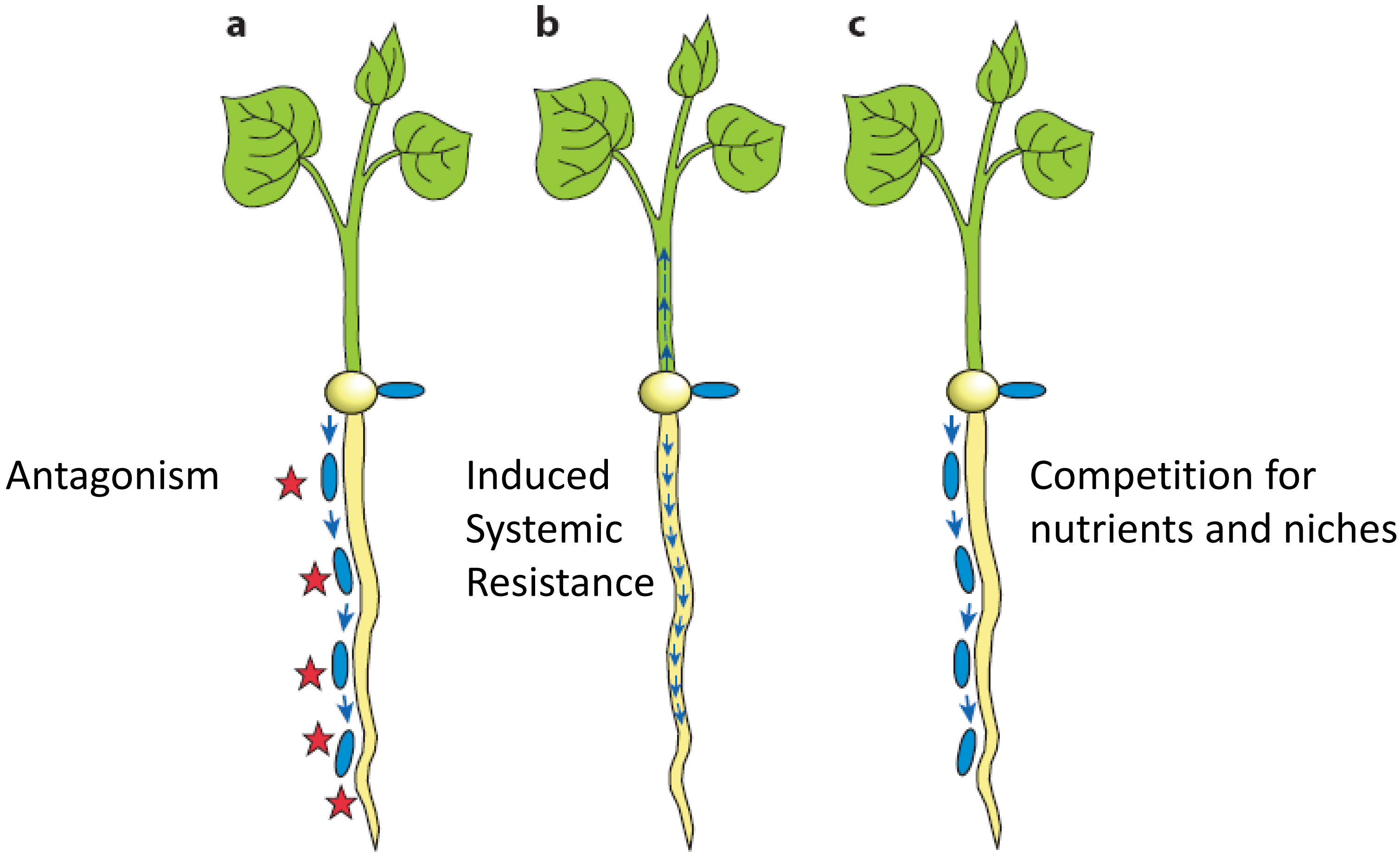
Biological Management

Biological Control of Plant Pathogens

- The terms “biological control” and its abbreviated synonym “biocontrol” have been used in different fields of biology, most notably entomology and plant pathology.
- In plant pathology, the term applies to the use of microbial antagonists to suppress diseases as well as the use of host-specific pathogens to control weed populations. In both fields, the organism that suppresses the pest or pathogen is referred to as the **biological control agent (BCA)**.

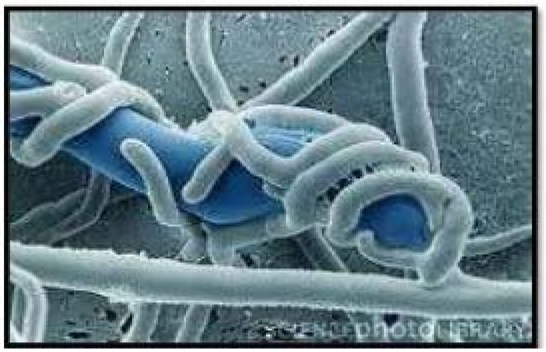
Types of interactions contributing to biological control

- In order to understand the mechanisms of biological control, it is helpful to appreciate the different ways that organisms interact.
- Note, too, that in order to interact, organisms must have some form of direct or indirect contact.
- The types of interactions were referred to as competition, parasitism, antagonism and induced systemic resistance.

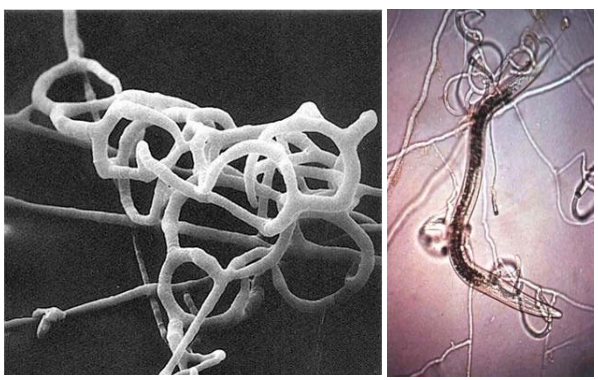

a
b
c
Antagonism
Induced
Systemic
Resistance
Competition for
nutrients and niches

Mechanisms of biological control

- Direct antagonism-Hyperparasitism/predation

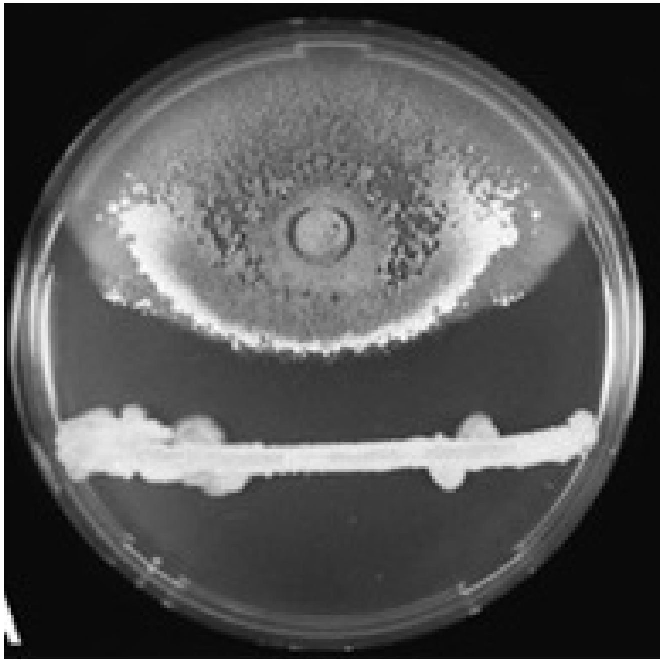


Trichoderma harzianum hyperparasitism on *Rhizoctonia solani*

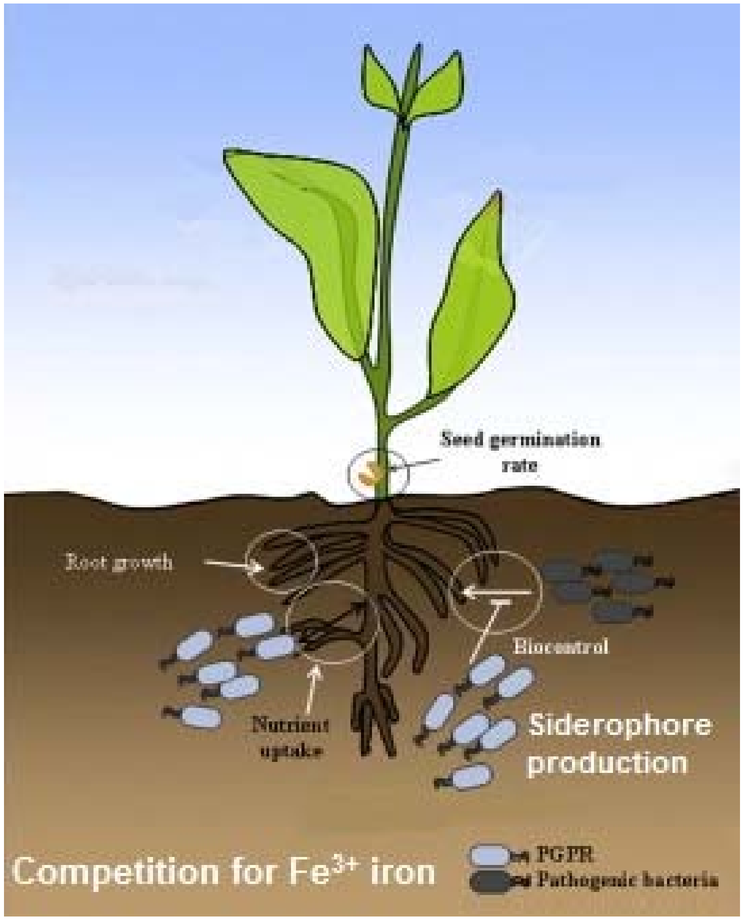


Arthrobotrys oligospora develop net-like structure for trapping nematode

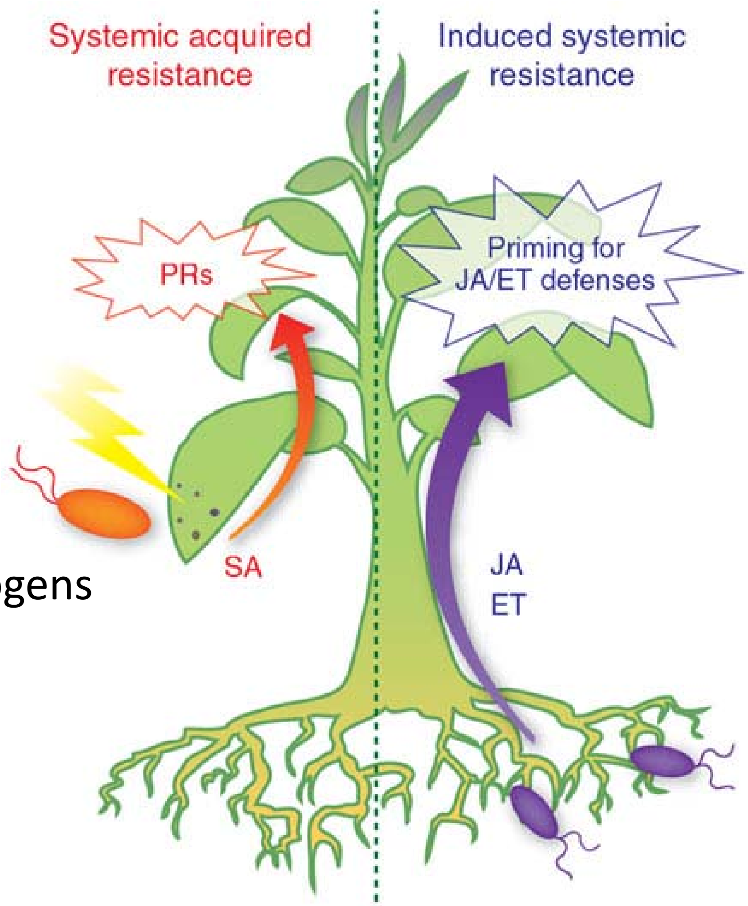
- Mixed-path antagonism – Antibiotics, Lytic enzymes, Unregulated waste products, Physical/chemical interference



- Indirect antagonism – Competition



- Induction of host resistance



Mild necrotic pathogens

Pseudomonas fluorescens
P. putida
Bacillus amyloliquefaciens
B. cereus

Microbial diversity and disease suppression

- Microbes that contribute most to disease control are most likely those that could be classified competitive saprophytes, facultative plant symbionts and facultative hyperparasites.
- These can generally survive on dead plant material, but they are able to colonize and express biocontrol activities while growing on plant tissues.
- A few, like avirulent *Fusarium oxysporum* and binucleate *Rhizoctonia*-like fungi, are phylogenetically very similar to plant pathogens but lack active virulence determinants for many of the plant hosts from which they can be recovered. Others, like *Pythium oligandrum* are currently classified as distinct species.

- Due to the ease with which they can be cultured, most biocontrol research has focused on a limited number of bacterial (*Bacillus, Burkholderia, Lysobacter, Pantoea, Pseudomonas*, and *Streptomyces*) and fungal (*Ampelomyces, Coniothyrium, Dactylella, Gliocladium, Paecilomyces*, and *Trichoderma*) genera.
- Still, other microbes that are more recalcitrant to in vitro culturing have been intensively studied. These include mycorrhizal fungi, e.g. *Pisolithus* and *Glomus* spp. that can limit subsequent infections, and some hyperparasites of plant pathogens, e.g. *Pasteuria penetrans* which attack root-knot nematodes. Because multiple infections can and do take place in field-grown plants, weakly virulent pathogens can contribute to the suppression of more virulent pathogens, via the induction of host defenses.

- **Specific suppression** results from the activities of one or just a few microbial antagonists. This type of suppression is thought to be occurring when inoculation of a biocontrol agent results in substantial levels of disease suppressiveness. Its occurrence in natural systems may also occur from time to time. For example, the introduction of *Pseudomonas fluorescens* that produce the antibiotic 2,4-diacetylphloroglucinol can result in the suppression of various soilborne pathogens
- However, specific agents must compete with other soil- and root-associated microbes to survive, propagate, and express their antagonistic potential during those times when the targeted pathogens pose an active threat to plant health.

- In contrast, **general suppression** is more frequently invoked to explain the reduced incidence or severity of plant diseases because the activities of multiple organisms can contribute to a reduction in disease pressure. High soil organic matter supports a large and diverse mass of microbes resulting in the availability of fewer ecological niches for which a pathogen competes. The extent of general suppression will vary substantially depending on the quantity and quality of organic matter present in a soil

- Functional redundancy within different microbial communities allows for rapid depletion of the available soil nutrient pool under a large variety of conditions, before the pathogens can utilize them to proliferate and cause disease. For example, diverse seed-colonizing bacteria can consume nutrients that are released into the soil during germination thereby suppressing pathogen germination and growth (McKellar and Nelson 2003). Manipulation of agricultural systems, through additions of composts, green manures and cover crops is aimed at improving endogenous levels of general suppression.