



# **Weerbaarheid in planten: wat, hoe en wanneer?**

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# Plant diseases



Viruses and viroids



Bacteria



Fungi and chromista

# Disease susceptibility and resistance

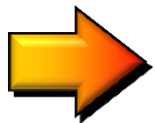


- **Susceptibility**

- Each plant is susceptible to a small number of different pathogens from a vast number of known pathogens
- Pathogens avoid or actively suppress plant defense responses

- **Resistance**

- Each plant is non-host to the vast majority of known pathogens

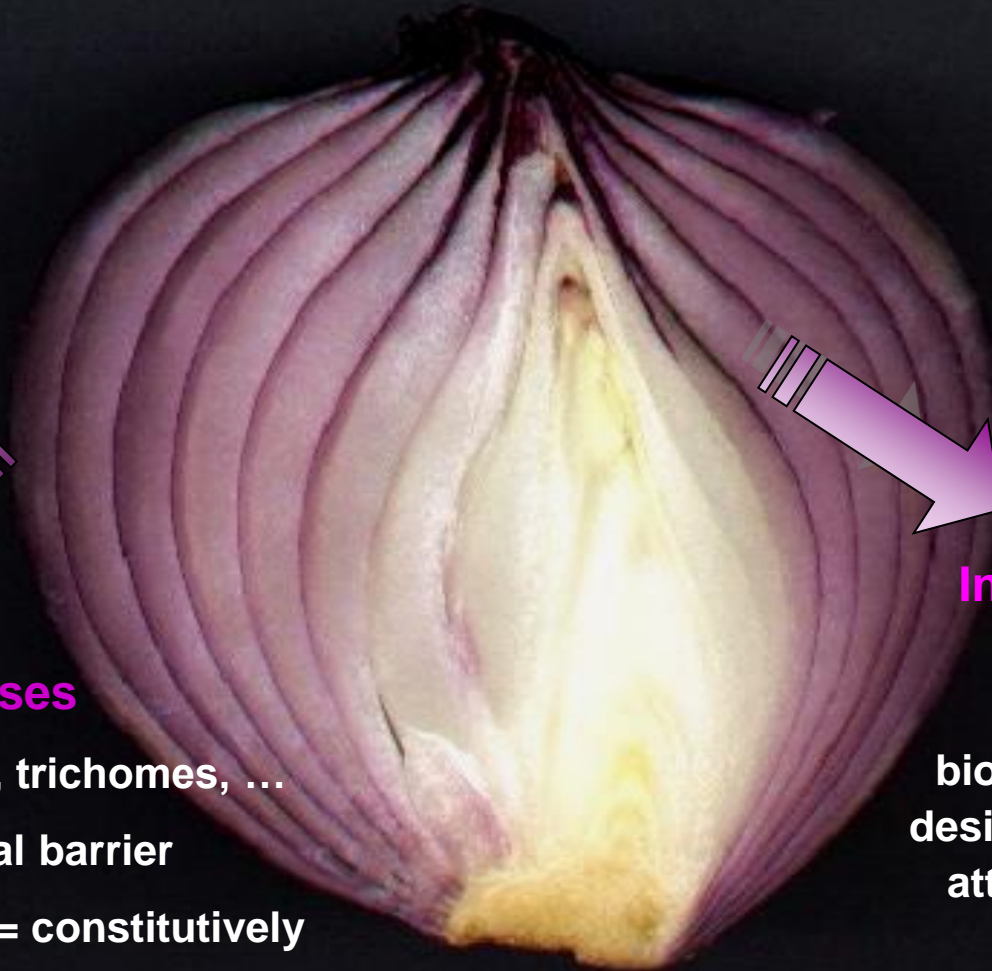


**Resistance = rule, Disease = exception**

# Plant innate immunity: multilayered process



'Peeling the onion'



## Constitutive defenses

- Thorns, needles, trichomes, ...
- Cuticle = physical barrier
- Phytoanticipins = constitutively produced allelochemicals

## Inducible defenses

wide spectrum of physiological and biochemical defenses, designed to prevent the attacker from causing further damage

# Constitutive or preformed defense



- **Physical barriers**

- cuticula and wax layers
- rigid cell walls
- lignin
- bark



# Constitutive or preformed defense



- **Chemical barriers**

- Plant-specific antimicrobial chemicals = antibiotics produced in planta
- Often referred to as **phytoanticipins**
- Examples:
  - Phenolics
  - Terpenes
  - Tannins
  - Saponines
  - Cyanogenic glycosides

# Phytoanticipins: some examples



Tomatine



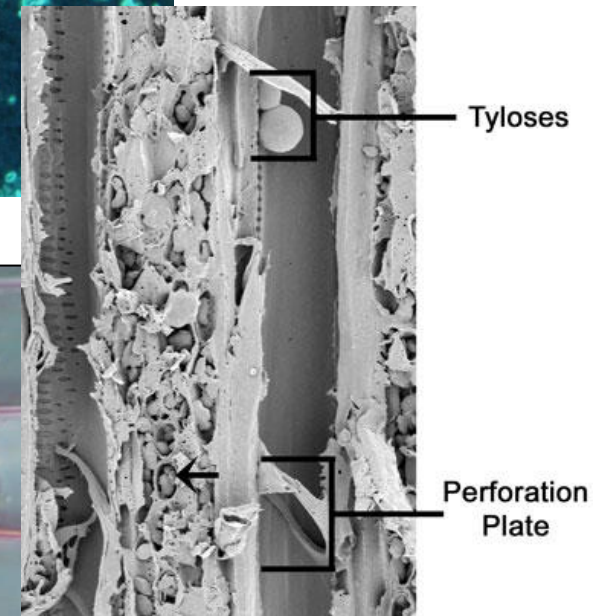
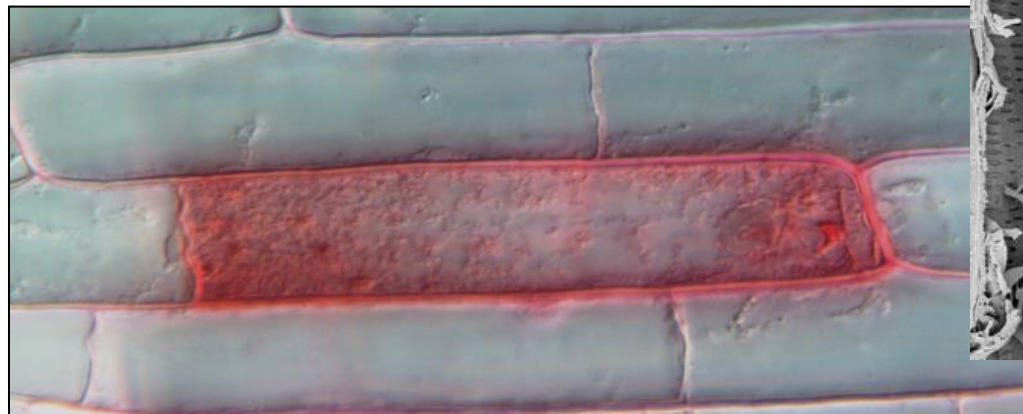
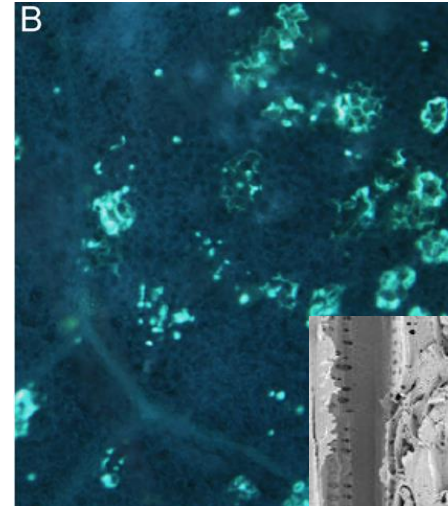
Glucosinolates

# Inducible defense



- **Structural defense**

- cell wall modification
- papillae formation
- tylose formation in xylem vessels
- formation of cork layers



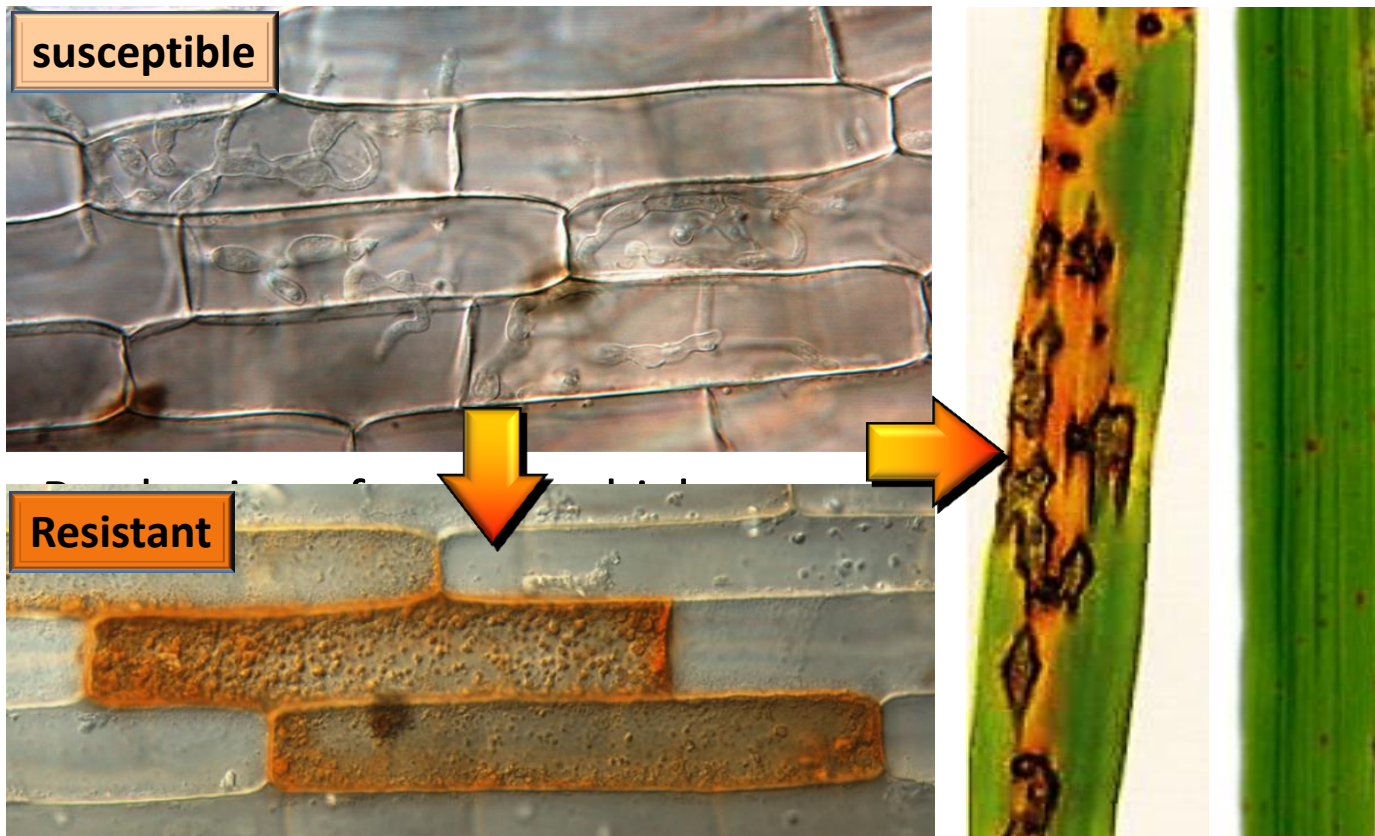


# Inducible defense



## Biochemical defense

– Hypersensitive response



# Inducible defense



## – Phytoalexins

- structurally diverse molecules
- nonspecific antifungal activity
- not present in healthy tissue



quercetin, naringenin



capsidiol



resveratrol

# Types of plant resistance



## Non-host resistance

Plant is not a host for the pathogen

Based on preformed and inducible defense mechanisms

## Host resistance

Plant is host but recognizes the pathogen at an early stage

Based on inducible defense mechanisms

## Induced resistance

Can be activated in either a resistant or a susceptible host

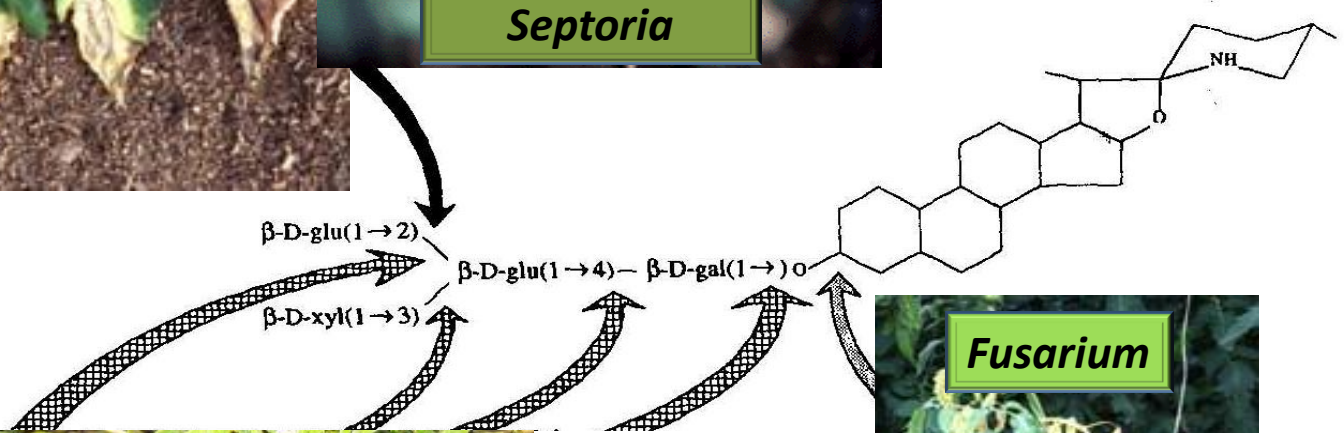
# Non-host resistance

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- Effective against most pathogens and pests
- Genetically complex
- Based on both constitutive and inducible defenses
- Successful pathogens are able to evade/suppress non-host resistance

# Tomato pathogens detoxify tomatin

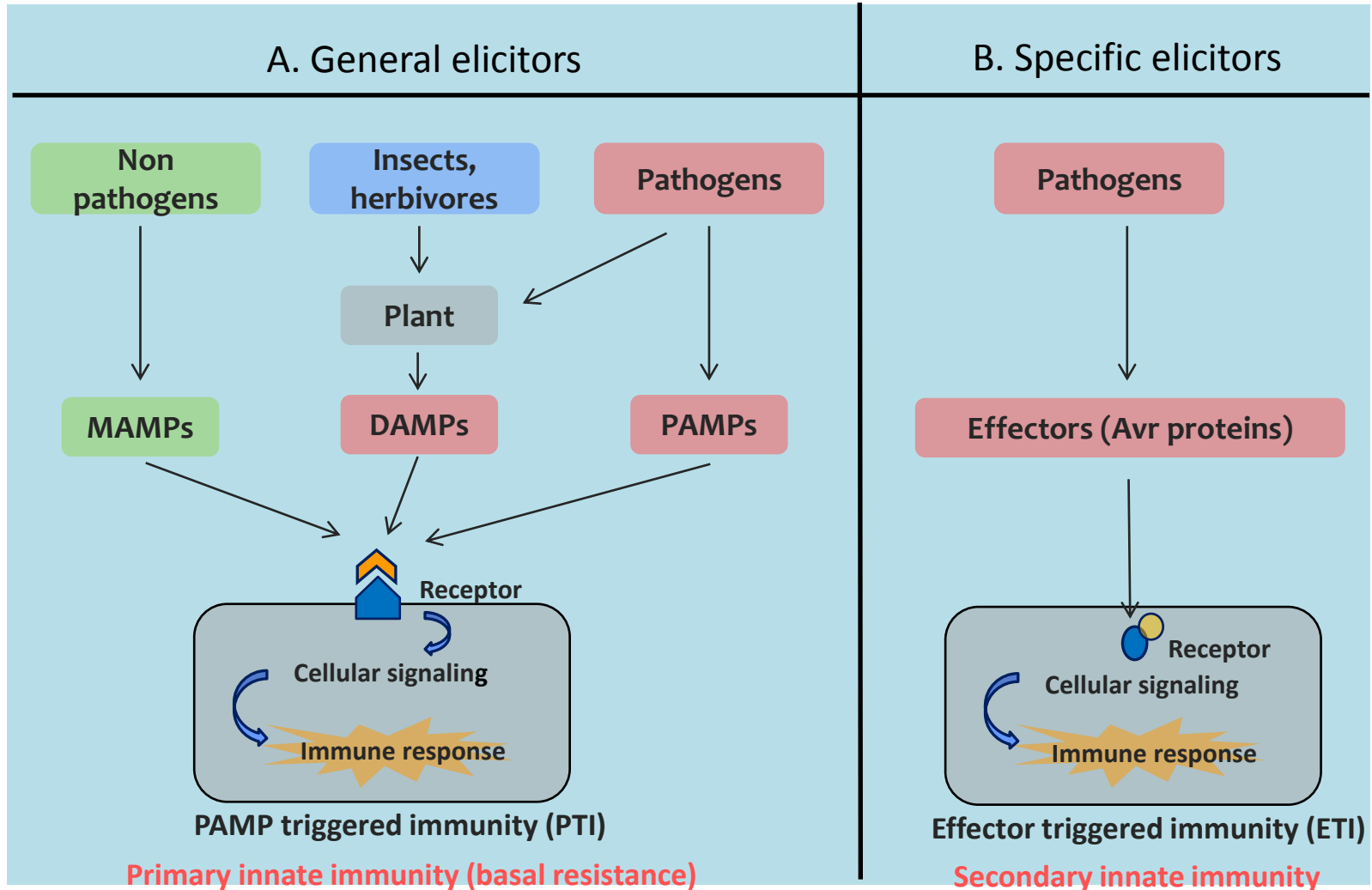


# Host resistance = Pathogen recognition



- Occurs within genotypes or cultivars of a given plant species susceptible to a specific pathogen
- Plant recognizes pathogens through specialized mechanisms
- Often conditioned by a single plant *R* gene
- Based on gene-for-gene interaction

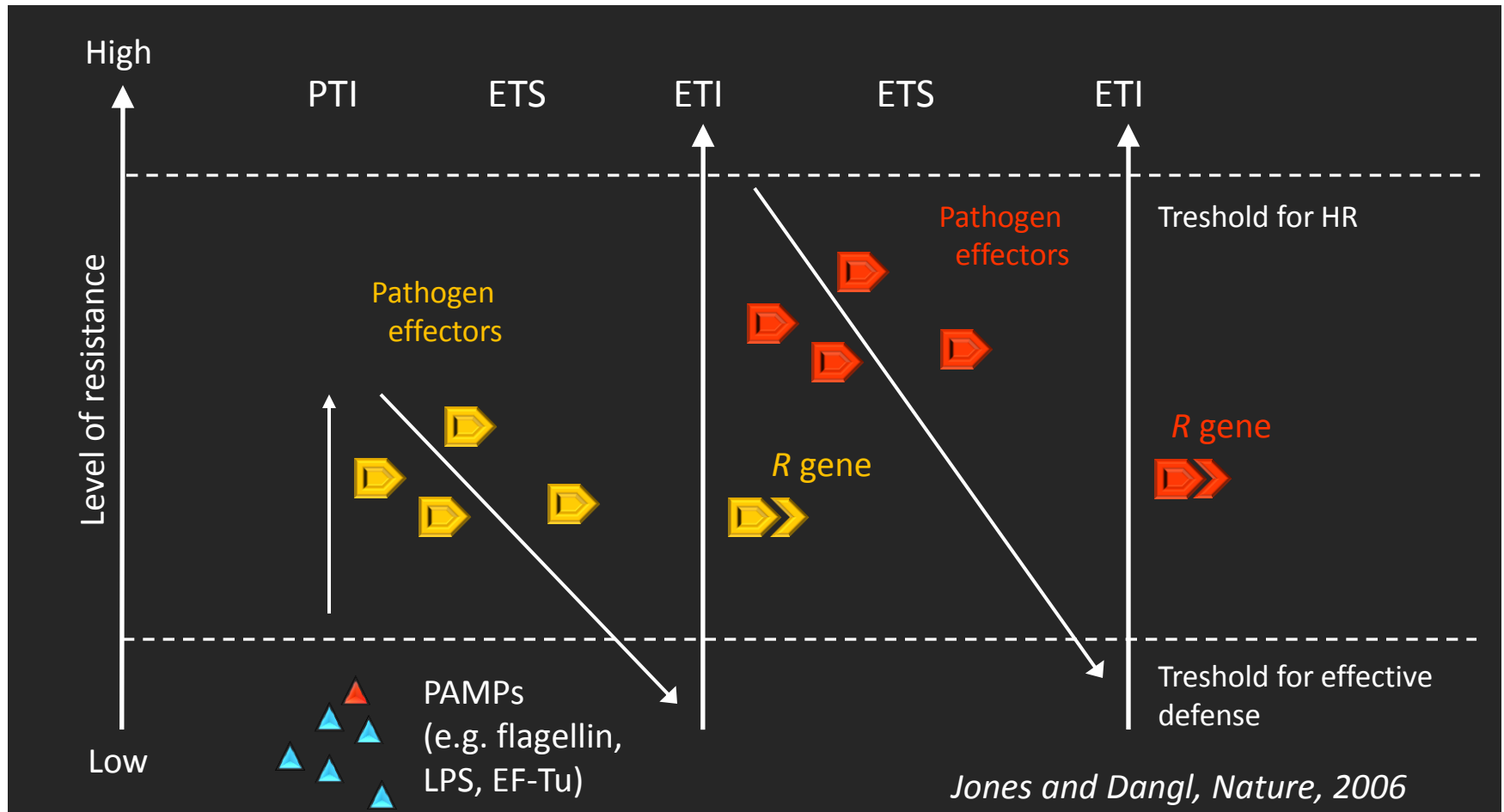
# Pathogen perception: know your enemy



# Plants versus pathogens: an evolutionary arms race



- **PTI** (basal defense; PRRs) and **ETI** (gene-for-gene resistance; *R* genes)





# Induced resistance



- Tertiary defense layered atop PTI and ETI and expressed in systemic leaves
- Induced resistance is a state of enhanced defensive capacity developed by the plant when appropriately stimulated



- Triggered by
  - Avirulent, non-pathogens
  - Beneficial rhizobacteria/fungi
  - Certain chemicals
- Induced resistance is **systemic and broad spectrum**

# Types of induced resistance



## SAR: Systemic Acquired Resistance

Triggered by necrotizing pathogen

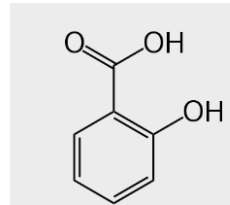
## ISR: Induced Systemic Resistance

Triggered by plant-growth promoting rhizobacteria

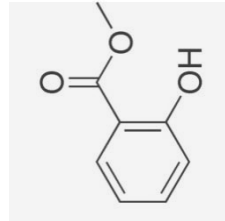
## WIR: Wound-Induced Resistance

Triggered by wounding

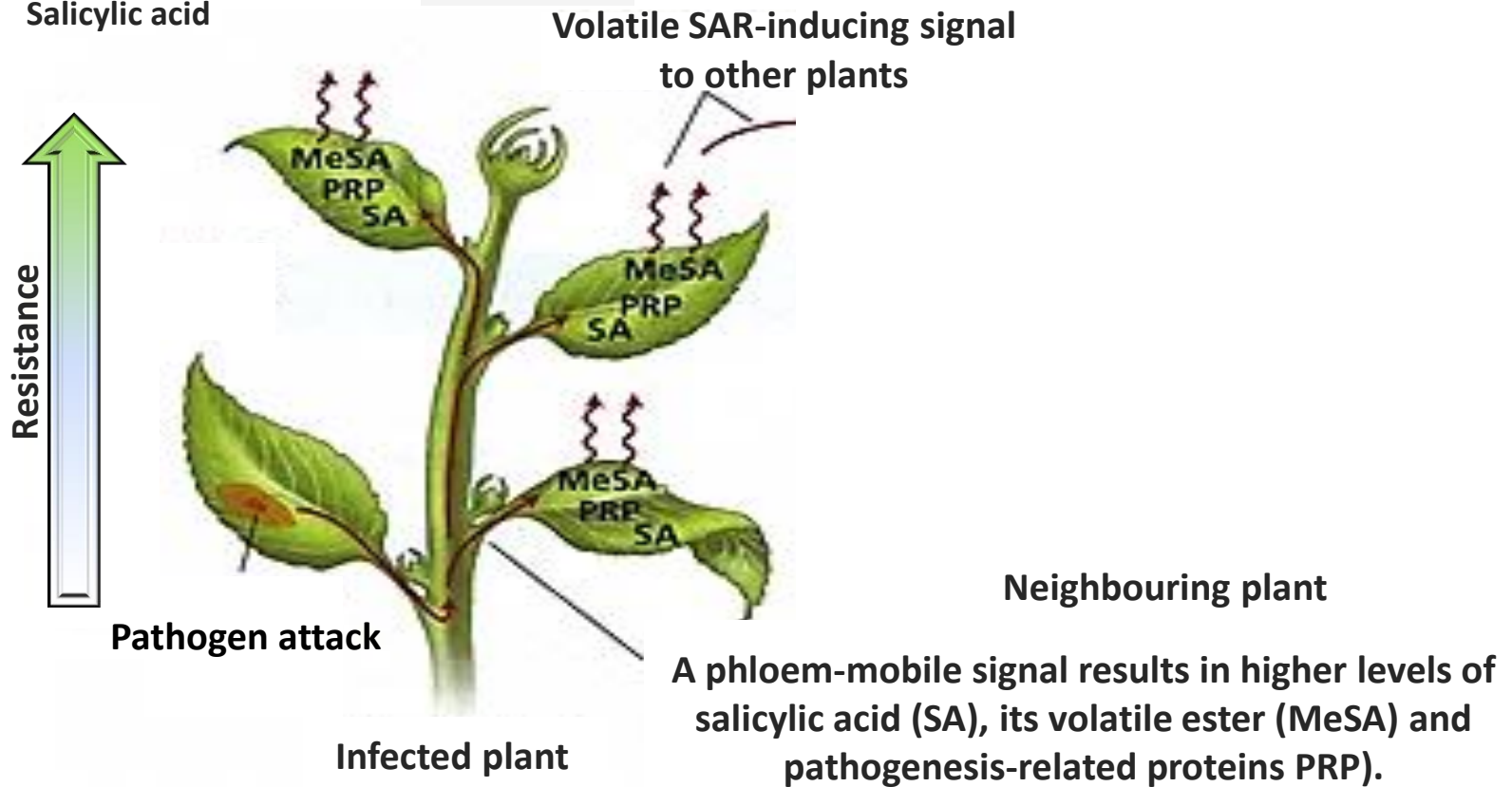
# SAR: Systemic Acquired Resistance



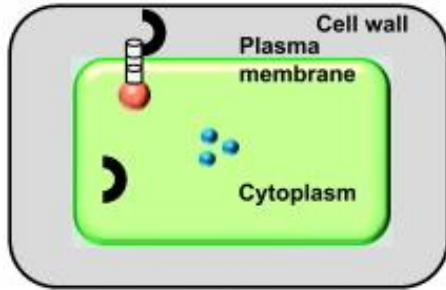
Salicylic acid



Methyl salicylate (MeSA)



# Induced resistance: priming of defense



Naïve cell with normal  
defence capacity

# Agents that can induce plant resistance



- **Inducers from biotic sources**
  - Products originating from plants
    - Plant extracts
  - Products originating from microorganisms
    - Chitin/chitosan
    - Glucans (laminarin) - Vacciplant
    - Proteins/peptides
  - Vitamins
    - Thiamin (vitamin B1)
    - Riboflavin (vitamin B2)
- **Synthetic resistance inducers**
  - Products based on plant defense components
    - Analogues/mimicks of **salicylic acid (Bion)**
    - Producers of active oxygen species (**Oxycom**)

# Agents that can induce plant resistance



- **Fungicides/Insecticides**

- Pyraclostrobin
  - Induced resistance against viruses and bacteria
  - Increased resistance to drought stress
- Imidacloprid

- **Minerals/nutrients**

- Phosphate salts
- Phosphonates
  - Commercial products: Aliette and Phytogard
- Silicon

# Some considerations...



- **Phytotoxicity or growth reduction can occur**
  - Induction of resistance is energy demanding
  - Depends on the concentration used (priming!)
  - Depends on the plant
- **Results with plant activators are variable**
  - Depends on environmental conditions (soil type, fertilizers, weather conditions – abiotic stress?)
  - Depends on host/cultivar
- **Conflicts in plant signalling pathways**
  - Biotrophs (SA) versus necrotrophs (JA)
  - Biotic stress versus abiotic stress

# Conclusies



Resistentie is de regel, ziekte is de uitzondering

Resistentie is gebaseerd op diverse mechanismen  
(constitutieve en induceerbare afweer)

Resistentie kan worden geïnduceerd in gevoelige planten  
(priming)





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***Thanks for your attention...***

***Questions?***