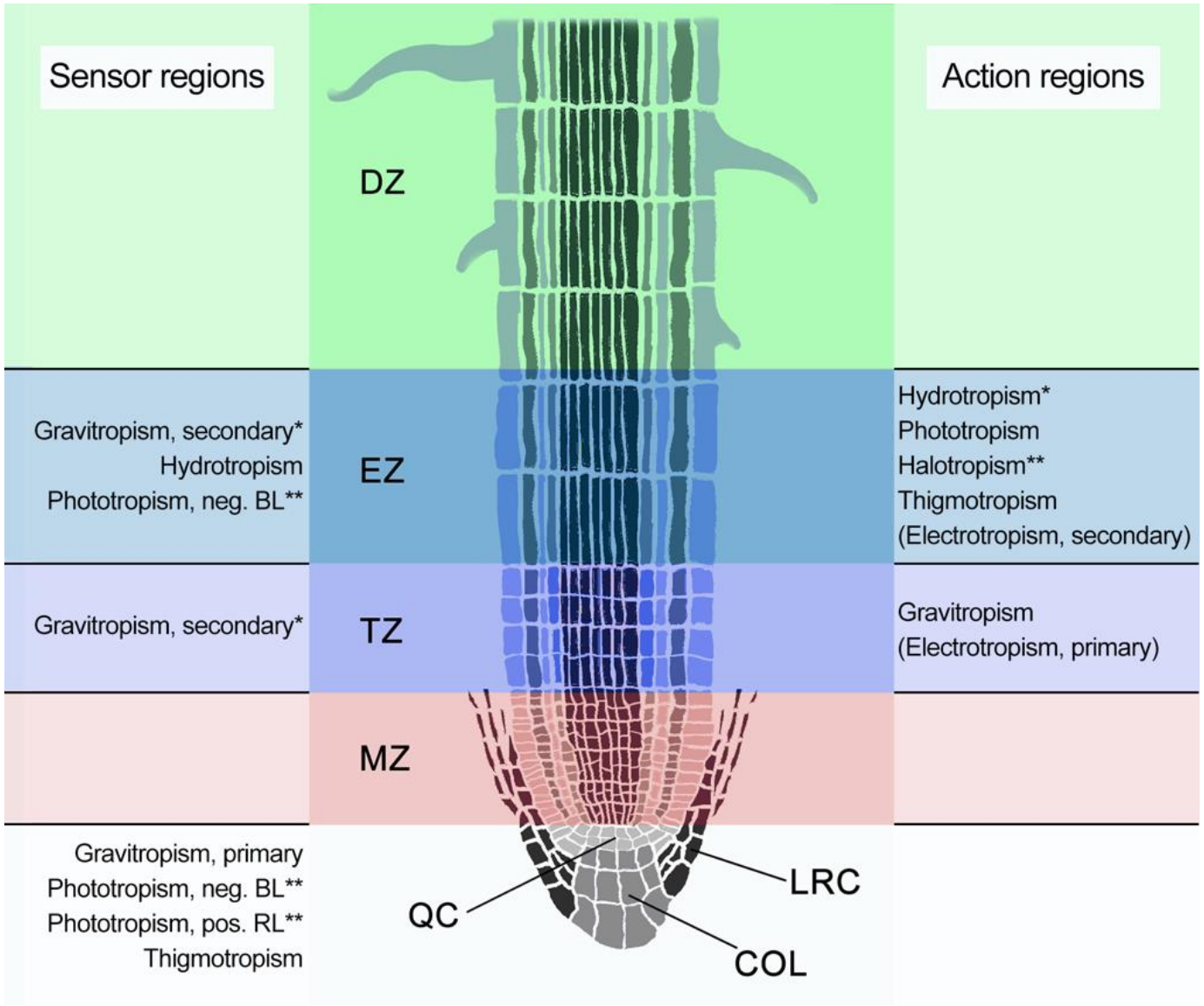


Root Phototropism

Photoreceptors in roots:

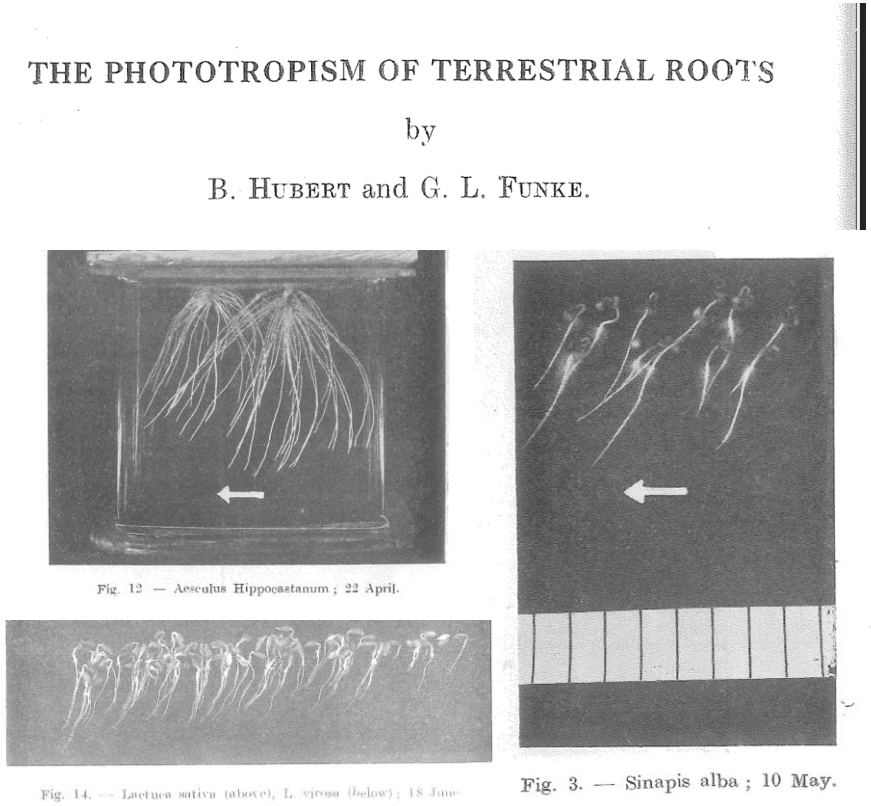
- Cryptochromes
- Phytochromes
- Phototropins





Gravitropism vs Phototropism

Gravity and light stimuli compete and interact with each other in shaping plant development through directional growth responses of plant organs



THE PHOTOTROPISM OF TERRESTRIAL ROOTS

by

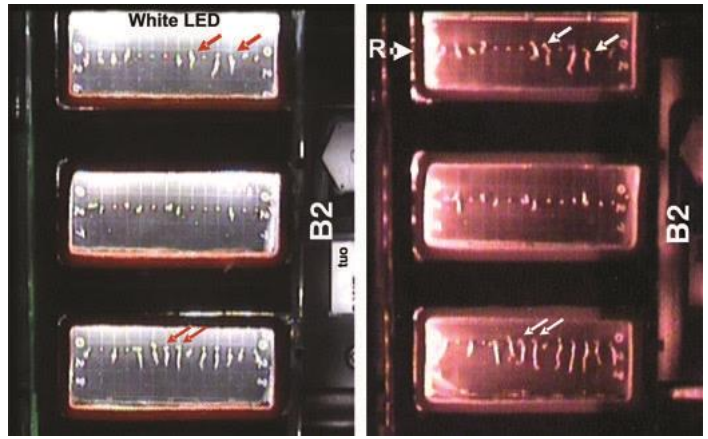
B. HUBERT and G. L. FUNKE.

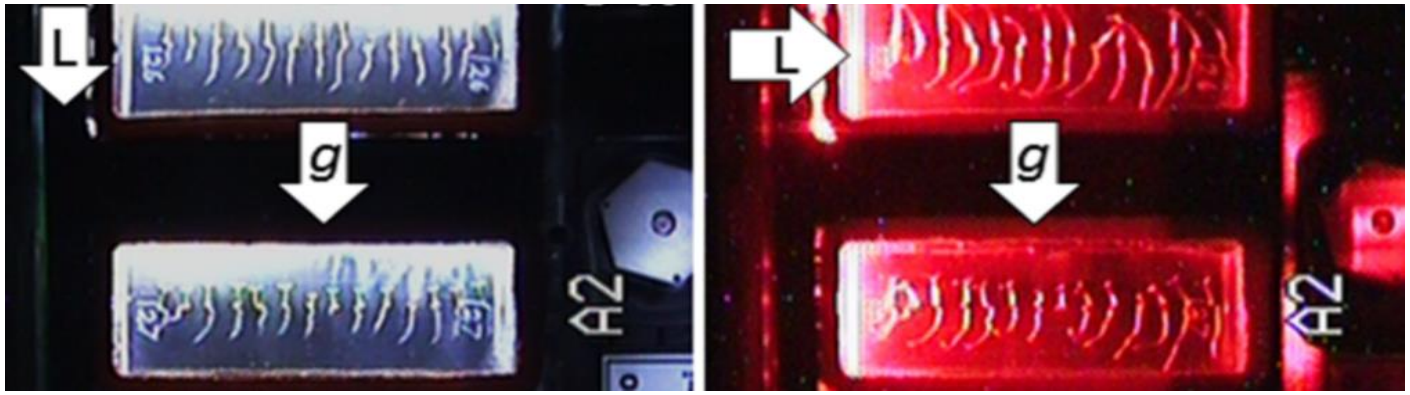
Fig. 12 — Aesculus Hippocastanum ; 22 April.

Fig. 14. — Lactuca sativa (above), L. virosa (below) ; 18 June.

Fig. 3. — Sinapis alba ; 10 May.

- A novel phototropic response to red light is revealed in microgravity (*Millar et al., 2011*)
- A novel blue-light phototropic response is revealed in roots of Arabidopsis thaliana in microgravity (*Vandenbrink et al., 2016*)



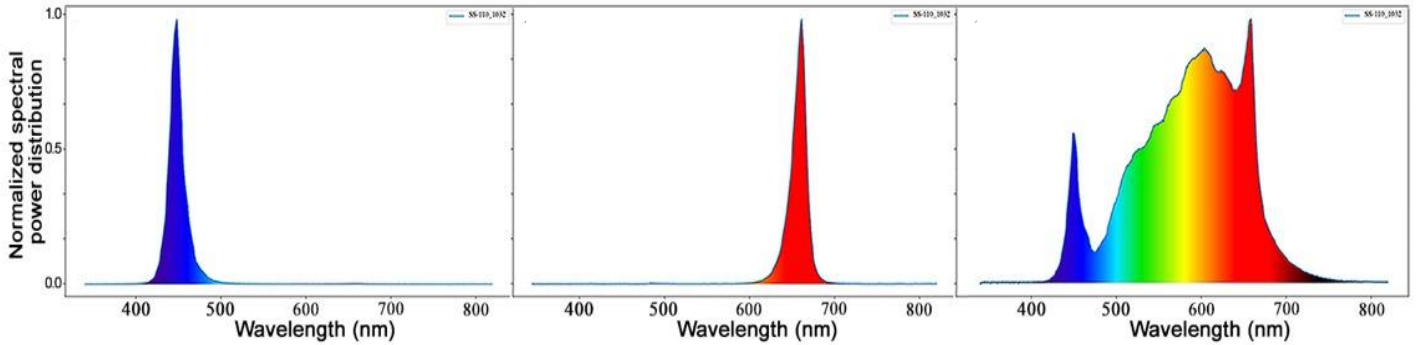


TACKLING THE ROOTS OF BENDING

Interaction of root gravitropism and phototropism in altered gravity

- ***Brassica oleracea***

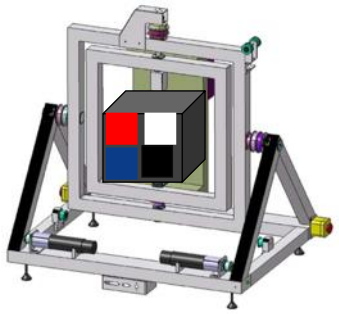
- **Light conditions**
  1. Monochromatic blue
  2. Monochromatic red
  3. Broadband white
  4. Dark



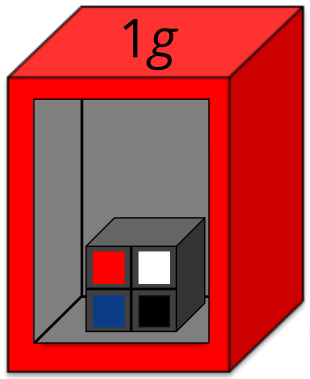
- **Gravity conditions**
  Control (1*g*), four hypergravity levels (5*g*, 10*g*, 15g, 20*g*), simulated microgravity (*μg*)

RPM

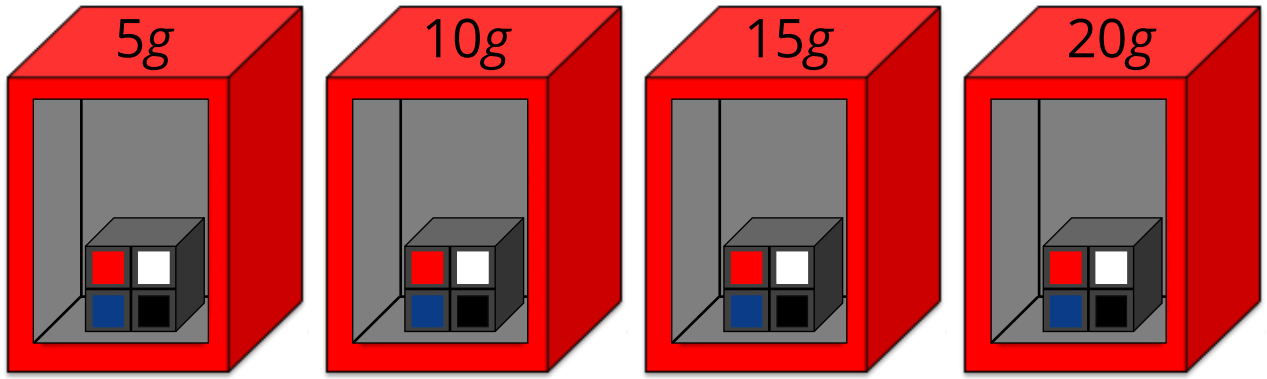
μg



Ground

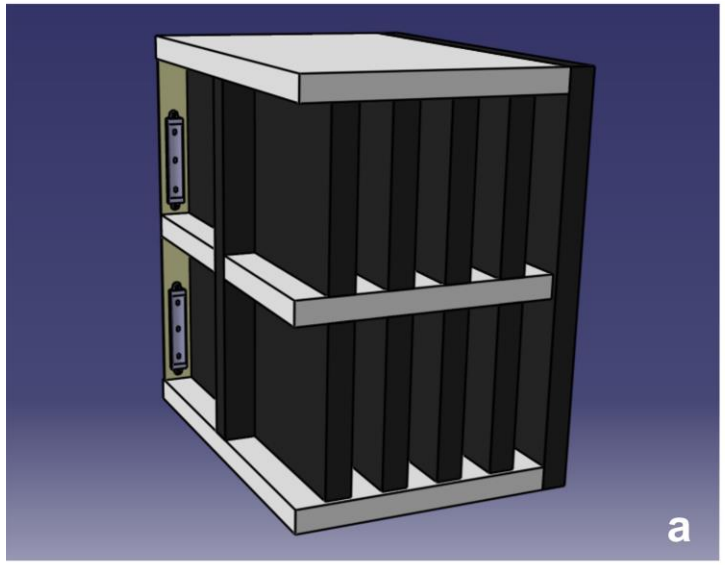


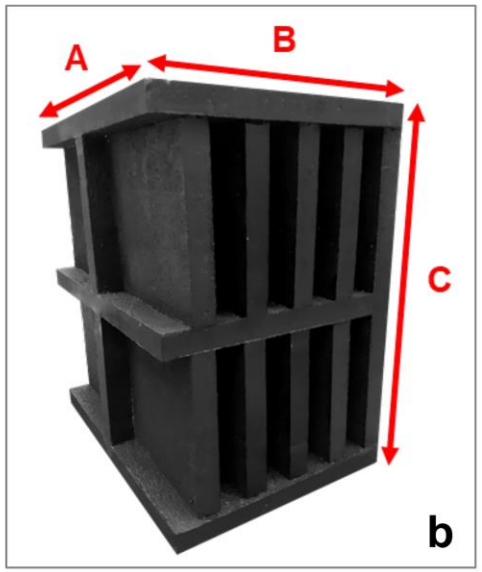
LDC

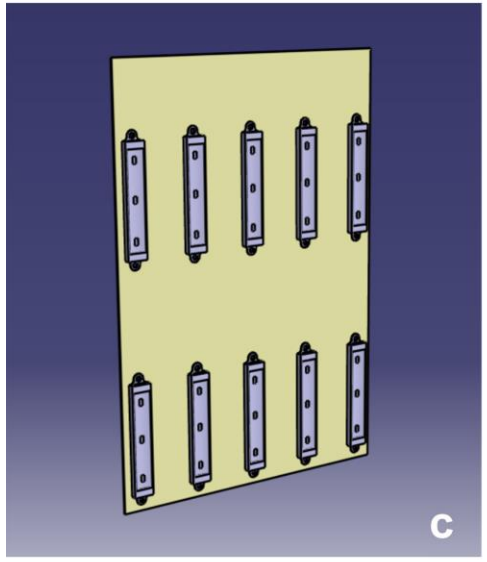


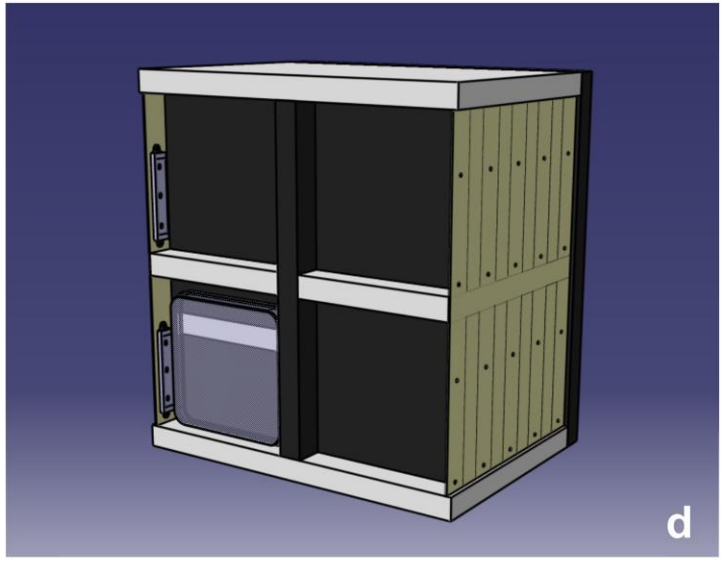
Hardware Development and Experiment Setup

MULTI-SLOT BOX WITH LEDS

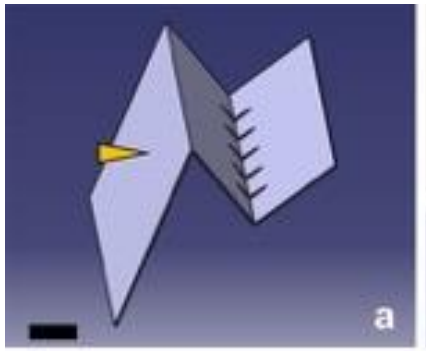


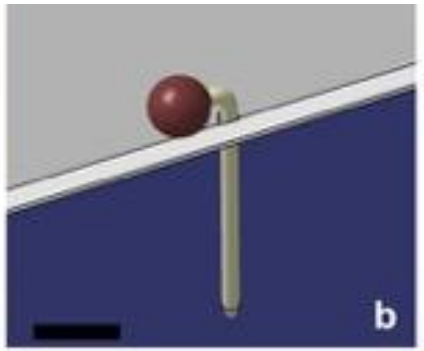


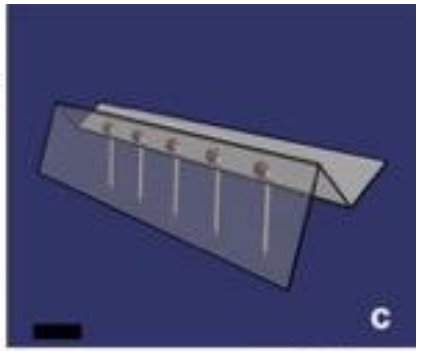


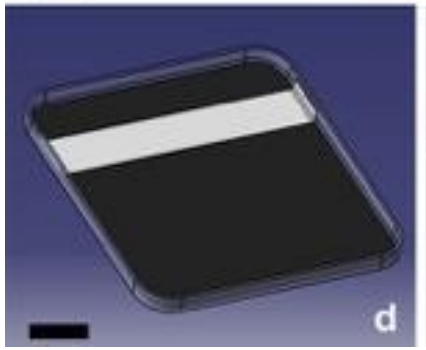


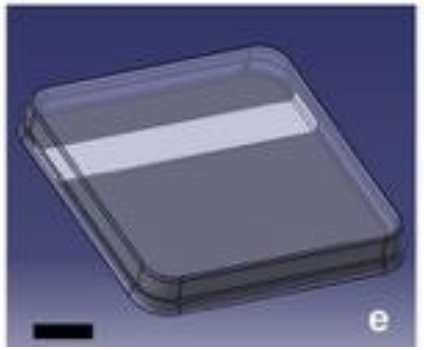
EXPERIMENTAL CONTAINER

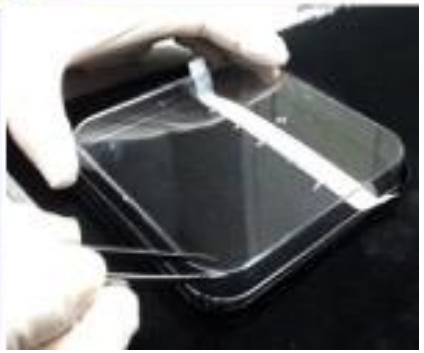


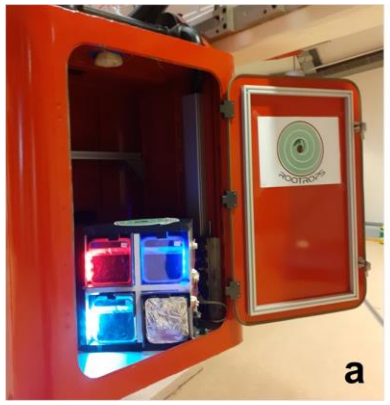


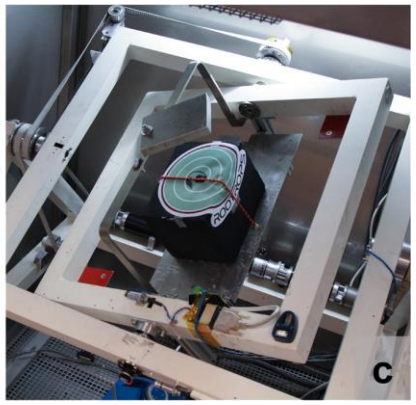






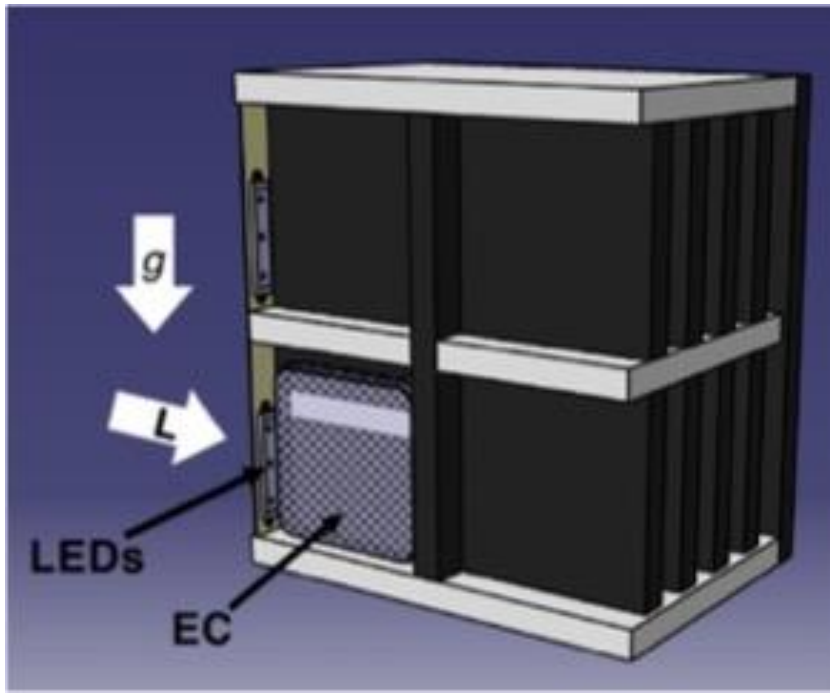


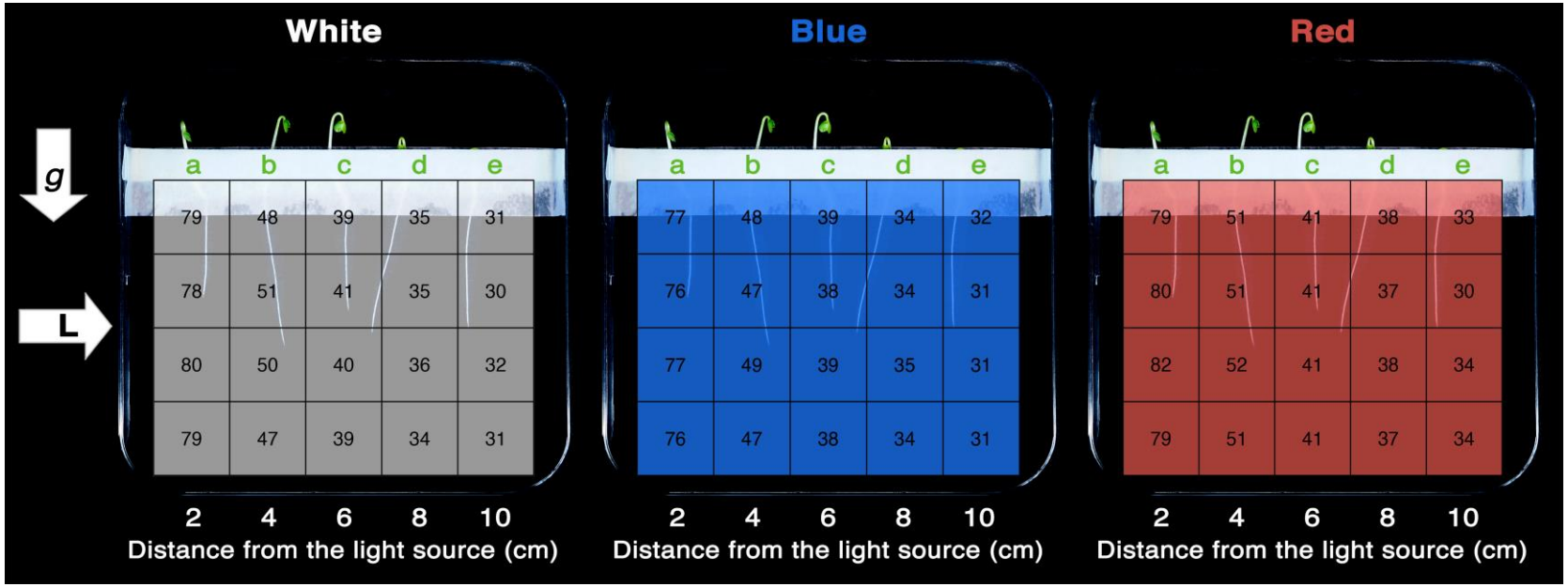




Aronne et al. (2022) - A novel device to study altered gravity and light interactions in seedling tropisms

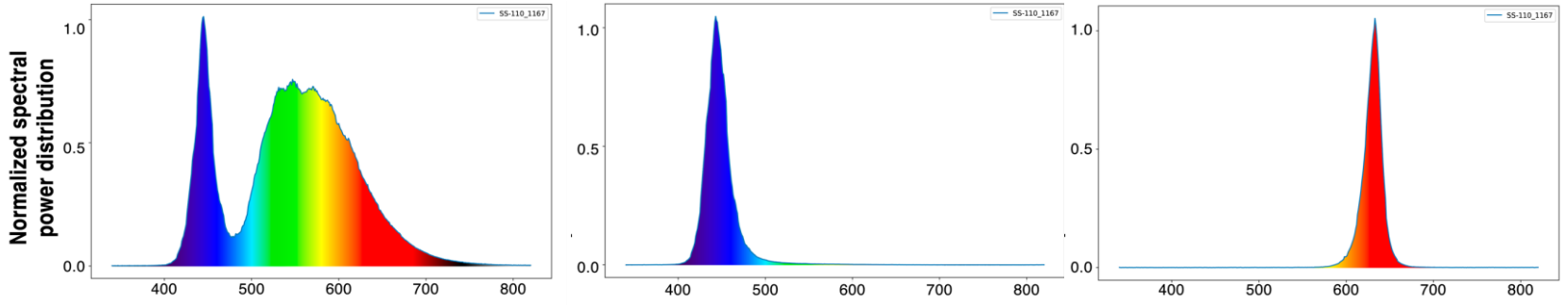
Light Mapping and Spectral Analysis





PPFD range = 30-80 µmol m^{-2} s^{-1}

- White light (400-730nm)
- Blue light (Peak = 443nm)
- Red light (Peak = 632nm)

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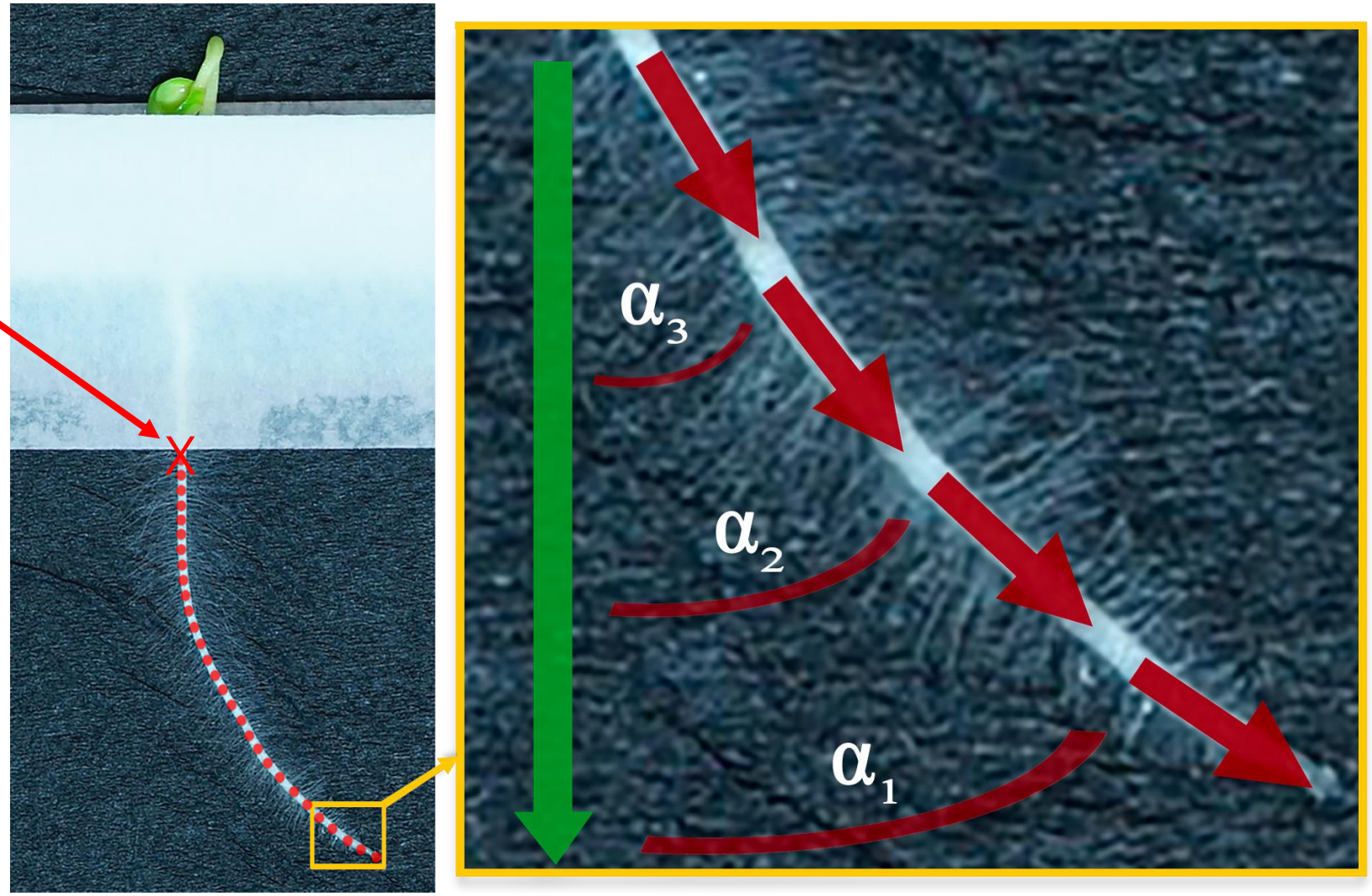
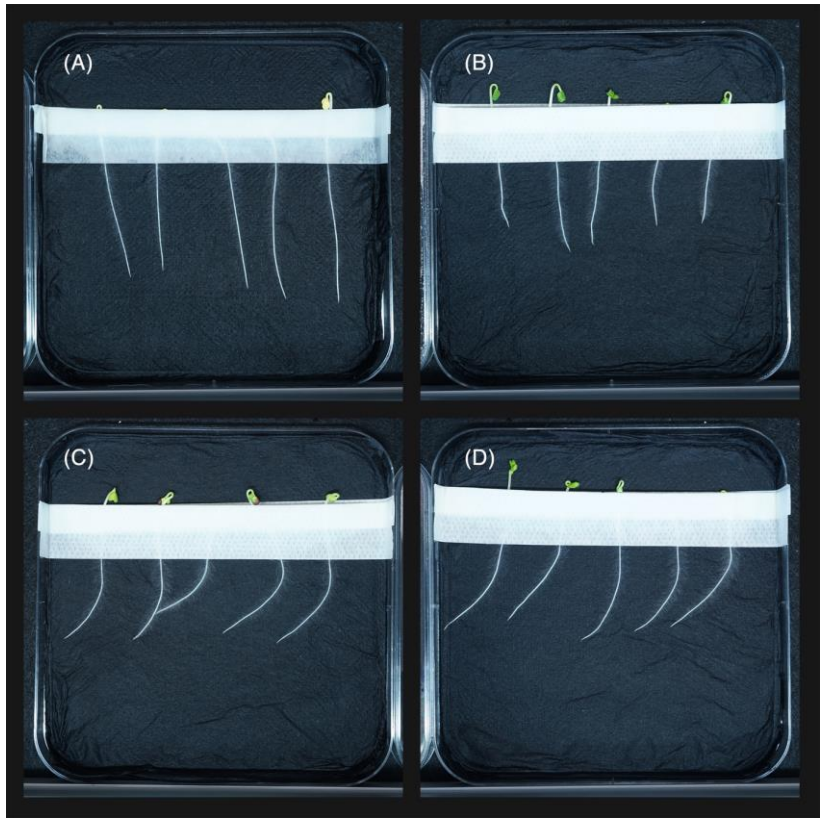
Post-Run: Image Analysis

ImageJ > *NeuronJ* tracing (≃30k measurements)

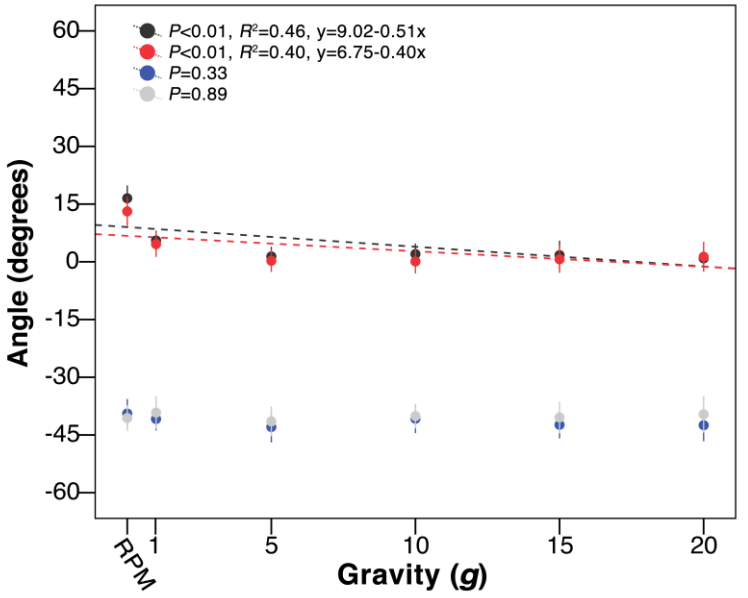
- Origin (X = 0 , Y = 0)
- Points (X, Y)
- Vectors
- Angles
- Length

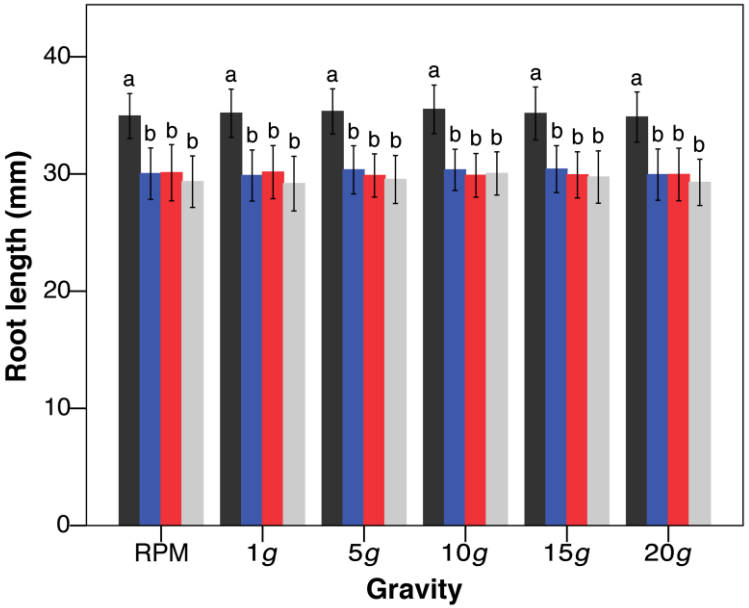


Results

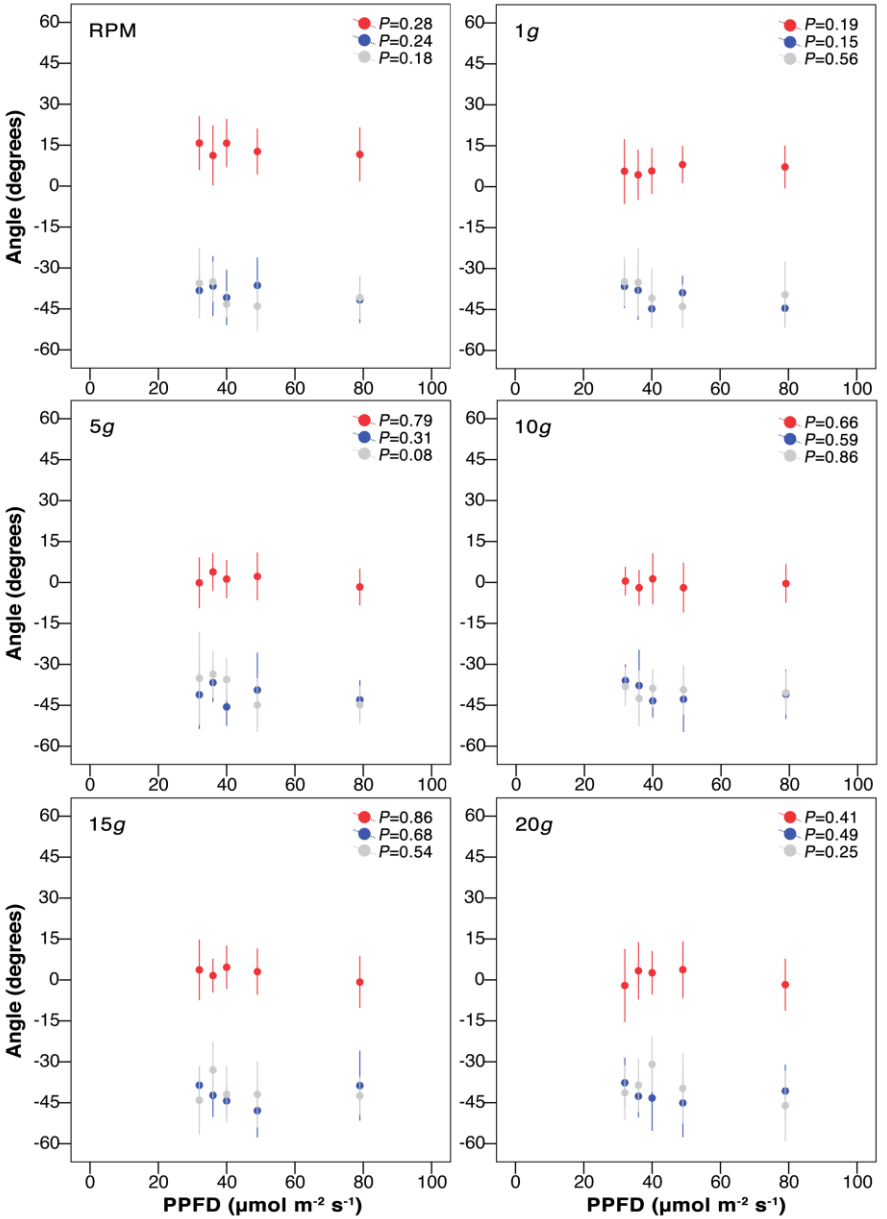


a) Dark
b) Red light
c) Blue light
d) White light

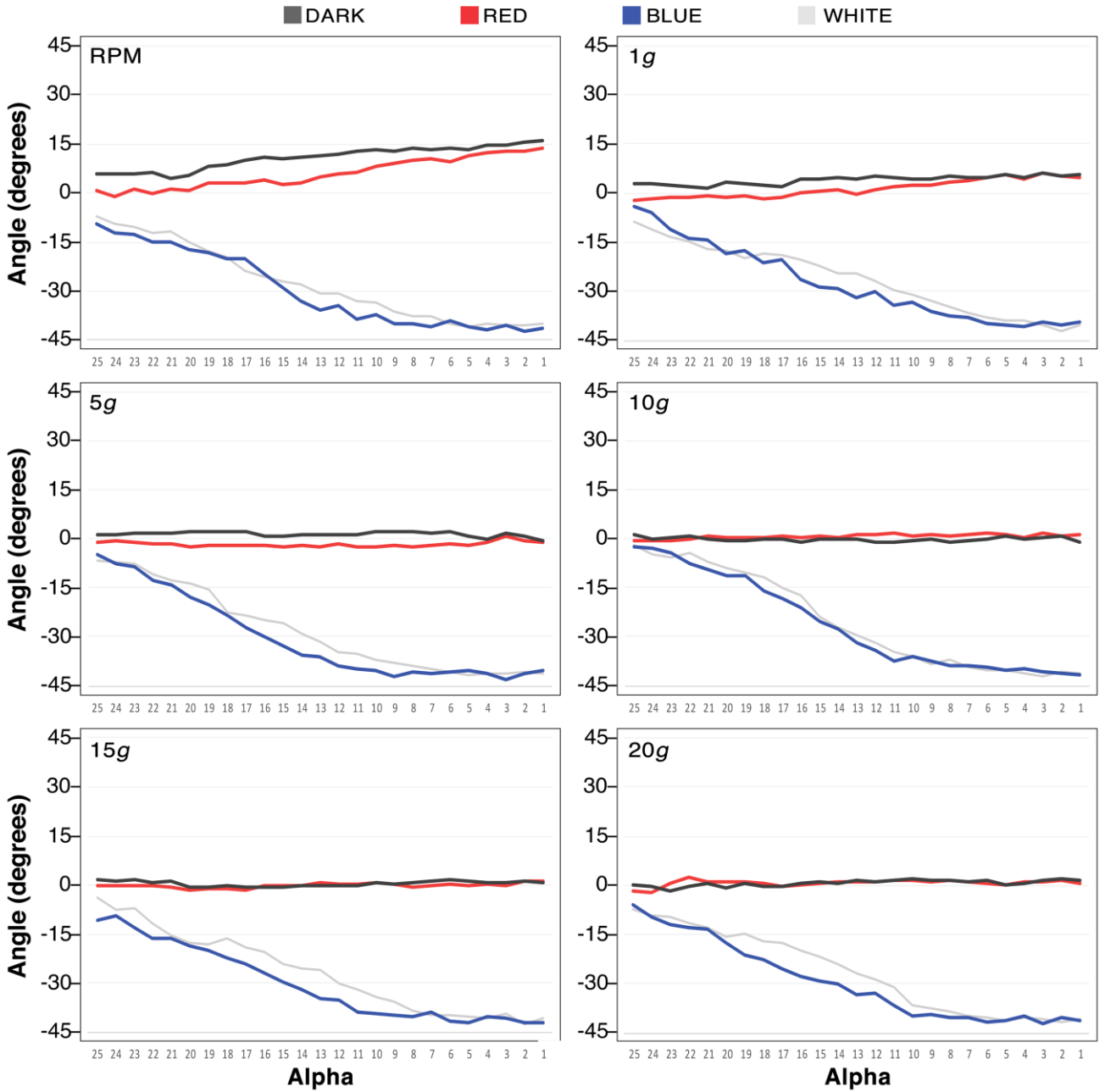




LIGHT INTENSITY RESPONSE



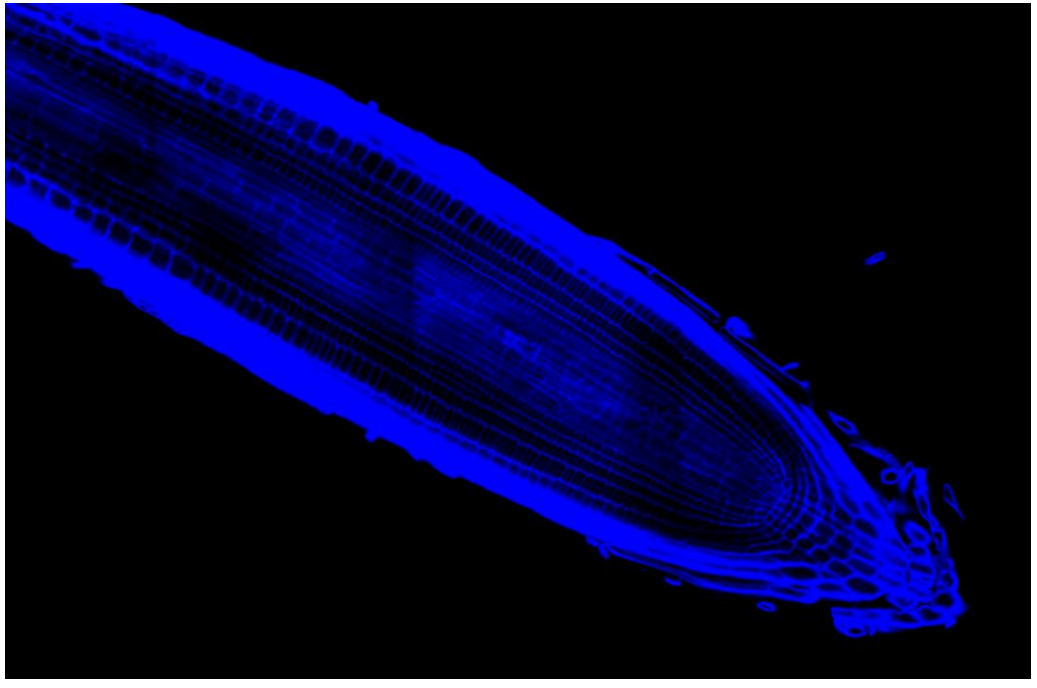
Results

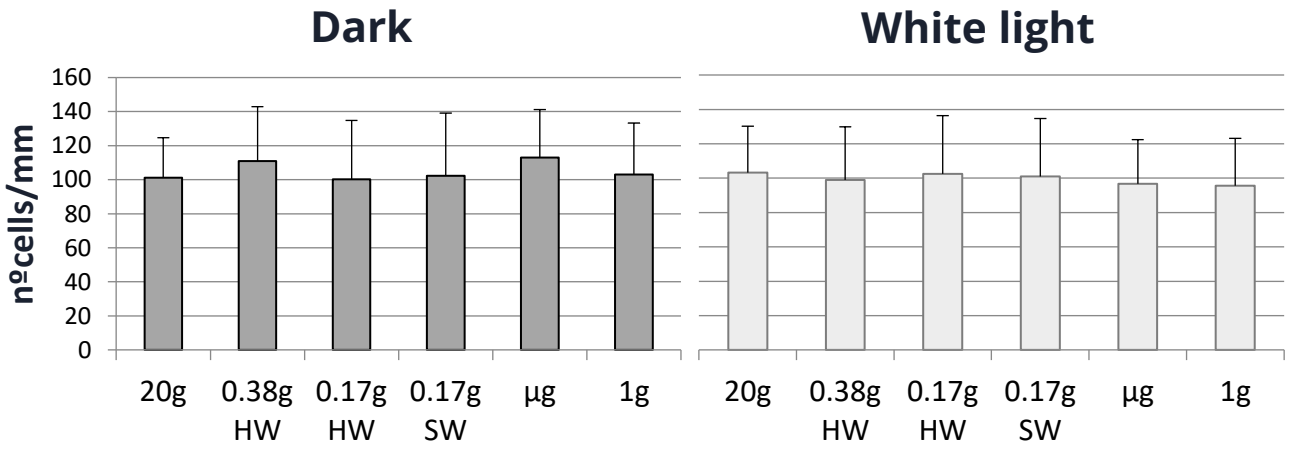


Izzo et al. (2022) - Interaction of gravitropism and phototropism in roots of *Brassica oleracea*

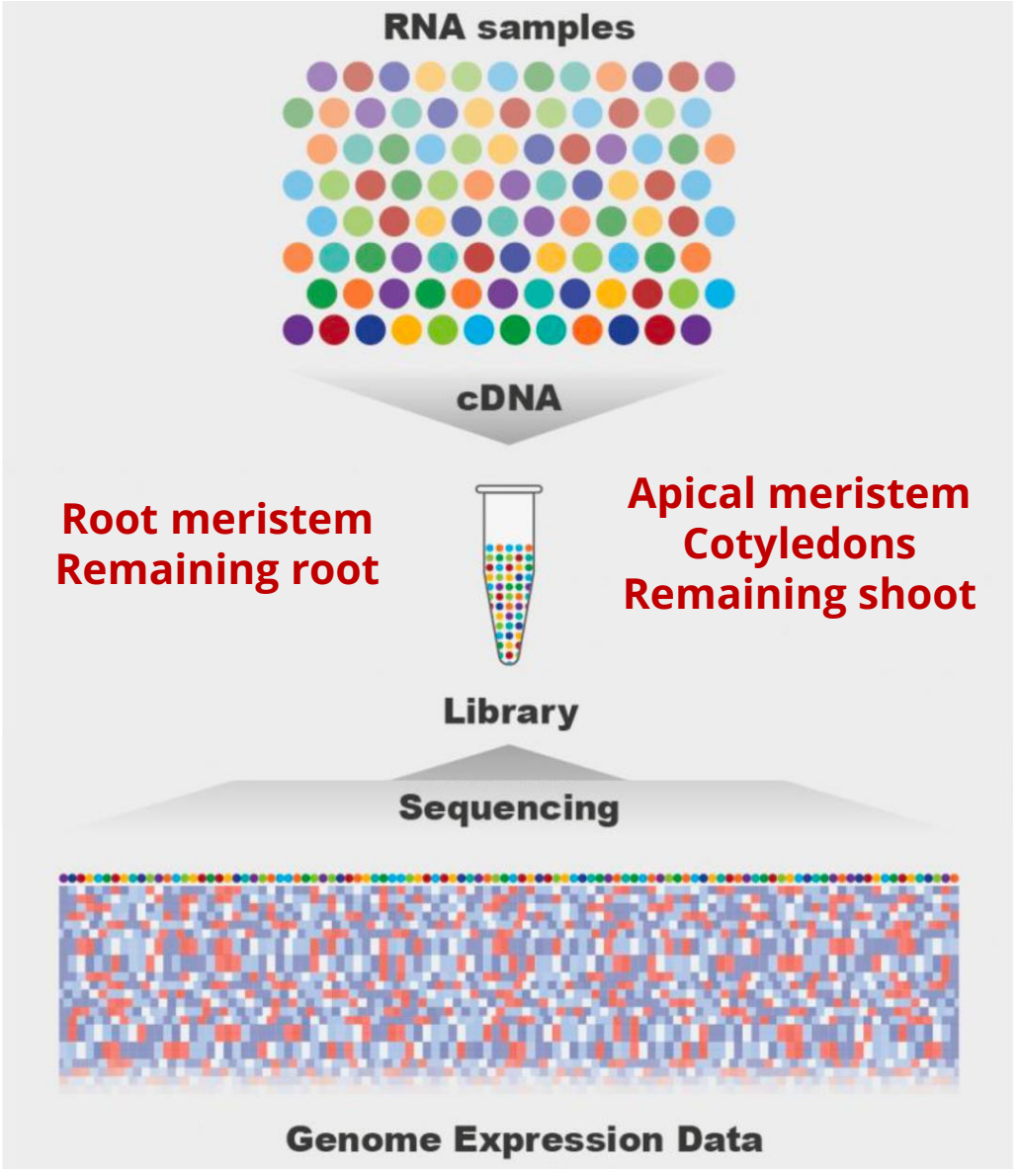
Ongoing Analysis

CONFOCAL MICROSCOPY



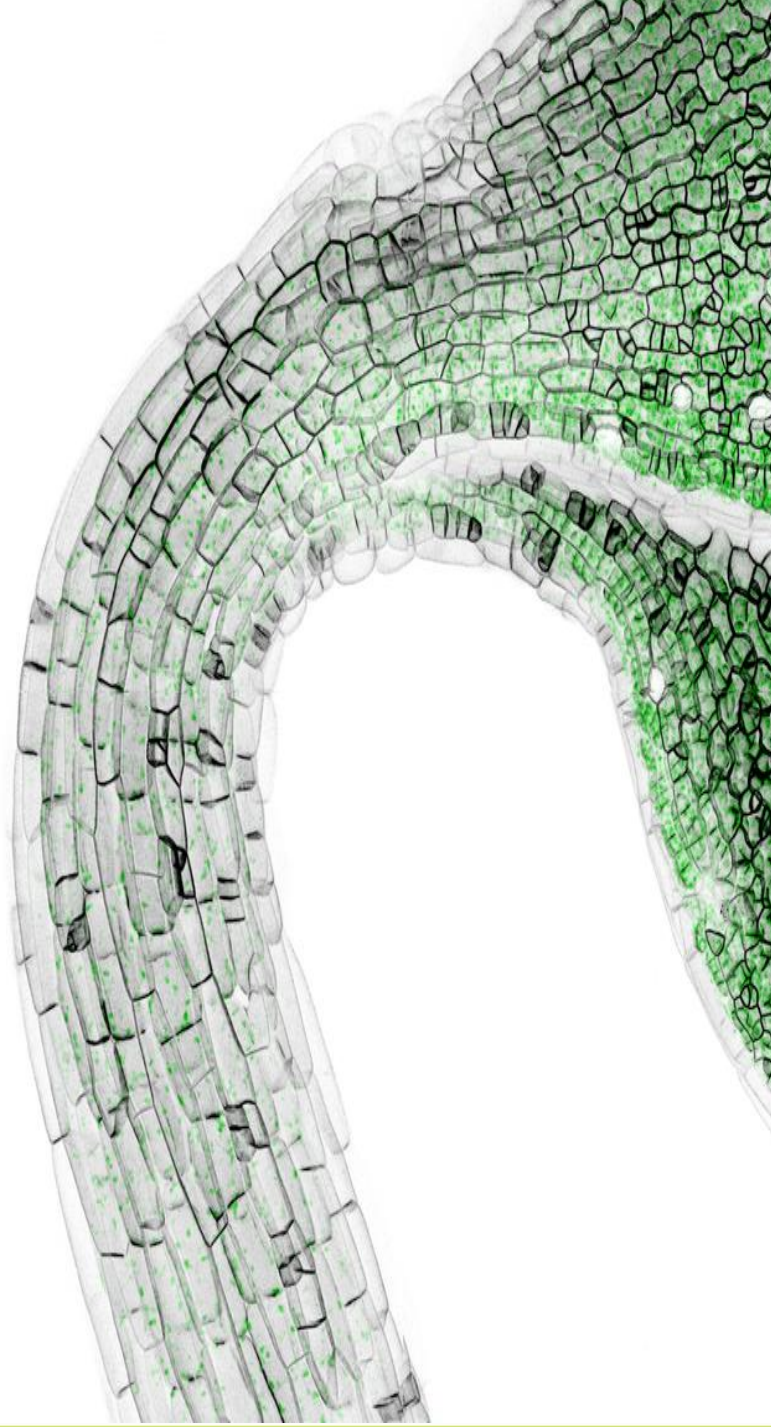


RNAseq



Conclusions

- Gravity vs light stimuli
- The role of light intensity and light quality
- Photomorphogenesis
- Agriculturally-important plants



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Luigi Gennaro Izzo
University of Naples Federico II
luigigennaro.izzo@unina.it

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