

# Agri-food nanotechnologies: status and perspectives



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# Traditional method

## Pesticide administration



**Dissolution in water**  
nebulisation on plants of the water solution

Ossidation

Fotossidation

Biodegradation

Leaching

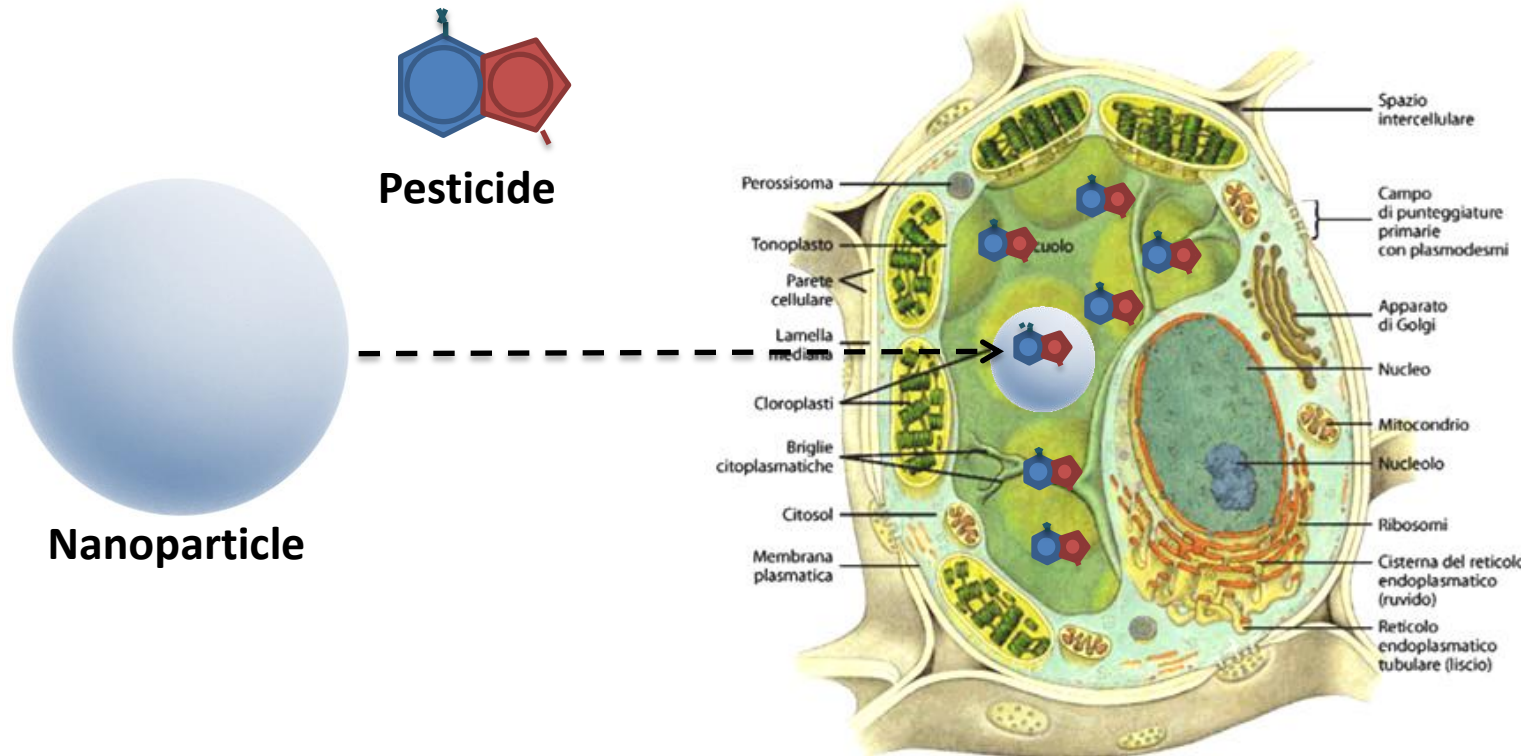


Soil  
pollution

Water  
pollution

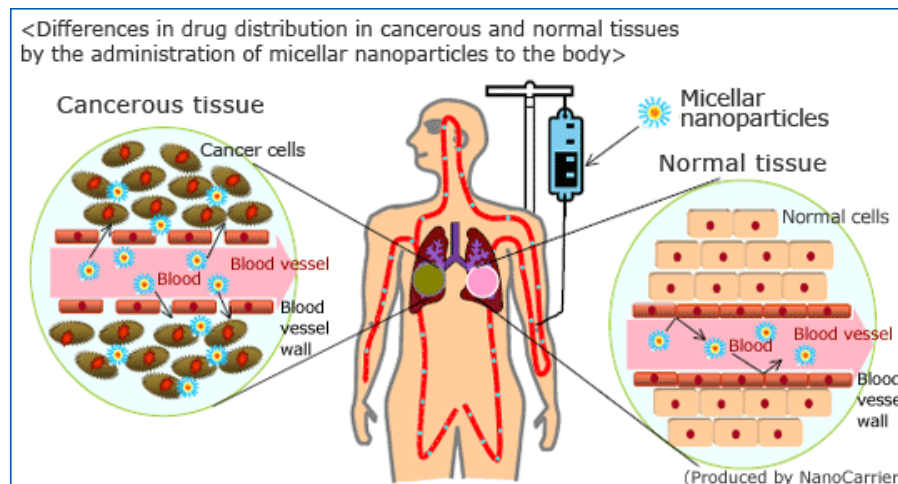
# Nanobiotechnology

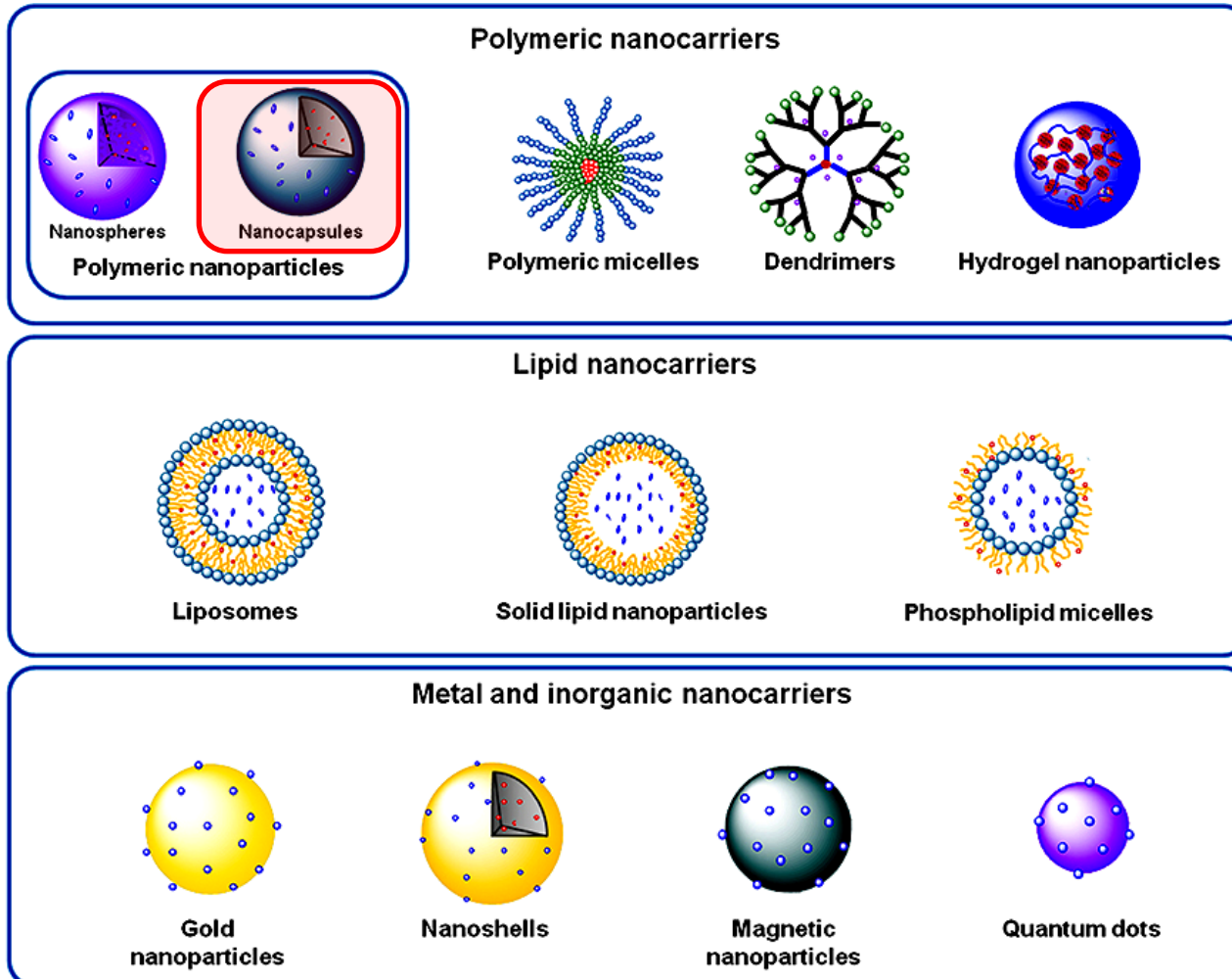
## Pesticide administration through nanocarrier



An important application of nanobiotechnology is the use of nanocarriers for the delivery of bioactive compounds

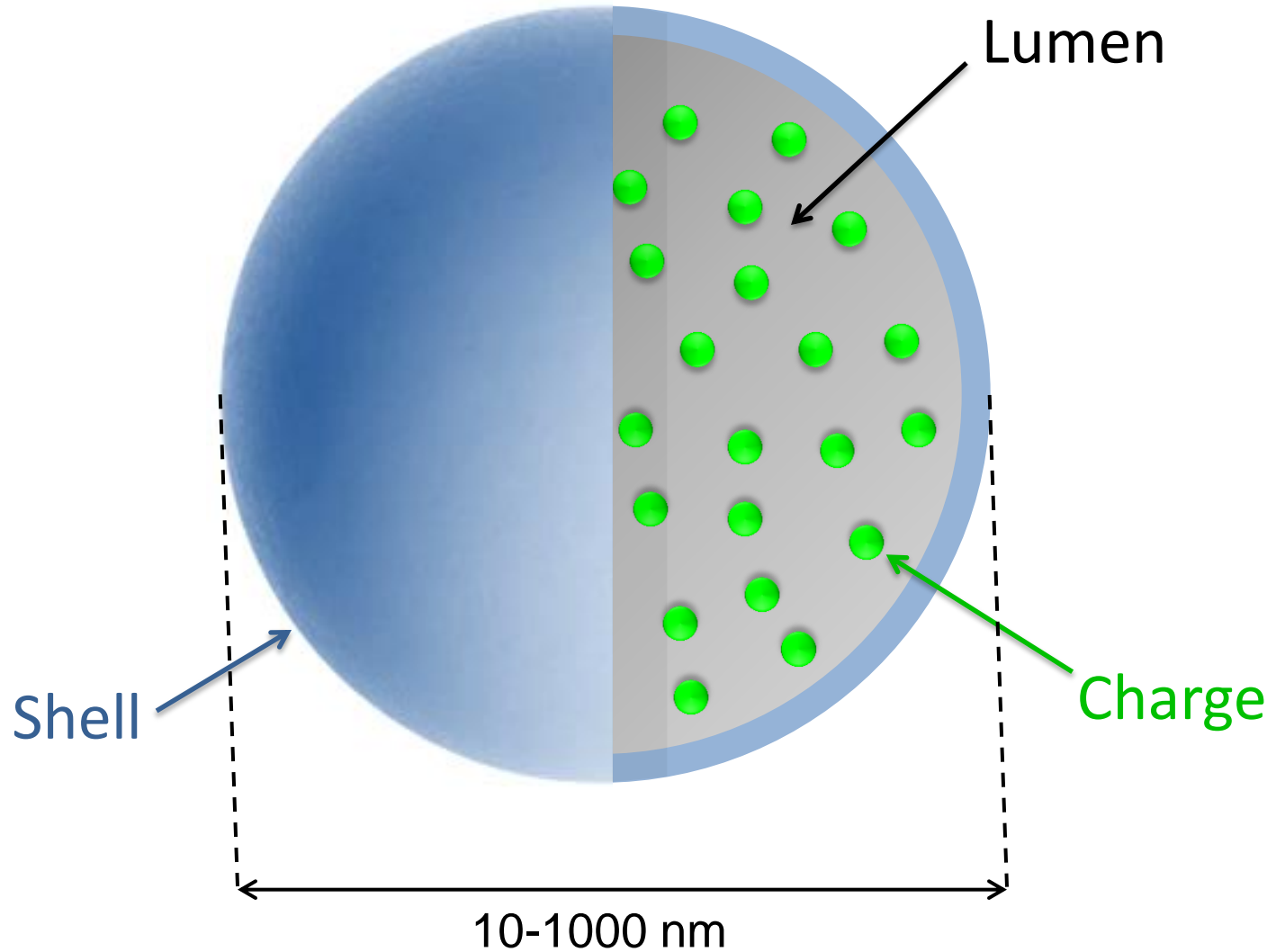
Up today, the nanobiotechnology has been studied mainly in biomedical field





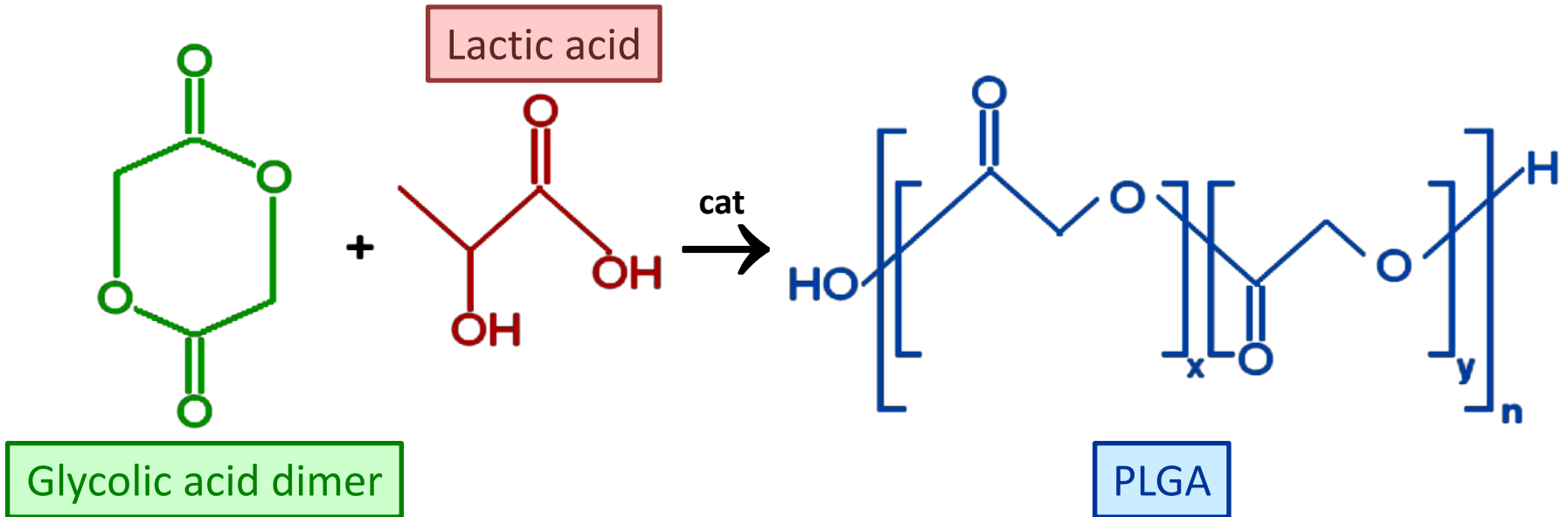
# Nanoparticles

## Polymeric nanocapsules



# The biopolymeric shell

## PLGA [Poly(Lactic-co-Glicol Acid)]



**Biocompatible**

**Approved by FDA for medical purpose**

**Biodegradable**

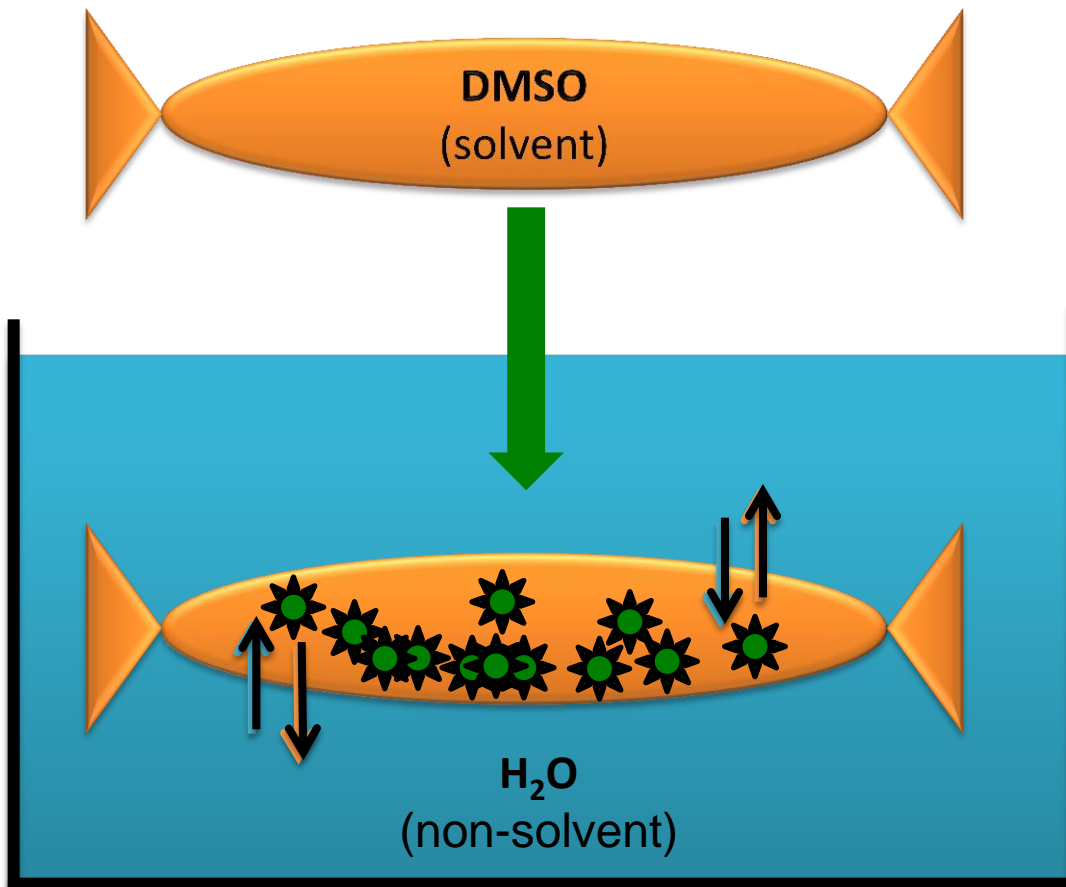
**Atoxic**

**Ecofriendly**

**Recognized as safe for humans by WHO**

# Synthesis of PLGA nanoparticles

## Osmotic method



A DMSO solution containing PLGA and the substance to encapsulate is placed in a dialysis bag

The dialysis bag is immersed in a non-solvent of PLGA

diffusion of the solvent and non-solvent through the membrane

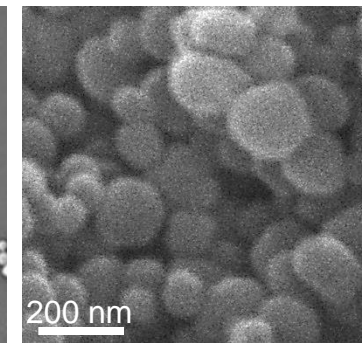
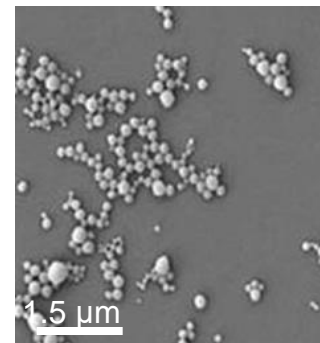
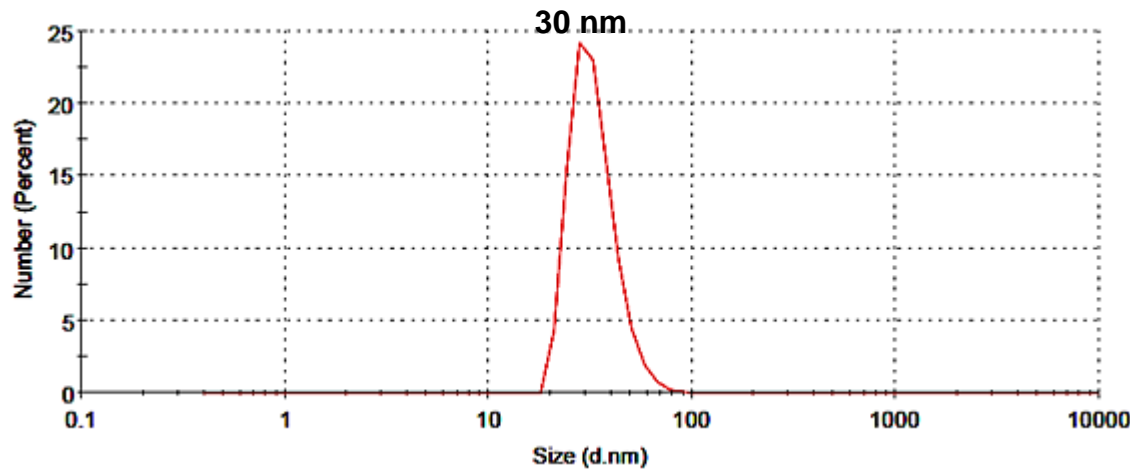
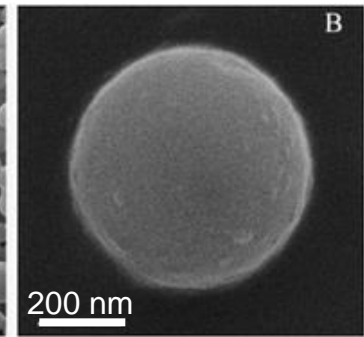
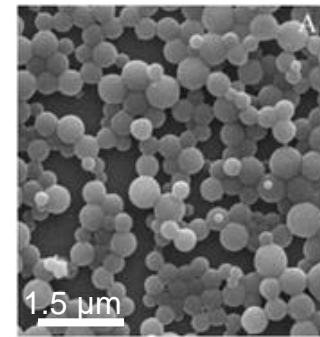
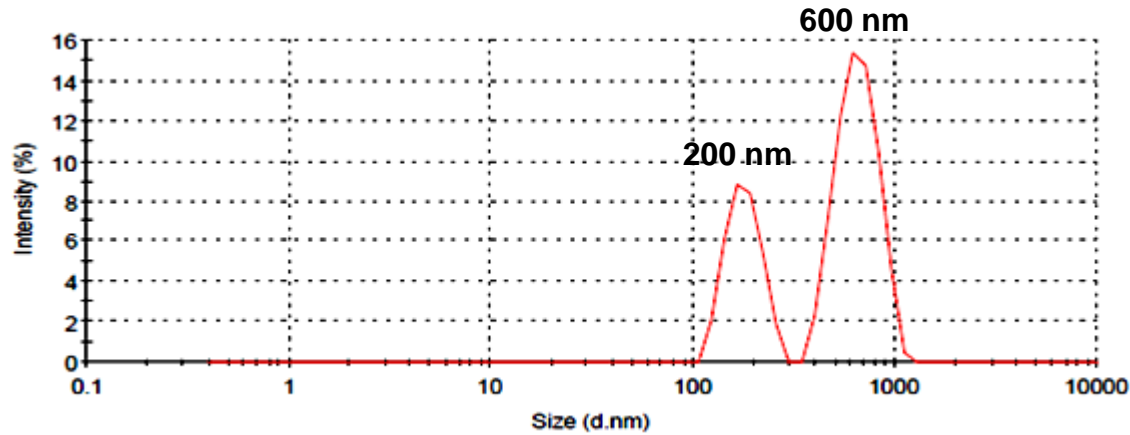
PLGA precipitation → NPs formation → entrapment



# Nanoparticle size



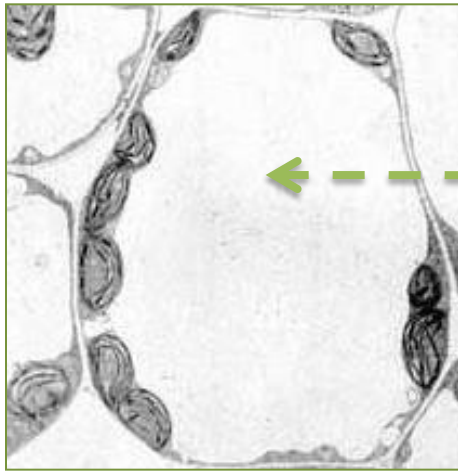
## Dynamic Light Scattering (DLS) and SEM analysis



# Cellular uptake

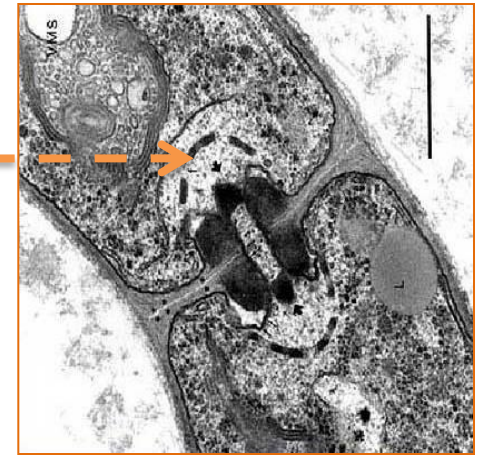
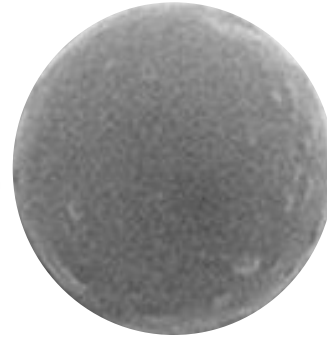


Are NPs able to cross the cell wall and the cell membrane?



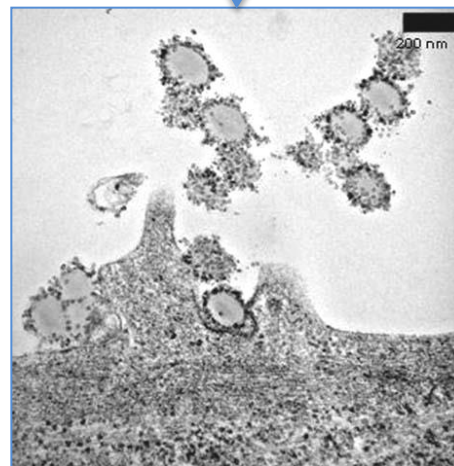
Plant cell

Schrade et al. 2013



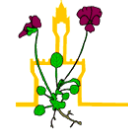
Fungal cell

Macromolecular Bioscience  
12: 1459-1471

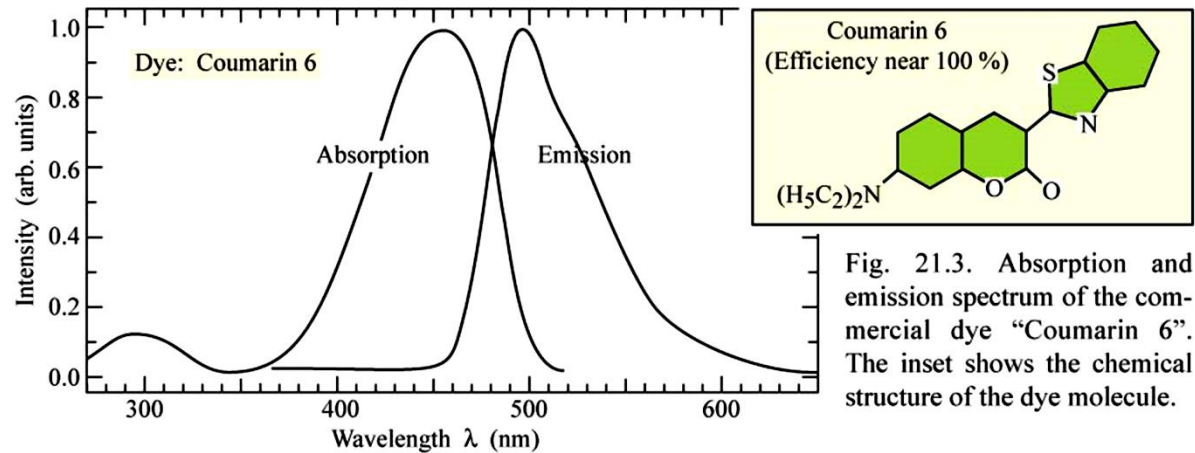
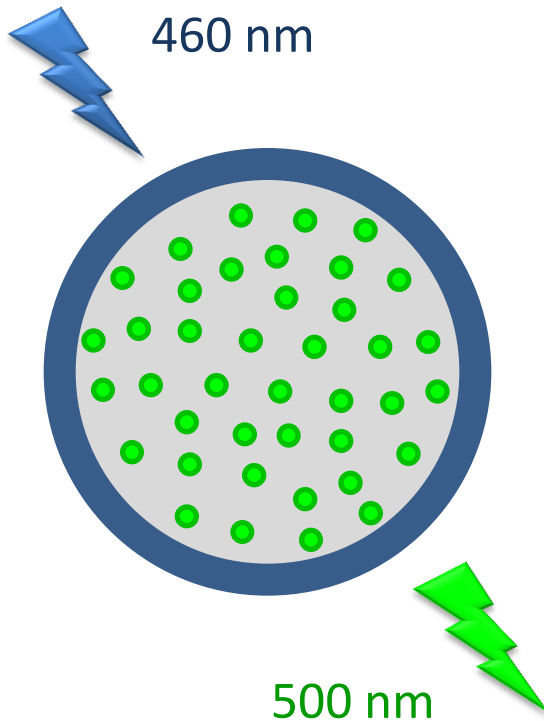


Animal cell

# Cellular uptake



Are NPs able to cross the cell wall and the cell membrane?

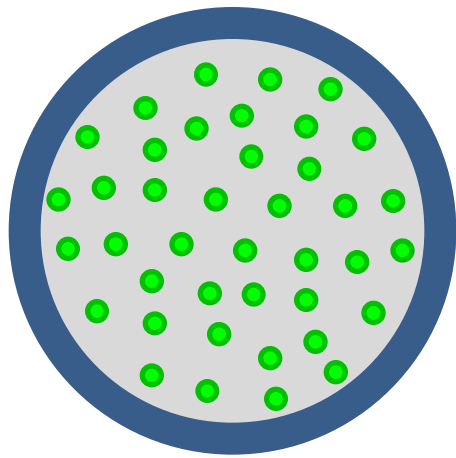


NP tagged with the high fluorescent probe coumarin-6

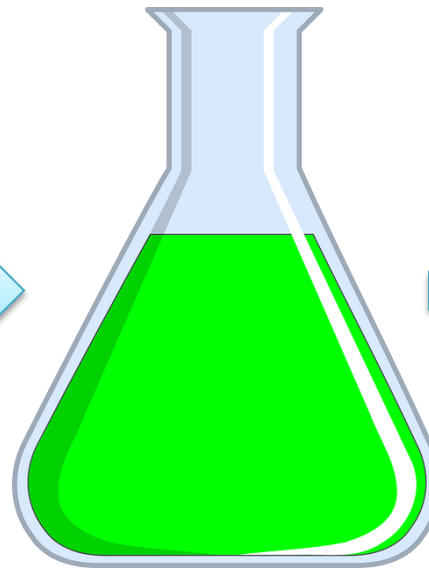
## Cellular uptake



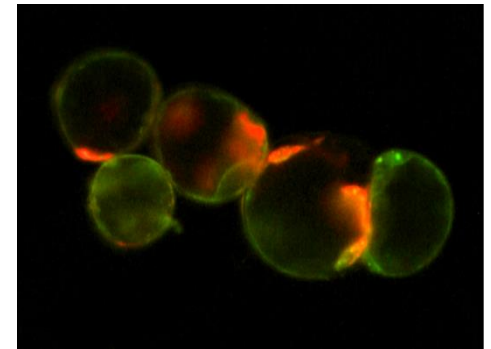
Are NPs able to cross the cell wall and the cell membrane?



NP tagged with a fluorescent probe



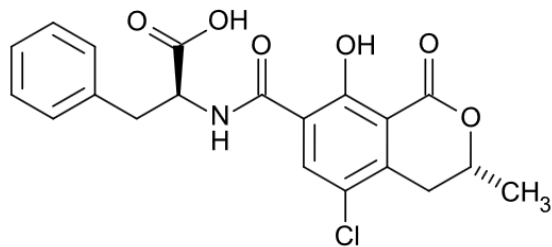
NP administration to grapevine cell cultures



Fluorescence analysis

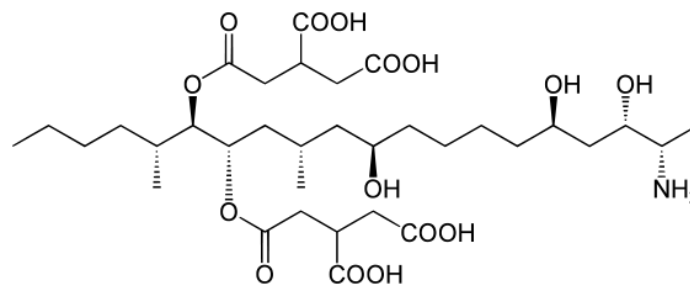


Infection of plants by pathogenic fungi → reduction in crop yield and quality + mycotoxin contamination of grape and wine



**Ochratoxin A**

*Aspergillus* spp., *Penicillium* spp.



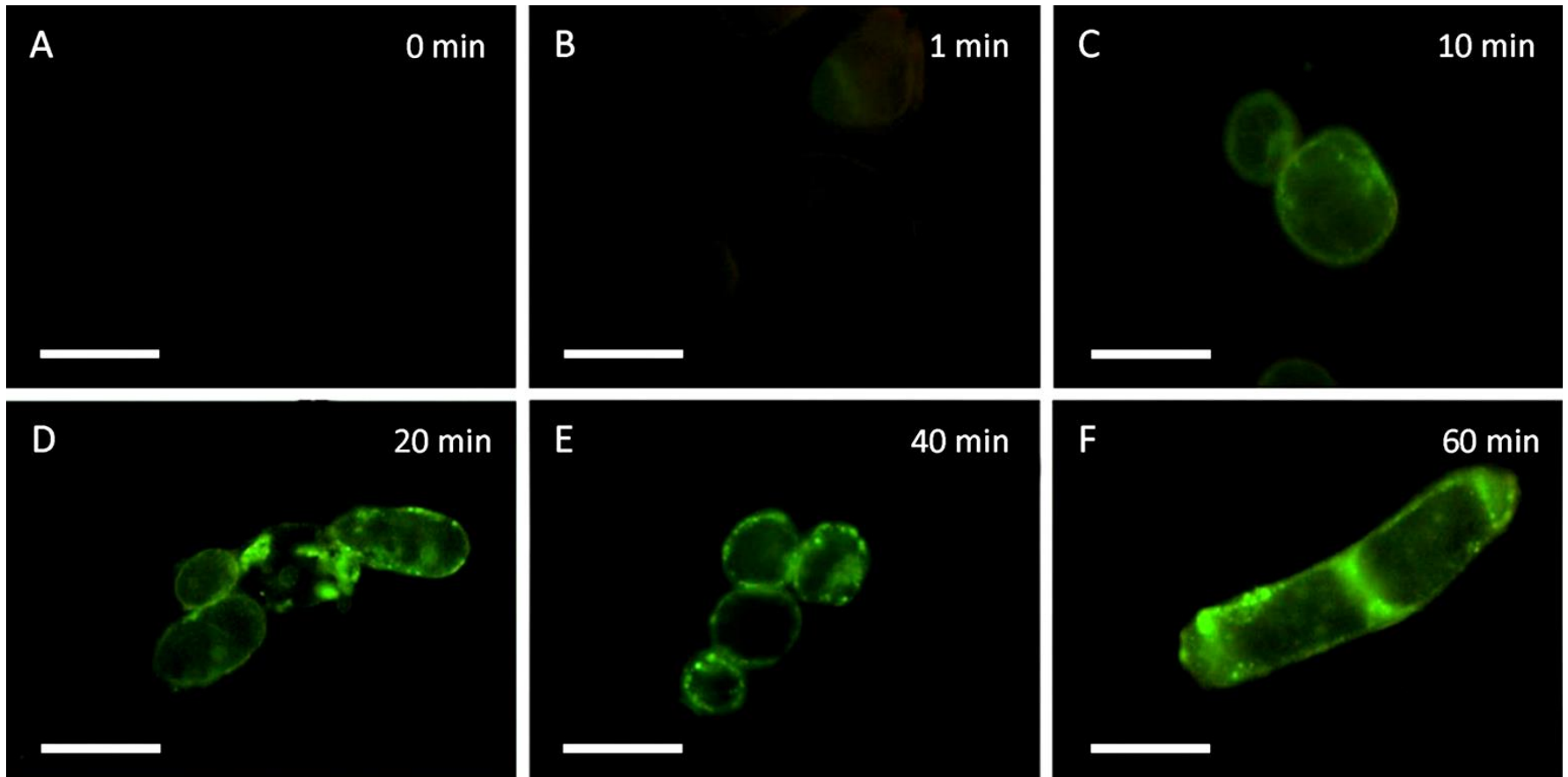
**Fumonisin B**

*Fusarium* spp.

# PLGA-6-coumarin-NPs in grapevine cell suspension



- NPs cellular uptake starts few minutes after the administration
- Little fluorescent bodies begin to be visible after 5-10 minutes
- Later on, an increase in size of fluorescent bodies can be observed

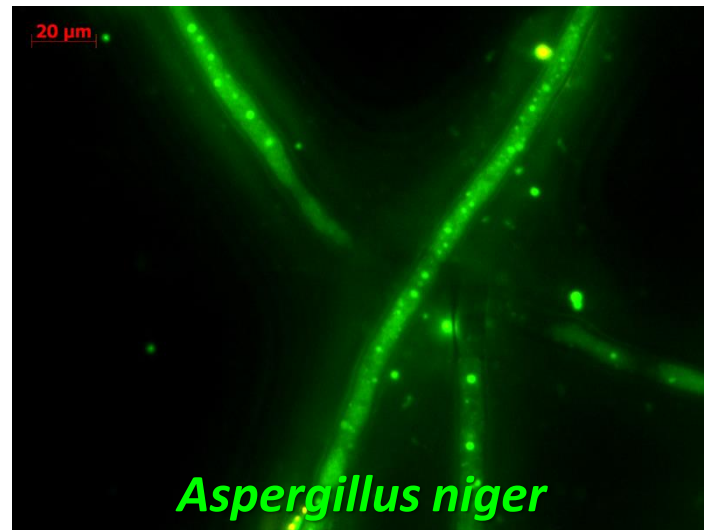
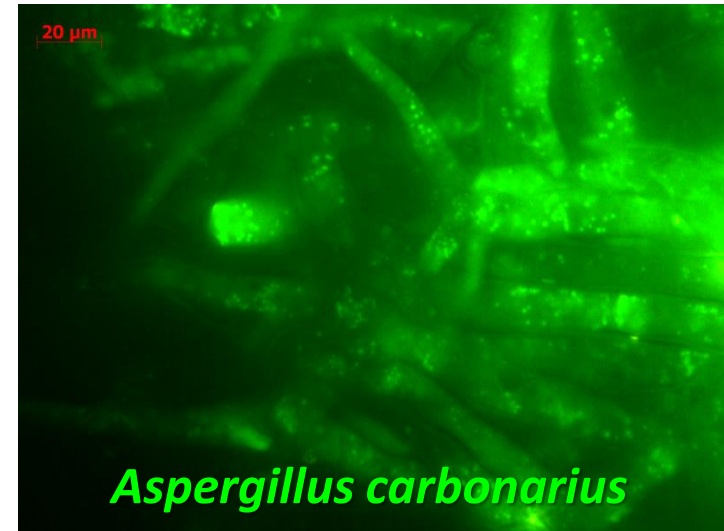
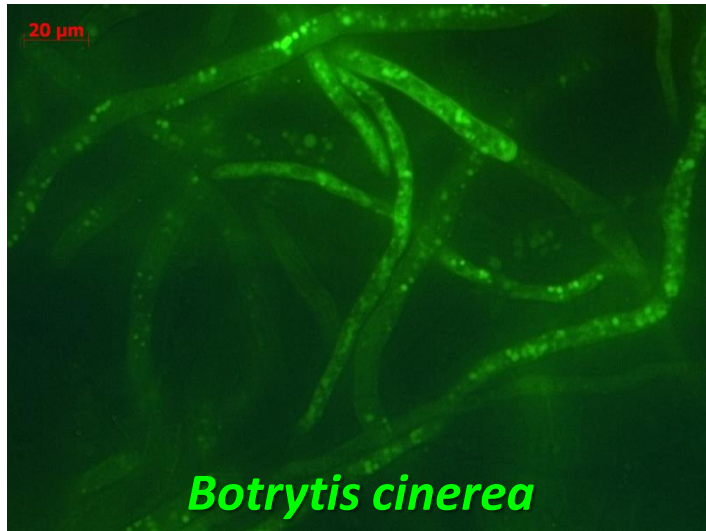




# PLGA-6-coumarin-NPs uptake by fungal mycelia



10 min - 2 h







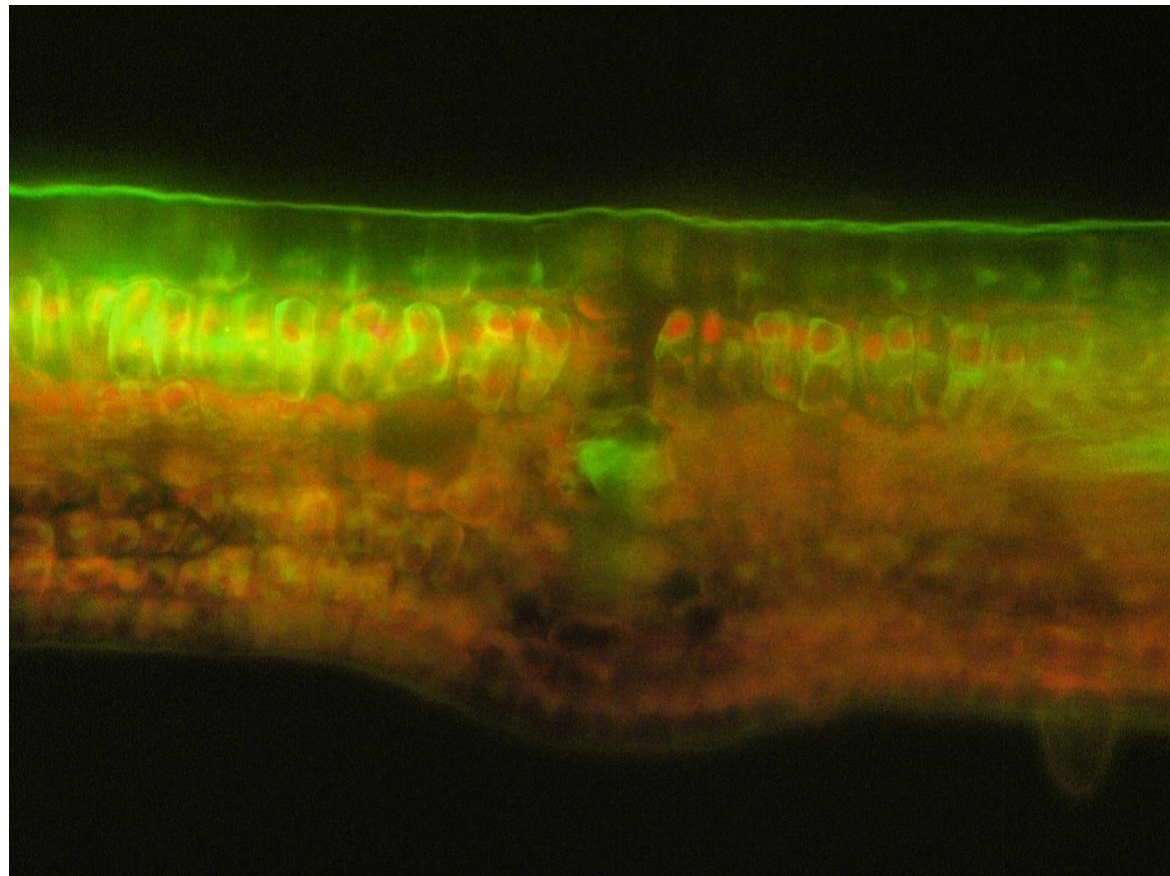
# PLGA-6-coumarin-NPs in grapevine *in vitro* plantlets



Leaf incubated in a solution containing NPs

After 24 hours NPs spread throughout the mesophyll and concentrate preferentially in the palisade parenchyma

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Adaxial epidermis  
-----  
Palisade parenchyma  
-----  
Spongy parenchyma  
-----  
Abaxial epidermis  
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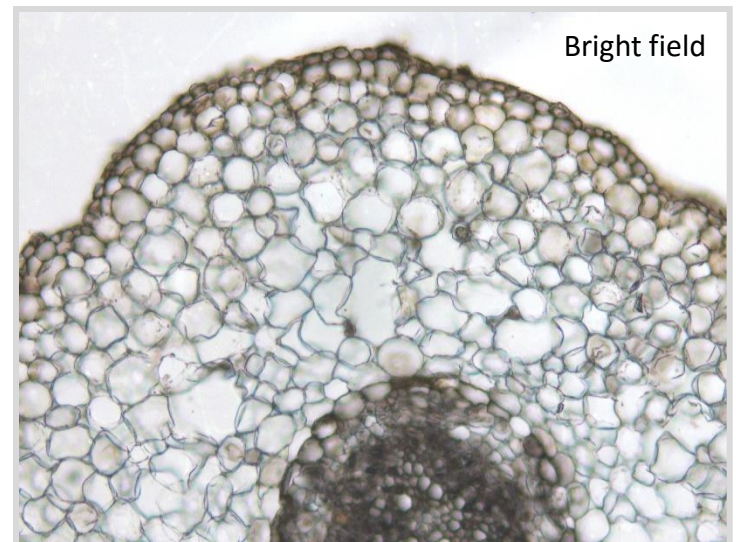
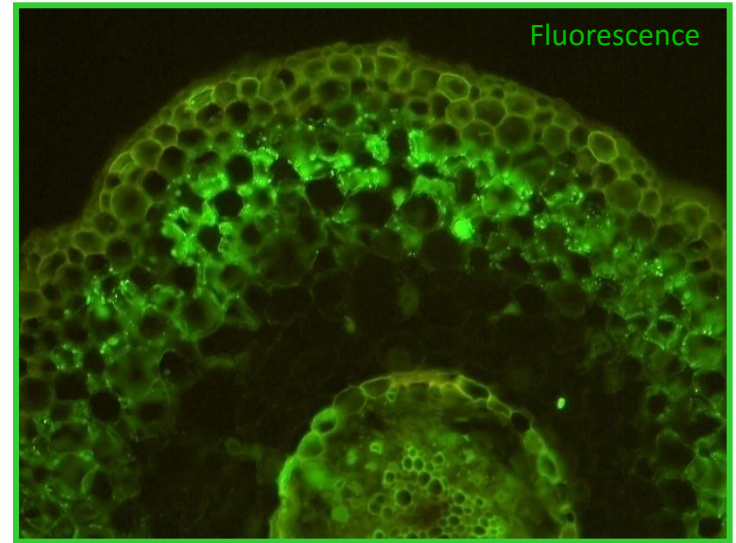
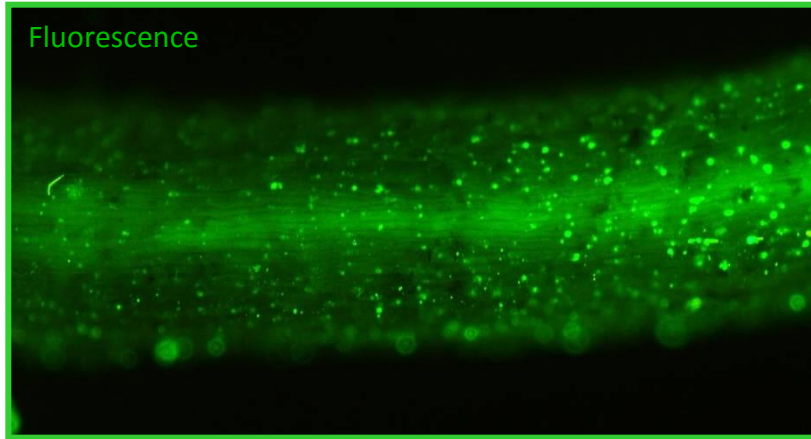




# PLGA-6-coumarin-NPs in grapevine *in vitro* plantlets



Roots at 48 h





# Perspectives



- **PLGA-based nanoparticles could be used in future as delivery vehicle of agrochemicals in plants.**
- **PLGA nanoparticles could contain plant-derived antimicrobial compounds as an alternative to traditional pesticides.**
- **The ability of PLGA NPs to penetrate in the fungal cells paves the way for a number of new and interesting applications in the agronomic field and in the control of postharvest diseases to fight pathogenic fungi of economically important crops.**
- **PLGA NPs could be also applied in food processing, storage, packaging and to increase product shelf life.**