Microscopes, jellyfish, and growing plants in space

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My Journey from the Philippine Islands to the Florida Space Coast

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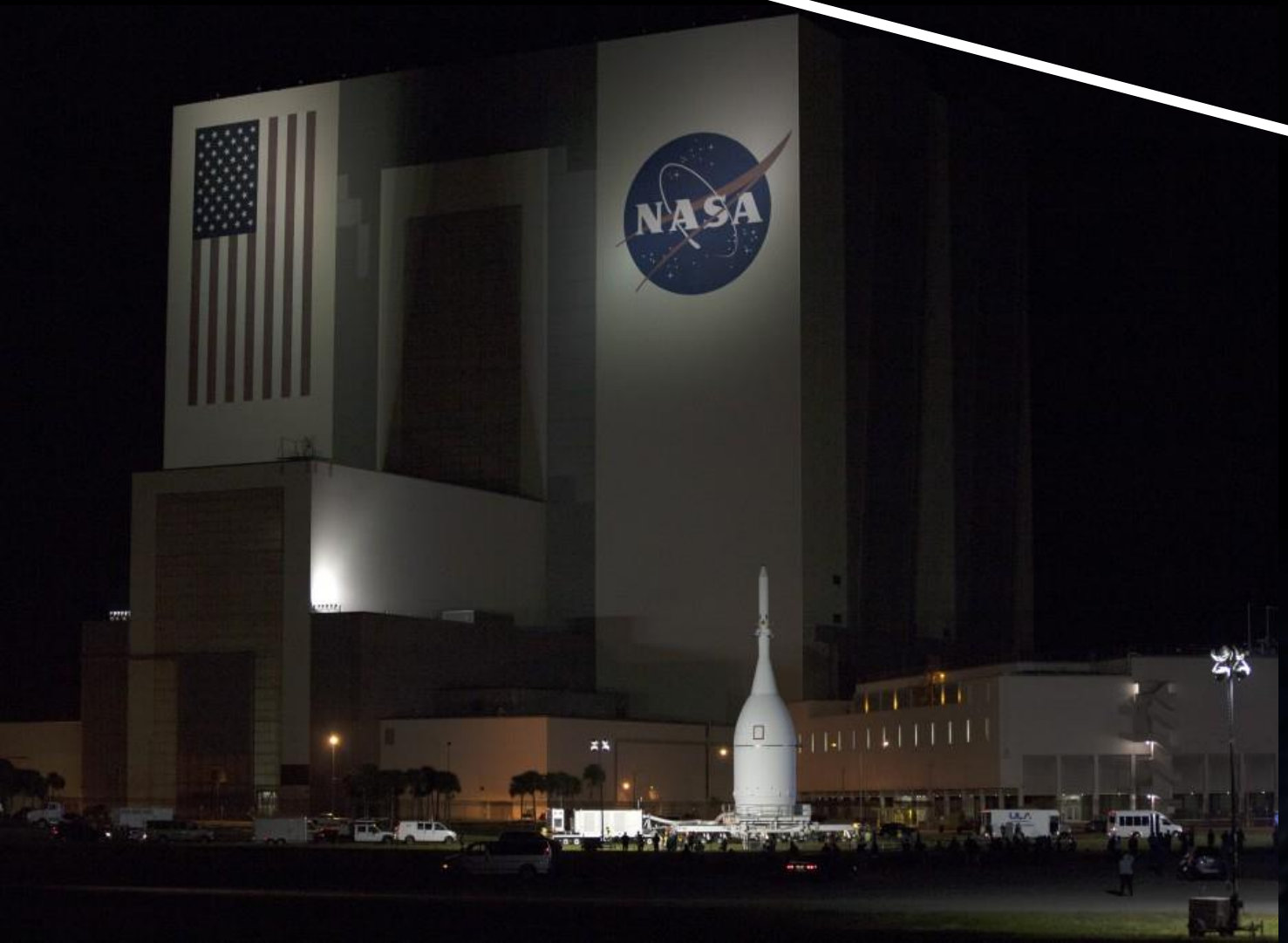
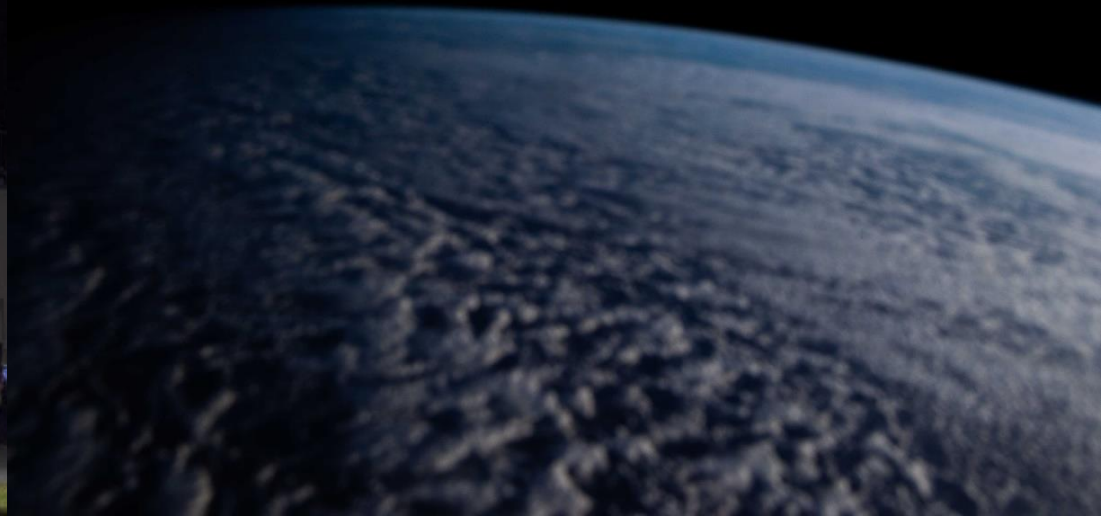
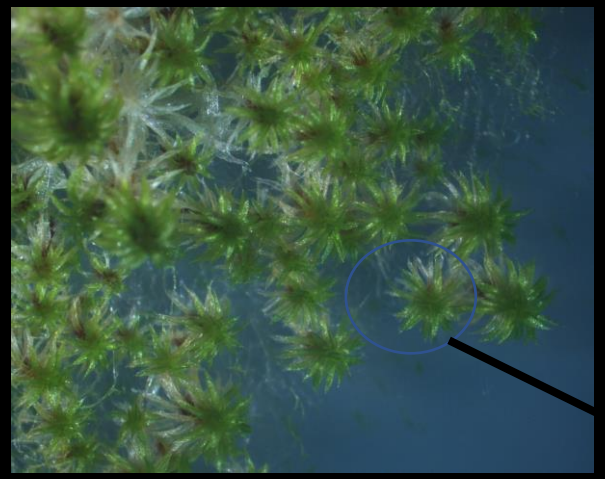
The Florida Space Coast

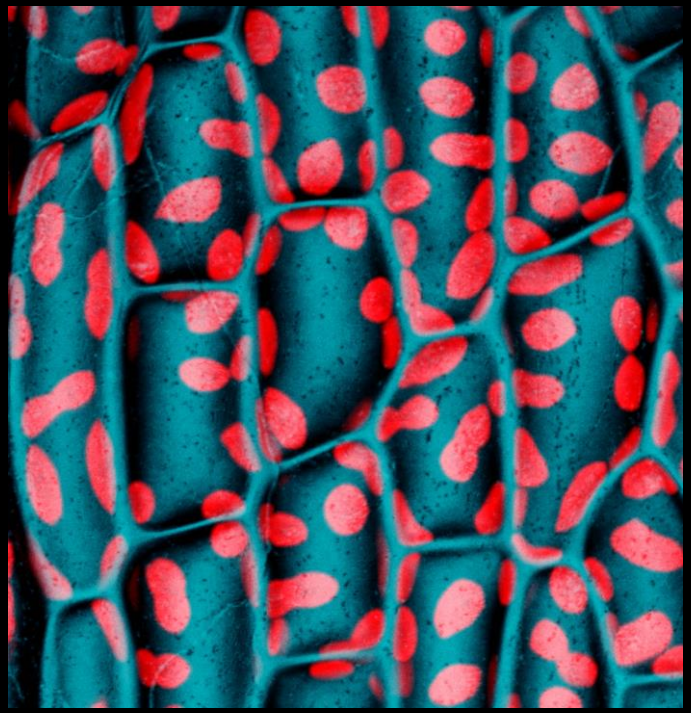




We use microscopes to understand how plants grow and develop

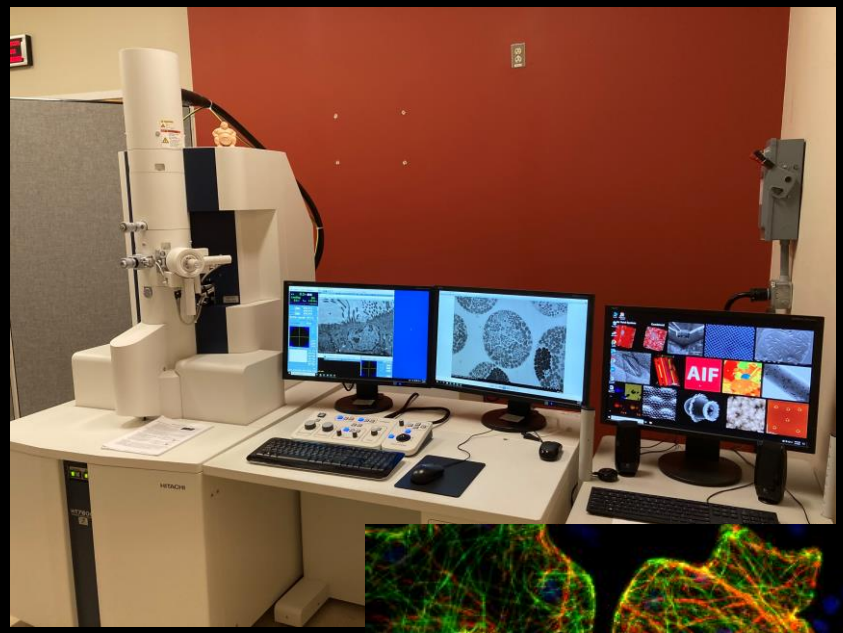


We use microscopes to study plants at the level of a single cell

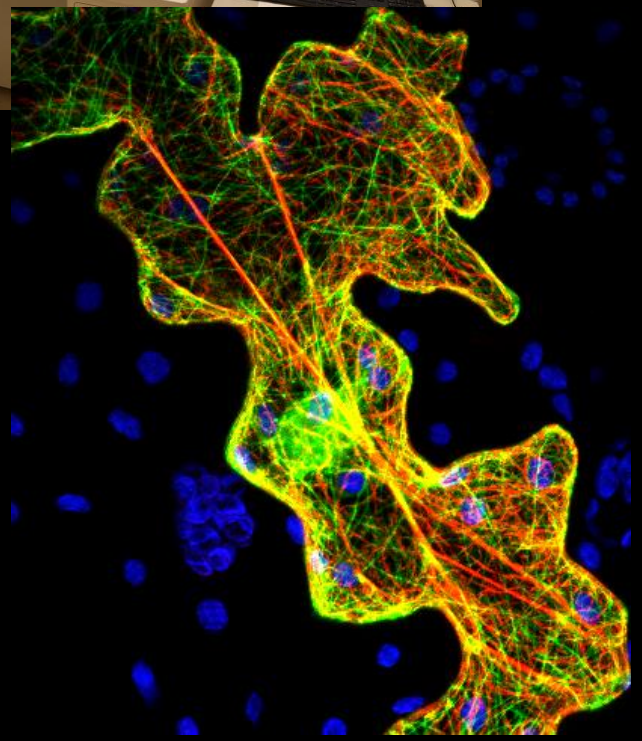


Microscopes are getting better every year

They are controlled by powerful computers that can process lots of digital images



New ways to label plant cells



Science (biology) questions that can be asked with microscopes have changed because of advances in technology

Early microscopes

What do things look like?

Where are things located?

Modern microscopes

Where are things going?

How are things associated with each other?

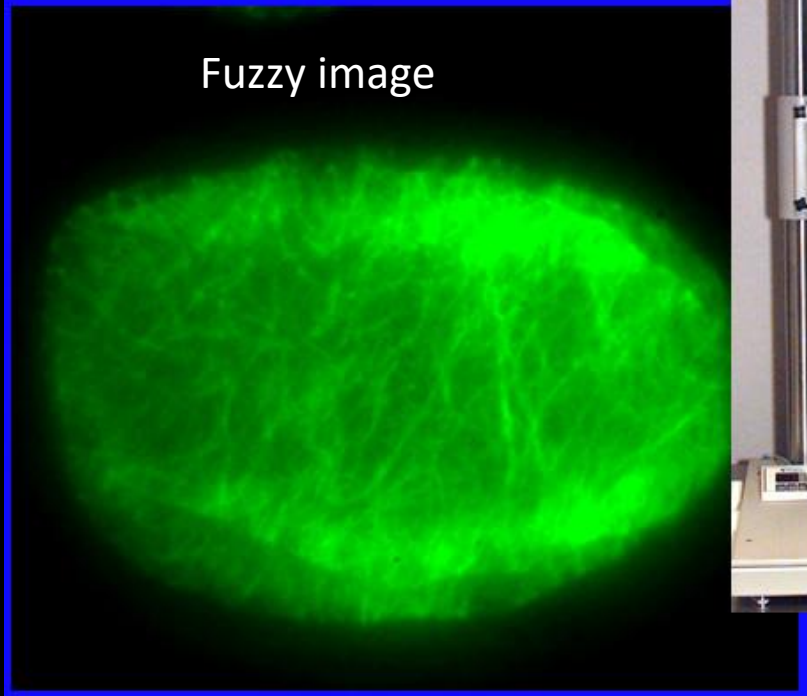
What is going on in a living cell?

My favorite microscope is called a confocal microscope

A confocal microscope improves how we see cells

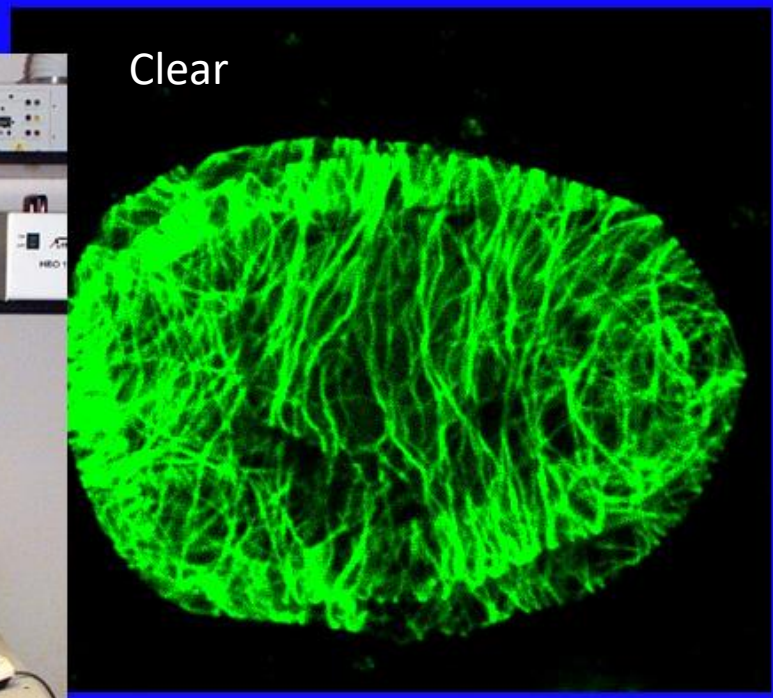
non-confocal microscope

Fuzzy image



confocal

Clear



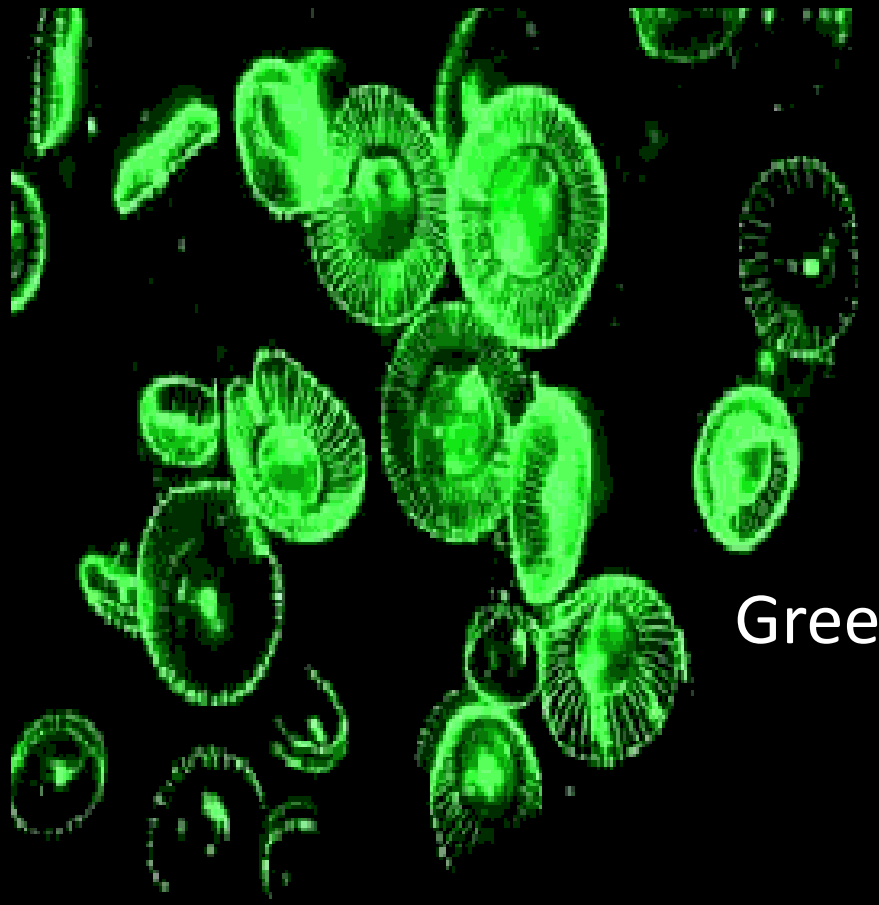
Uses a laser as a light source

A confocal microscope slices through a part of a plant (optical sections)

To create a 3-D image

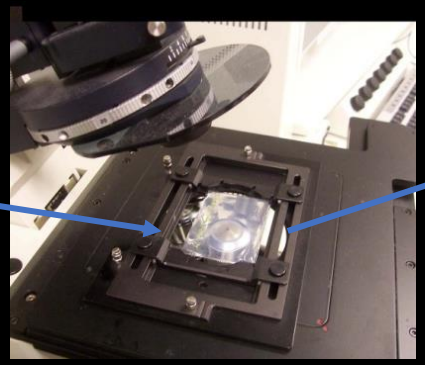
New ways to mark cells and parts of the cell

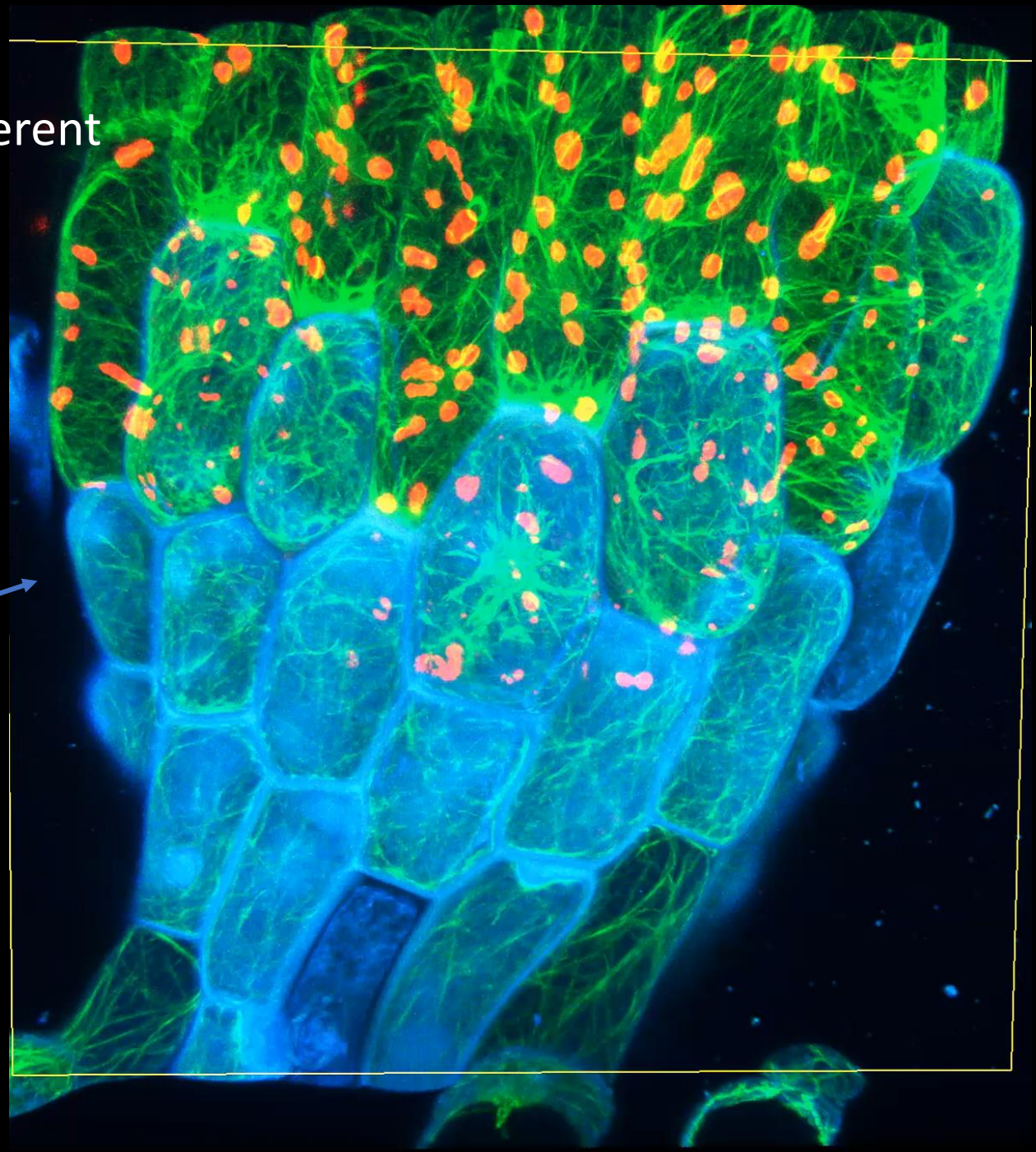
This is where the jellyfish comes in



Green Fluorescent Protein (GFP)

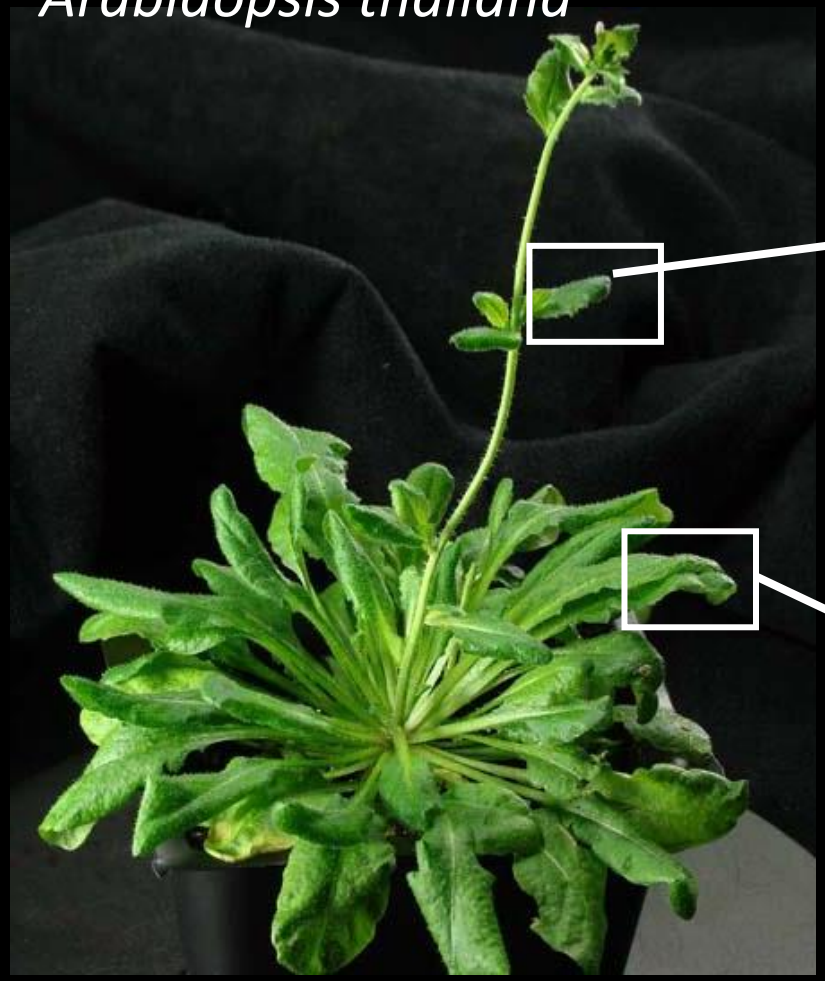
Sectioning with light using a confocal microscope, GFP, and dyes to mark different parts of the plant

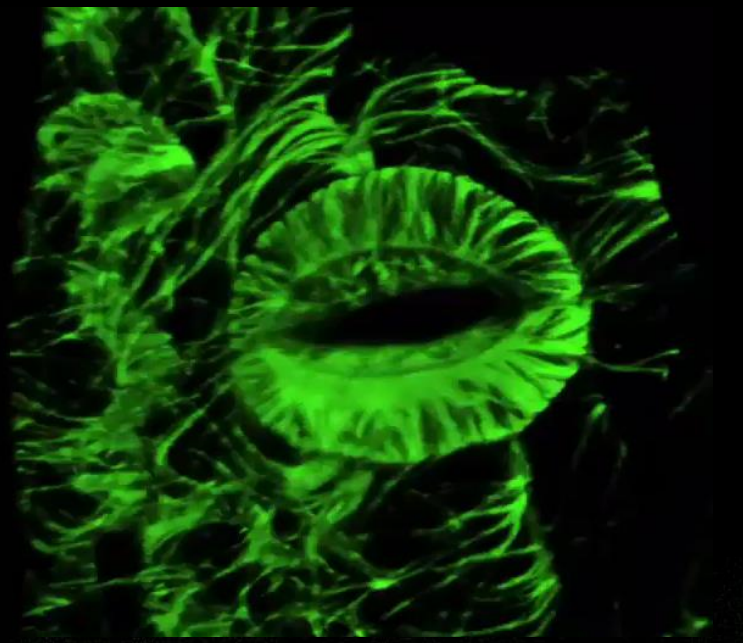


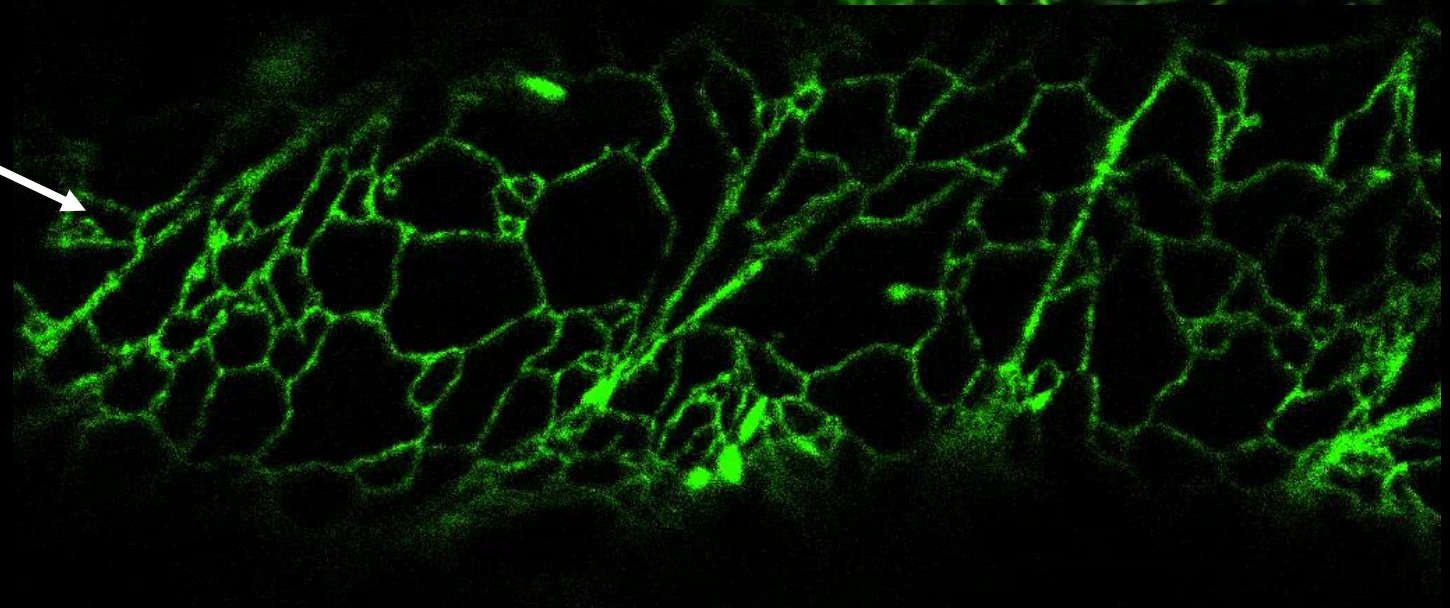


Uncovering fine structure and dynamics of plant cells using a confocal microscope and GFP

Arabidopsis thaliana

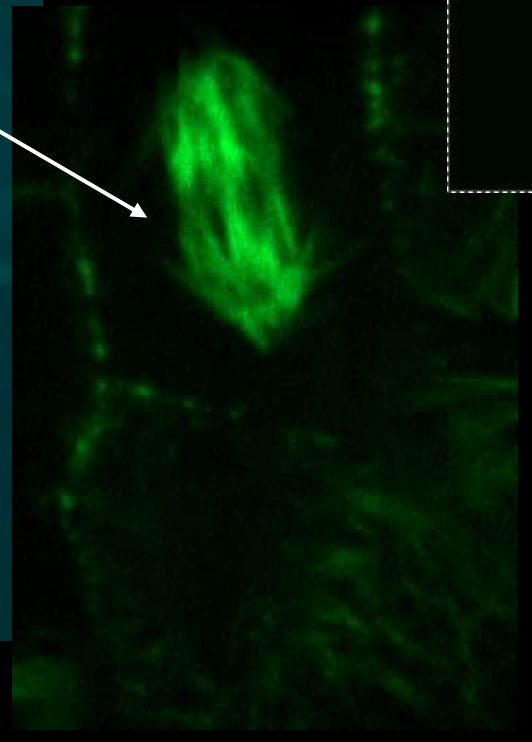






Microscopes and GFP reveal secrets about how plants grow

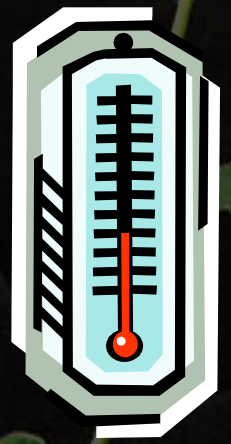
Arabidopsis seedlings



We can use microscopes and GFP sensors observe how cells within a root communicate with each other

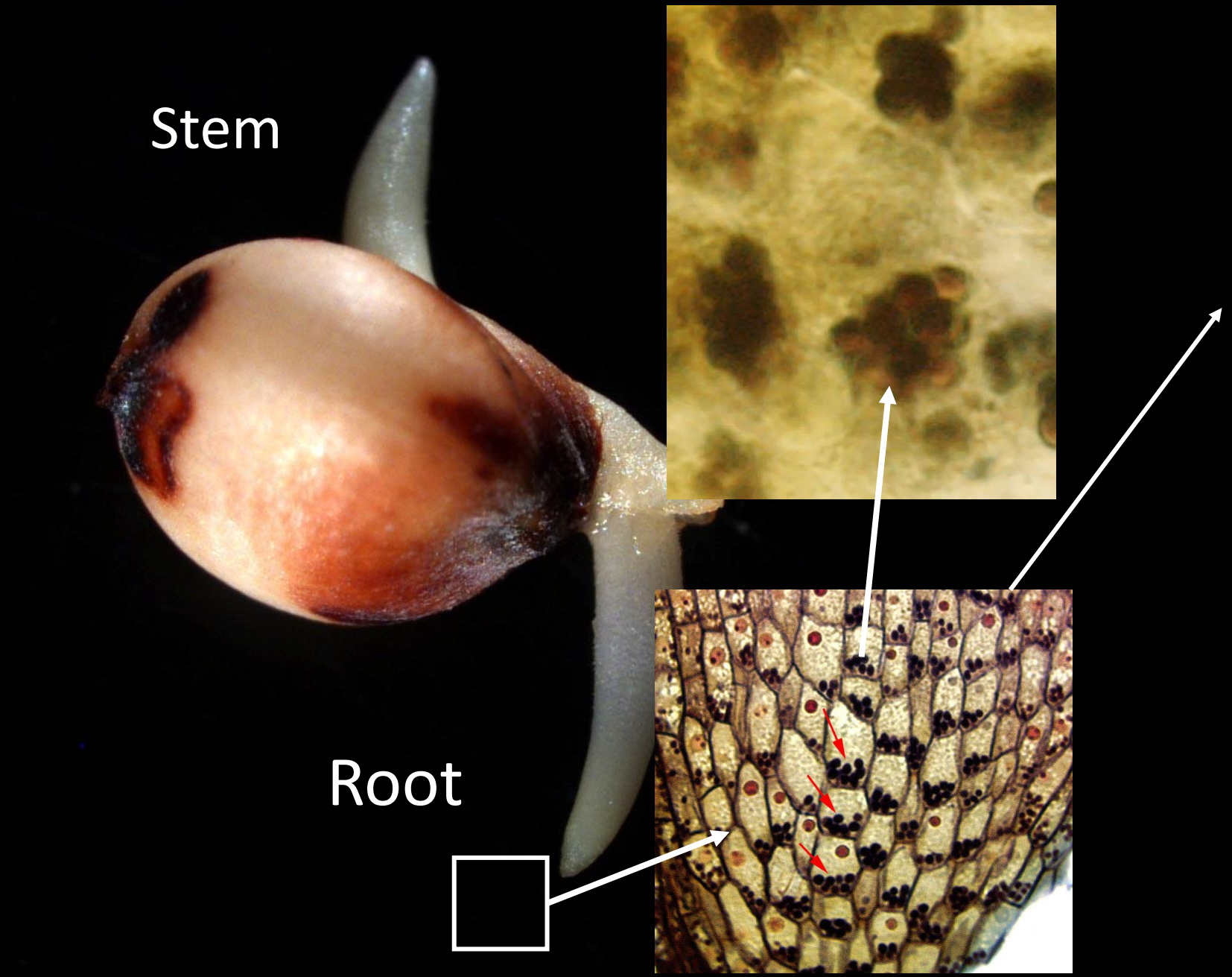
GFP-based calcium sensor genetically engineered into roots

What do we need to know about plants so we can use them effectively space?



O_2 CO_2

How do roots know the way down and stems the way up?

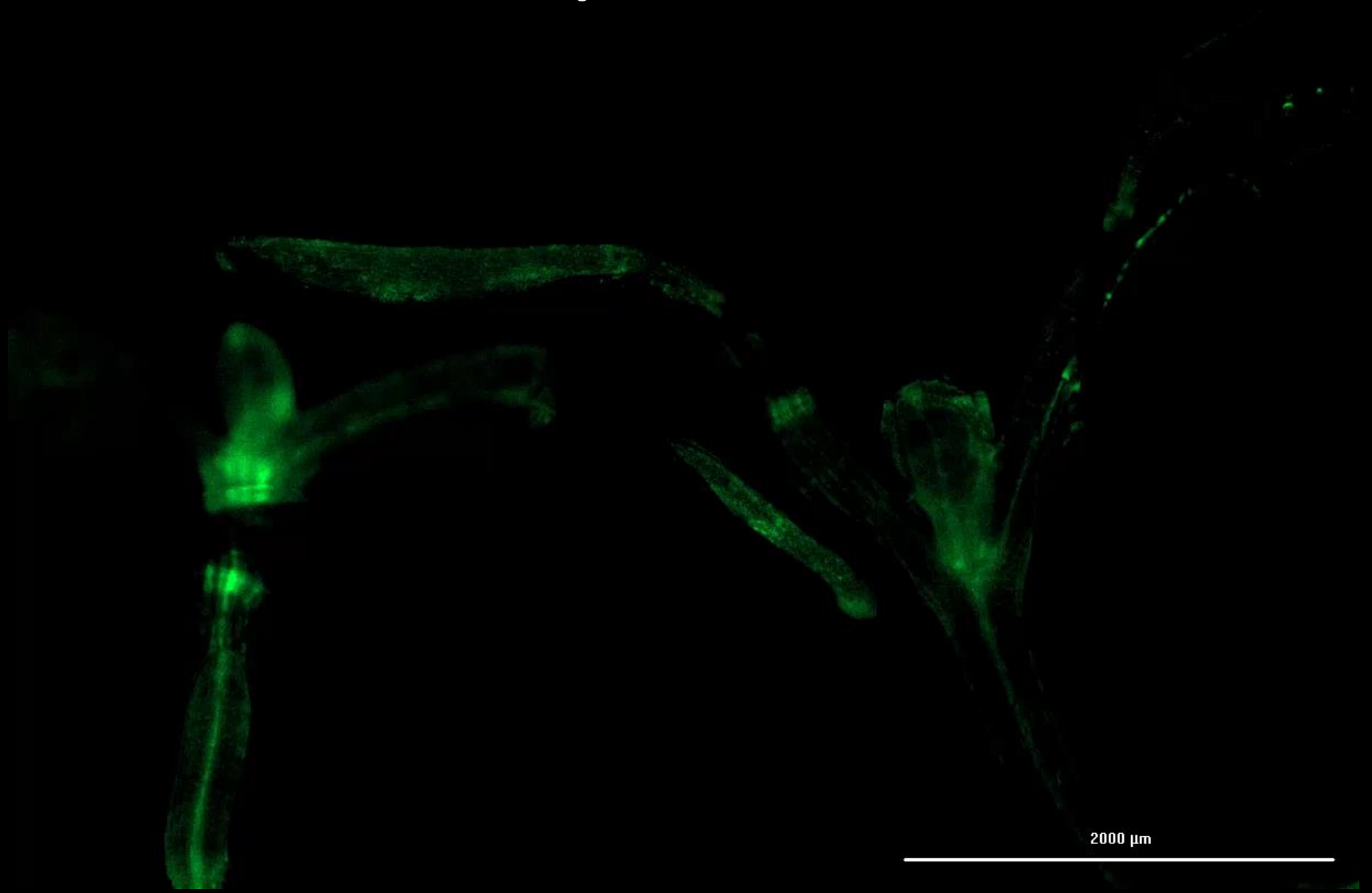


Gravitropism

How do plants “know”, how and where to grow without gravity to guide them?

Tropism – growth of a plant toward or away from something in the environment

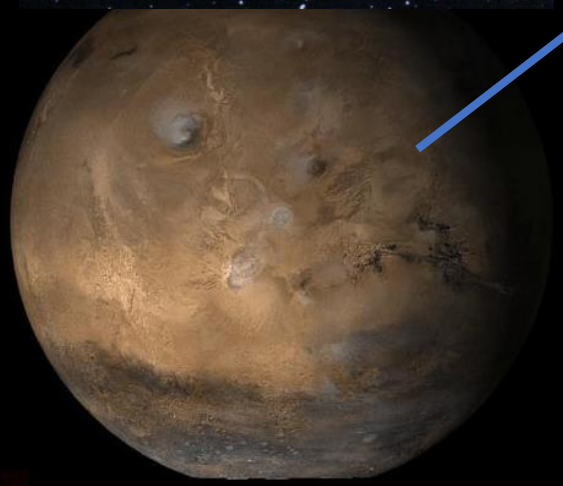
Do plants feel?



Why grow plants in space?

- Food
- Keep astronauts happy
- Provide oxygen
- Water

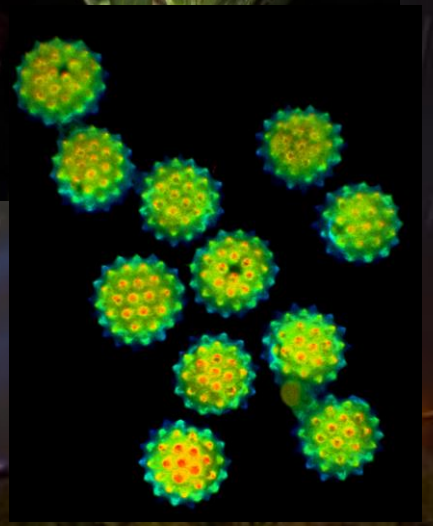
Packing for Mars

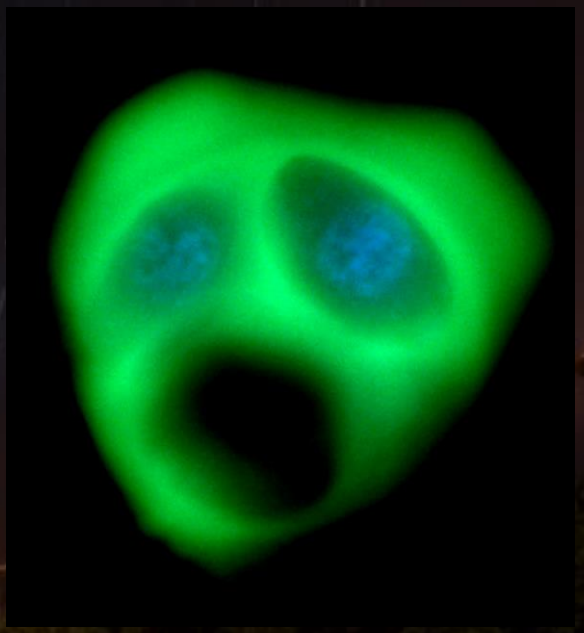


What other questions do we have to ask to more efficiently grow crops in space?

Is flowering and seed production affected by the space environment?

How will plants pollinate in an environment without wind or insects?





How will the radiation environment of deep space, such as on a mission to Mars, affect seeds and the next generation of plants?

Knowledge about how plants do what they do at the level of single cells can guide us with strategies to grow crops in space and on Earth

Knowledge can help predict how plants will respond to novel stresses on Earth, such as climate change, pollution and harsh environments.

Modern microscopes and jellyfish have provided us with new knowledge about how plants do what they do at the cellular level

It is expected that this knowledge will enable humans to thrive in space through the many benefits that plants provide