



Effect of heavy ions on development, photosynthesis and fruit antioxidant production in Microtom plants: a Space Perspective

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JOURNEY TO MARS

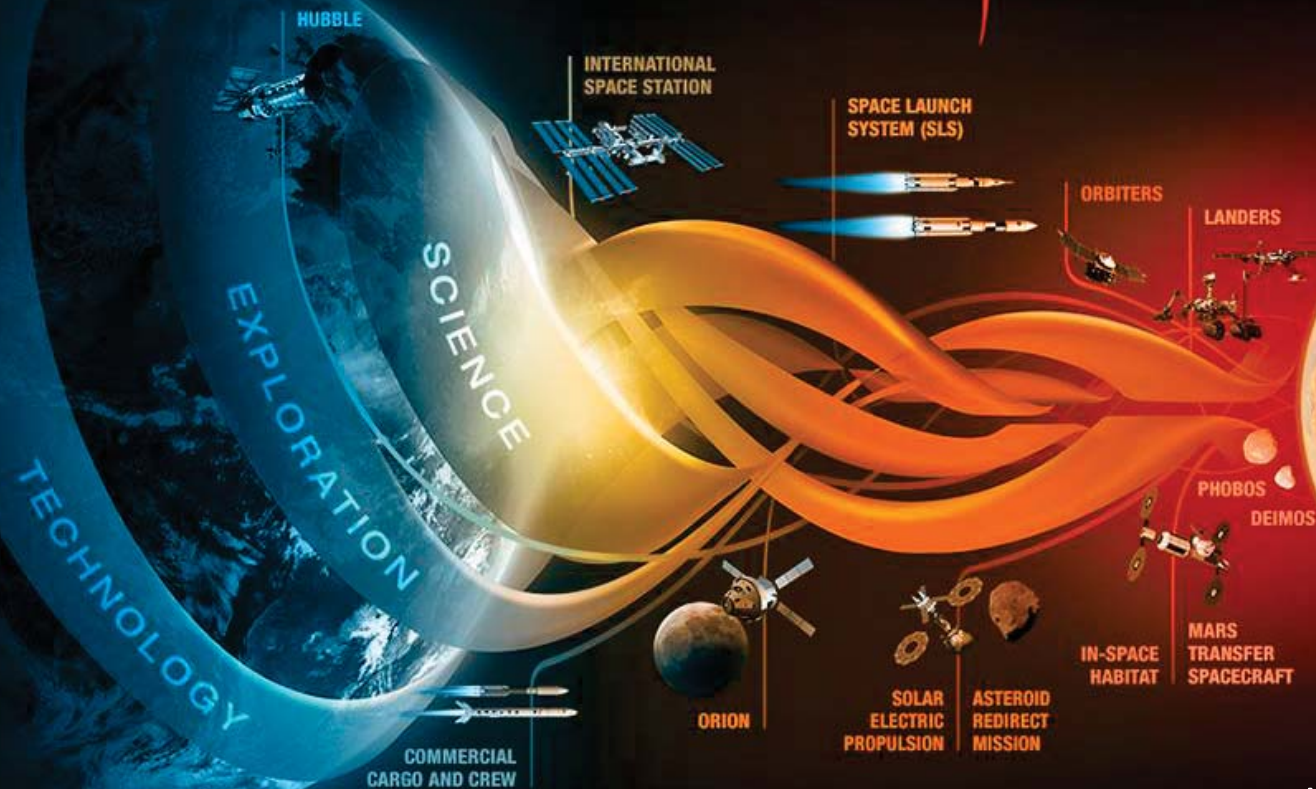
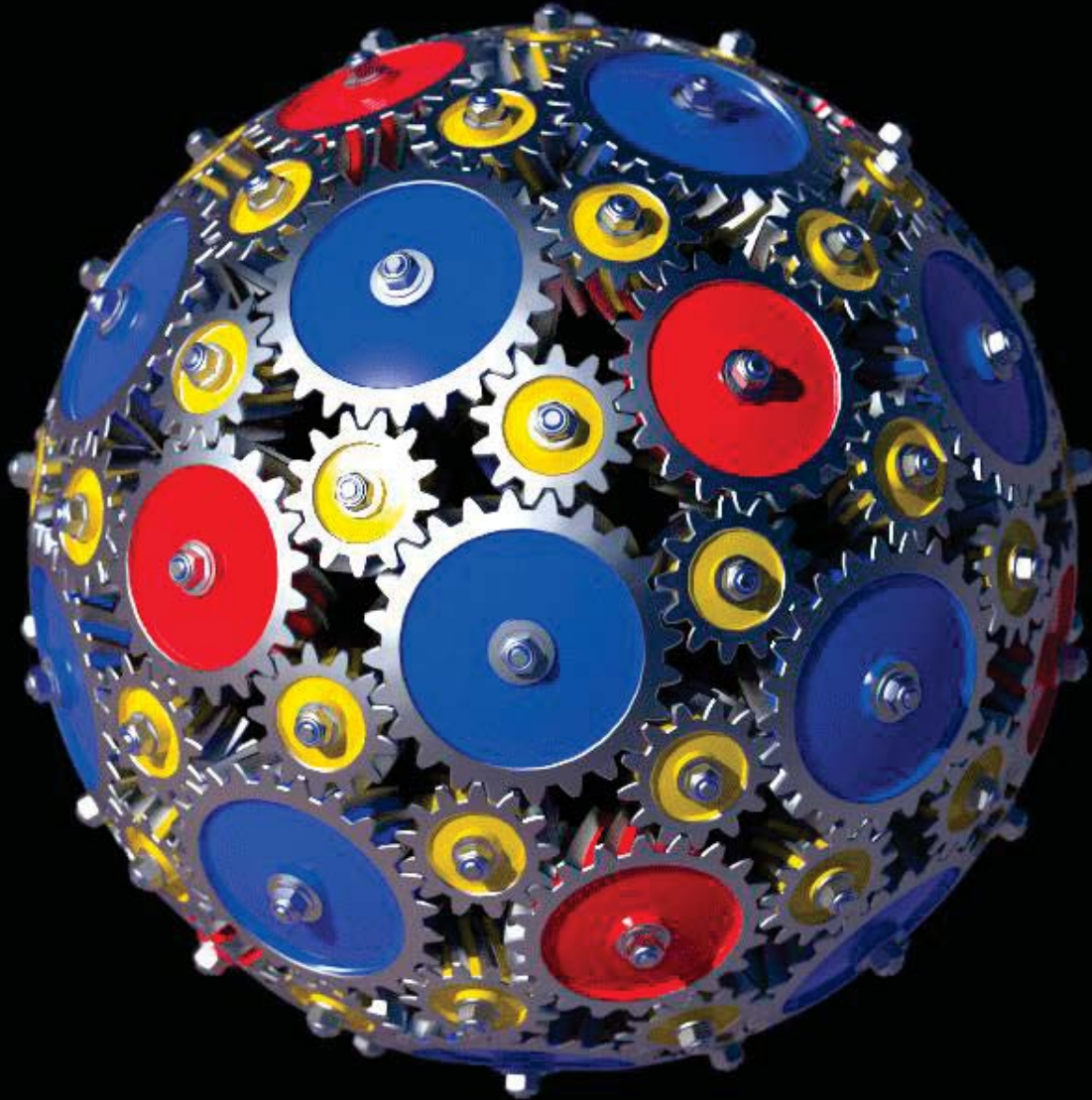


Image credit: NASA

To reach planets in outer Space we need long-term manned missions. The regular supply of resources for the crew is expensive and difficult to be provided by the EARTH

The need to produce food directly in Space

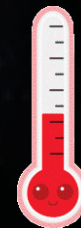
LEARNING FROM THE NATURE: ARTIFICIAL ECOSYSTEMS



ECOSYSTEM FUNDAMENTAL COMPONENTS

ABIOTIC
COMPARTMENT

BIOTIC
COMPARTMENT



THE SPACE ECOSYSTEMS: BLSSs

Bioregenerative Life Support System

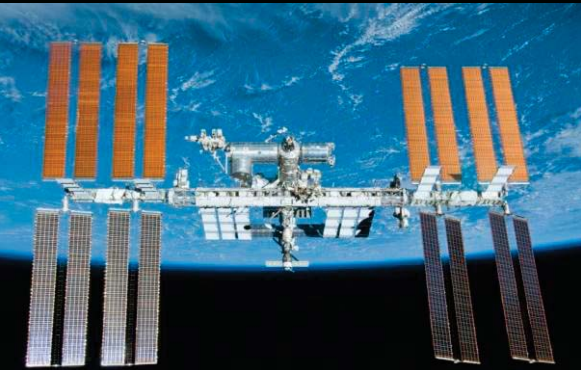
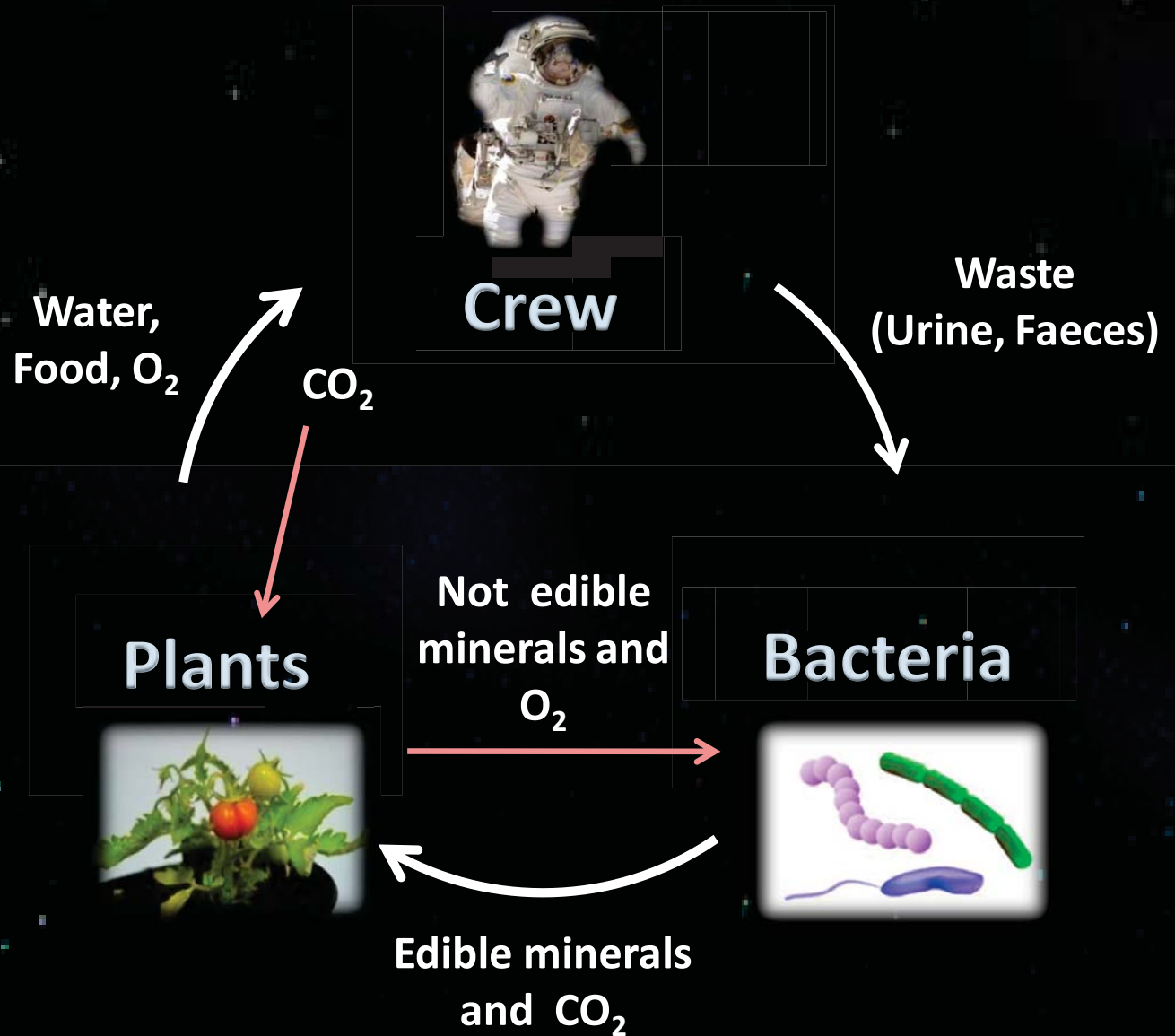


Image credit: NASA



THE SPACE IS RADIOACTIVE: GALACTIC COSMIC RAYS



- Helium (14%)
- High energy nuclei (HZE ions - Ne, Ca, Fe)
- High energy protons (85%)

Norbury et al., 2016. *Life Science in Space Research* 8:38-51

MAY IONISING RADIATION EXCERTS POSITIVE OUTCOMES?

Hypothesis:

not-lethal doses of heavy ions may induce favourable effects on Microtom



Irradiation on dry seeds

- Dose: Ca 25 Gy
- Energy: 200 MeV/u
- LET: 180 KeV/ μm



Growth and leaf anatomy

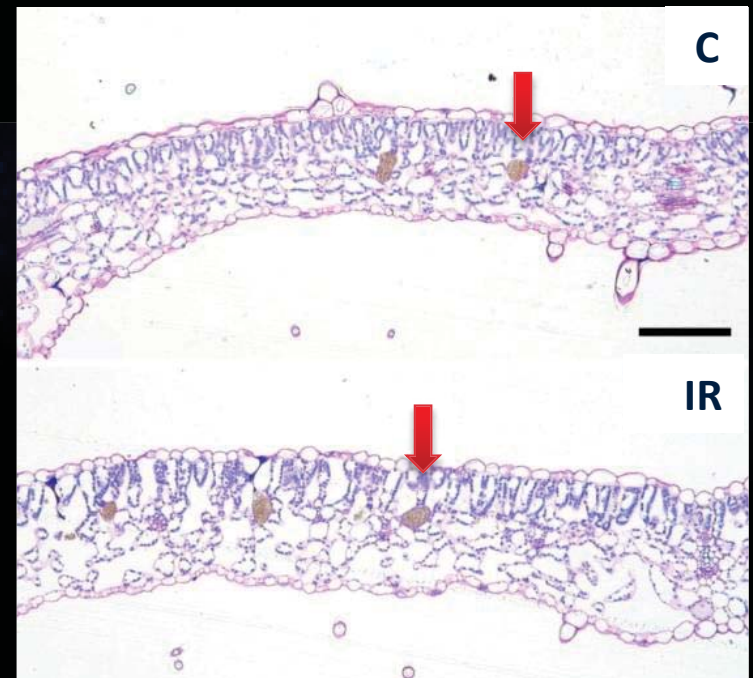
Photosynthesis

Fruit antioxidants

PLANT GROWTH AND REPRODUCTION

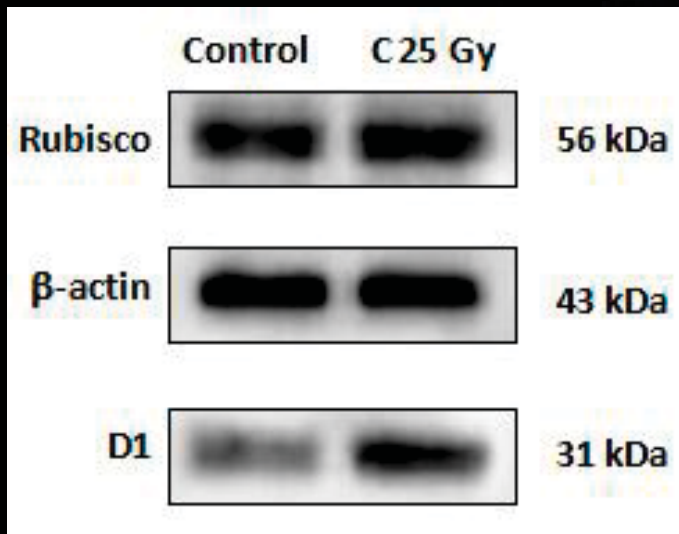
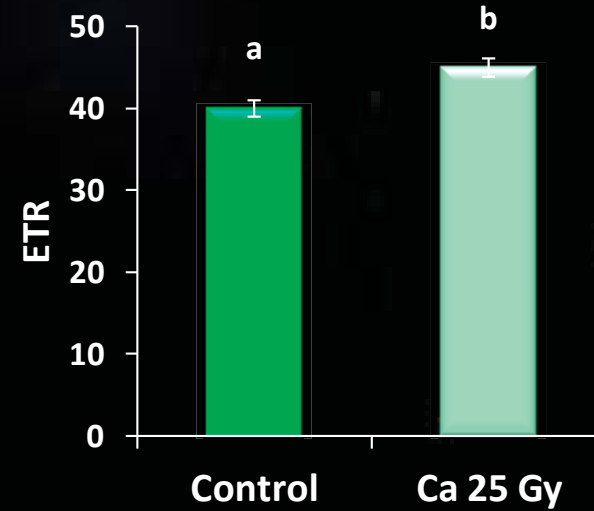
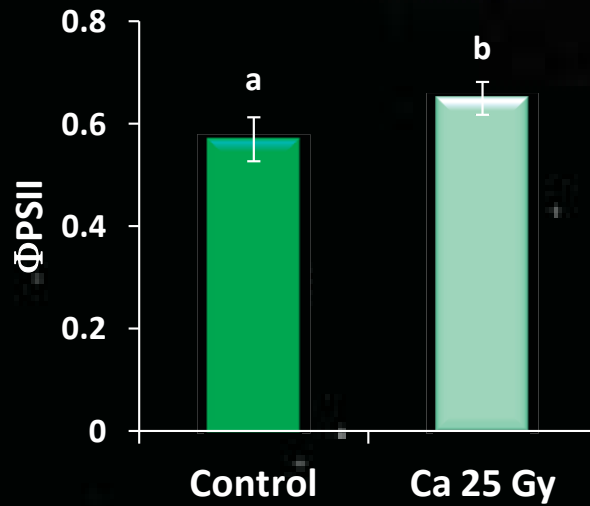


| | Control | Ca 25 Gy |
|---------------------|----------------|----------------|
| Germination % | 100 % a | 80% a |
| Flower number | 16.2 ± 0.84 a | 8.0 ± 0.34 b |
| Fruit number | 23.0 ± 1.00 a | 11.0 ± 0.52 b |
| Fruit diameter (cm) | 0.16 ± 0.001 a | 0.24 ± 0.001 b |
| Dry biomass (g) | 2.90 ± 0.07 a | 2.00 ± 0.04 b |



Presence of calcium oxalate crystals

PHOTOSYNTHESIS



Proteins involved in photosynthesis

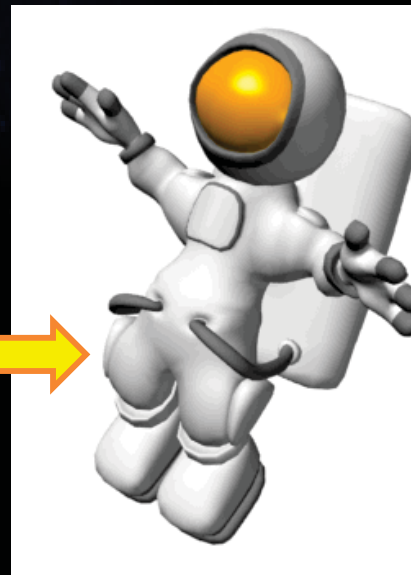
ANTIOXIDANT PRODUCTION



| | Control | Ca 25 Gy |
|---|----------------|----------------|
| Ascorbic Acid Content (ng ml ⁻¹) | 30.4 ± 0.68 a | 38.9 ± 1.27 b |
| Total Carotenoids (mg g ⁻¹ FW) | 29.1 ± 4.87 a | 59.7 ± 7.96 b |
| Anthocyanin Content (mg g ⁻¹ FW) | 132.3 ± 9.53 a | 170.1 ± 4.96 b |



Increase of
antioxidants



Beneficial
outcomes for the
astronaut' diet

TAKE HOME MESSAGE

In Calcium 25 Gy irradiated plants:

1. Life cycle completed *from seed to seed*
2. More compact plant size
3. Improved performance of photosynthetic process
4. Largest berries with significant increase of carotenoids, ascorbic acid and anthocyanins levels

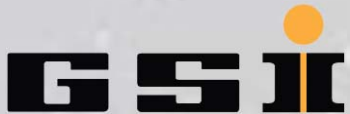


Microtom plants irradiated with Ca 25 Gy perceive ionising radiation as a stimulus to produce antioxidants and secondary metabolites to protect cells

Opportune shield procedure on space platform may reduce ionising radiation to doses useful rather than detrimental for plants

Thank you for your attention!

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