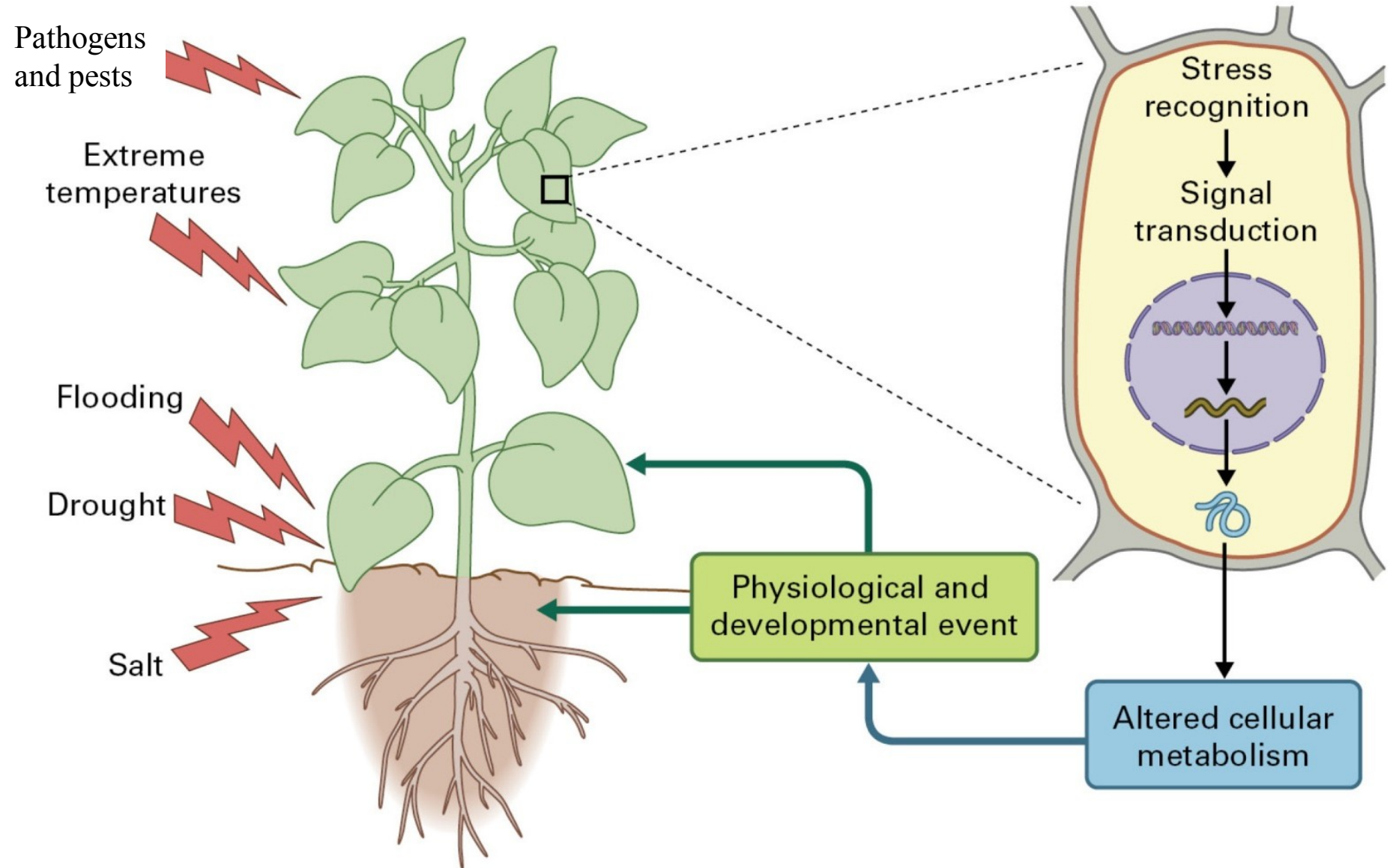




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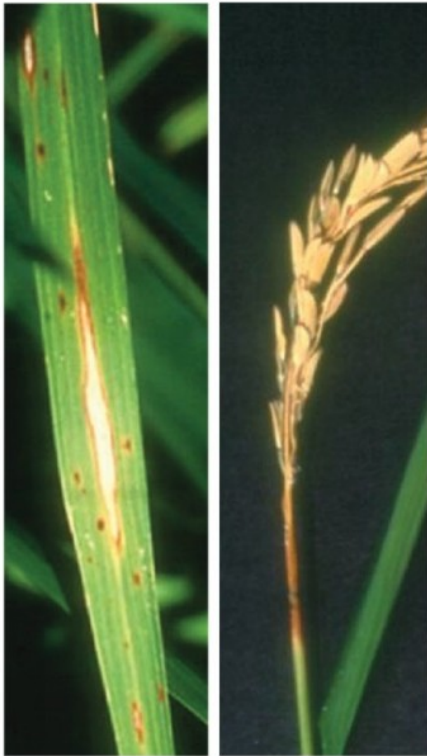
Responses to stress





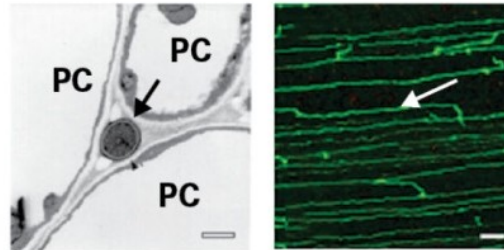
Plant-microbe interactions

Pathogen



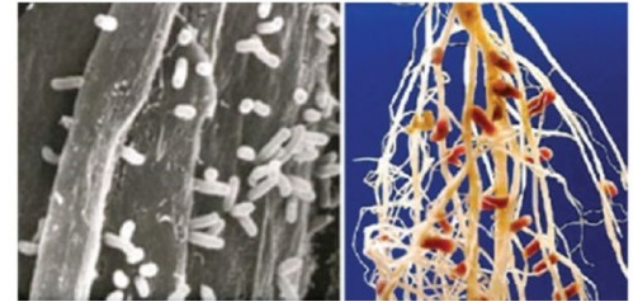
Magnaporthe oryzae - rice

Endophyte

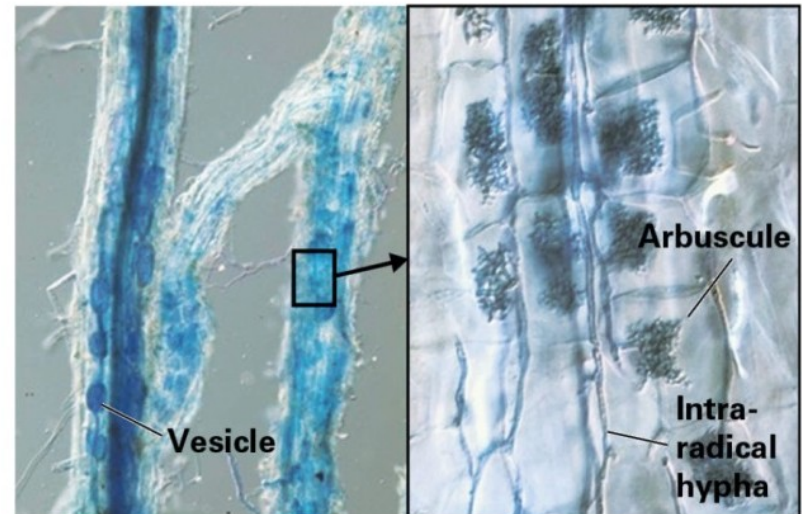


Epichloe festucae - ryegrass

Symbiont



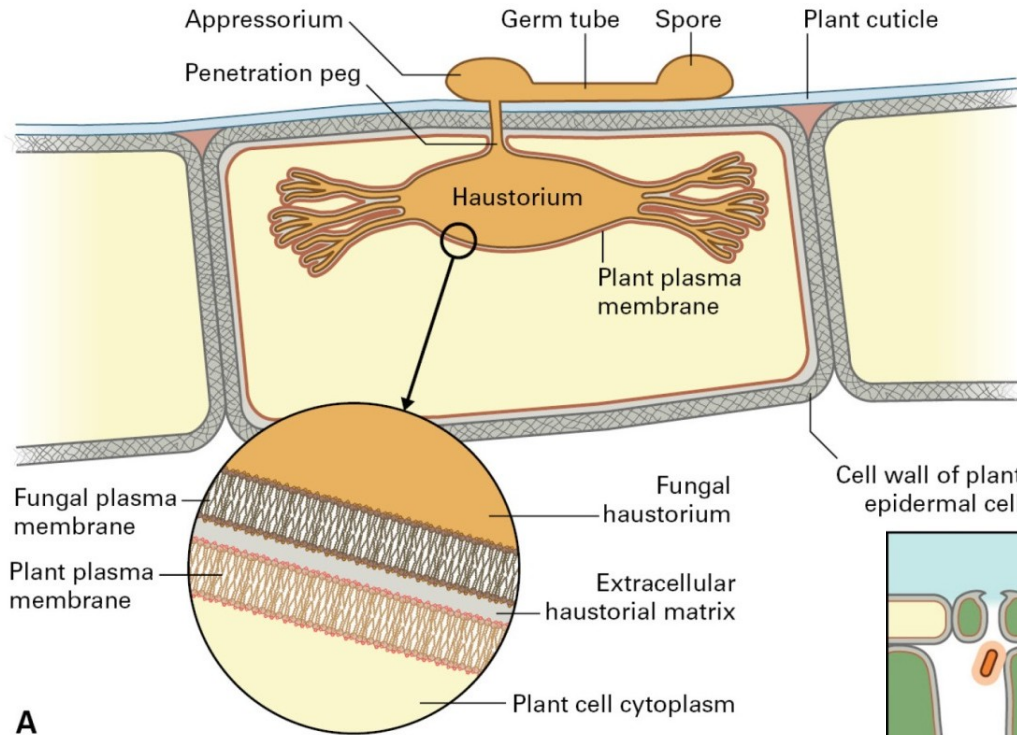
Rhizobium - Legume roots



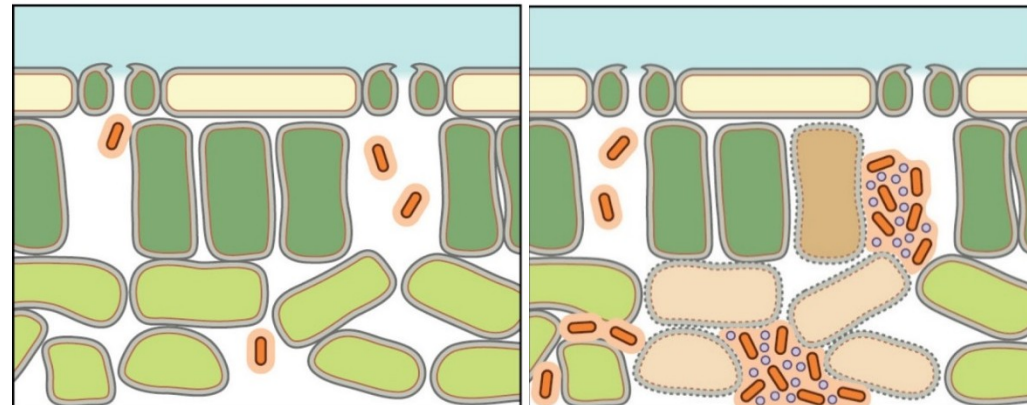
Arbuscular mycorrhiza

Pathogens

- Necrotrophy
- Biotrophy
- Hemibiotrophy



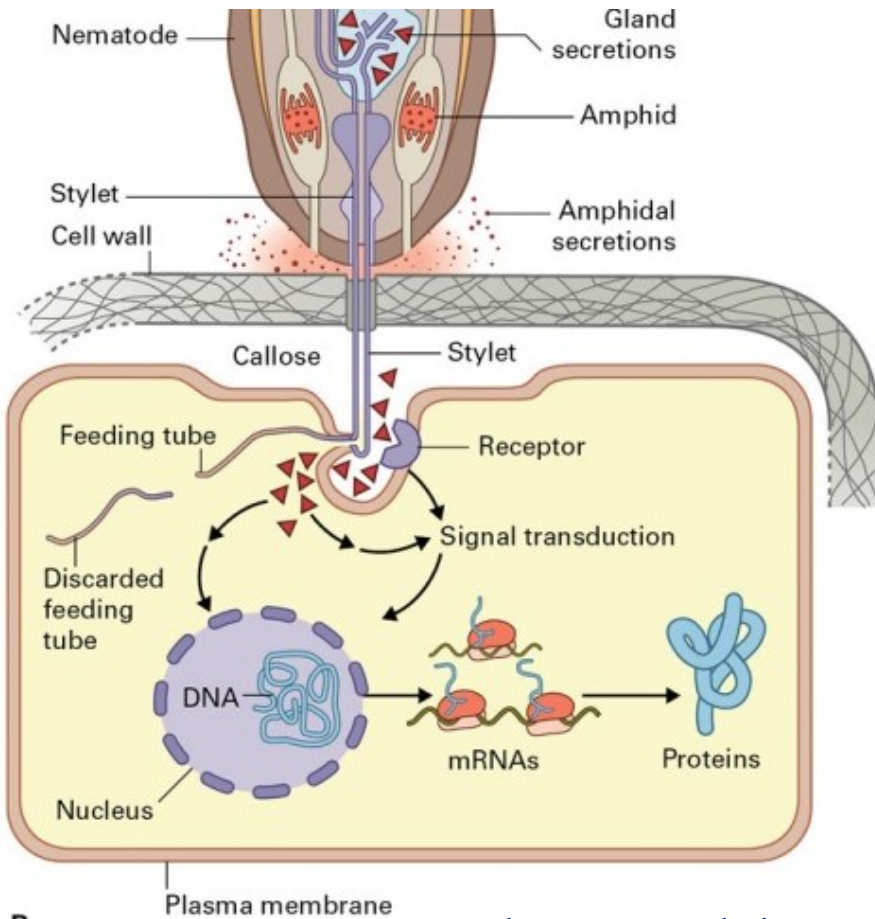
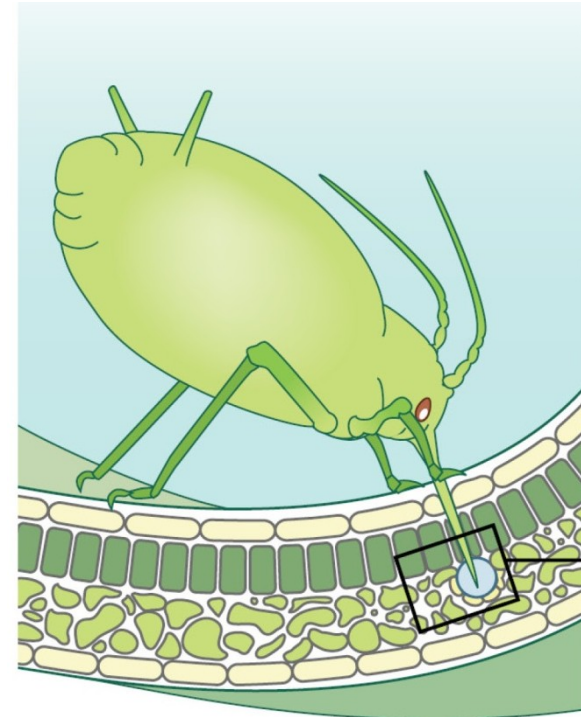
Pathogenic bacteria often enter the leaves through stomata, and produce effector molecules only at higher density of bacterial population, leading to the death of plant cells.



A
Biotrophic fungi usually form haustoria

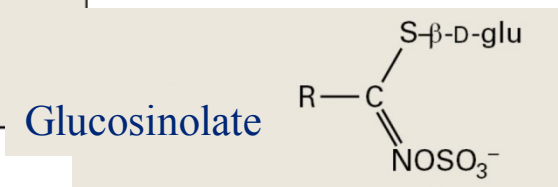
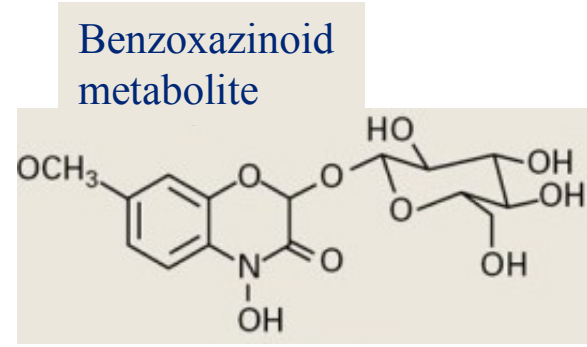
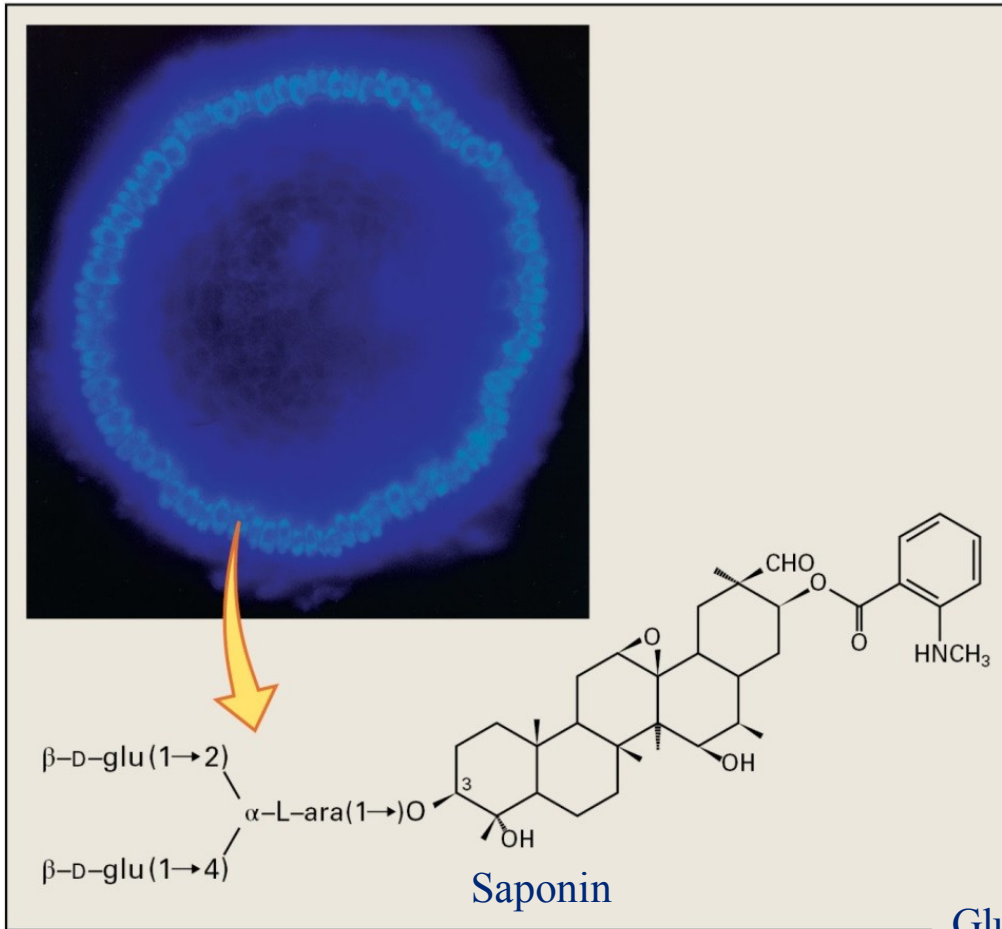
Pests

Aphids locate and penetrate the phloem sieve elements, and remove the sap

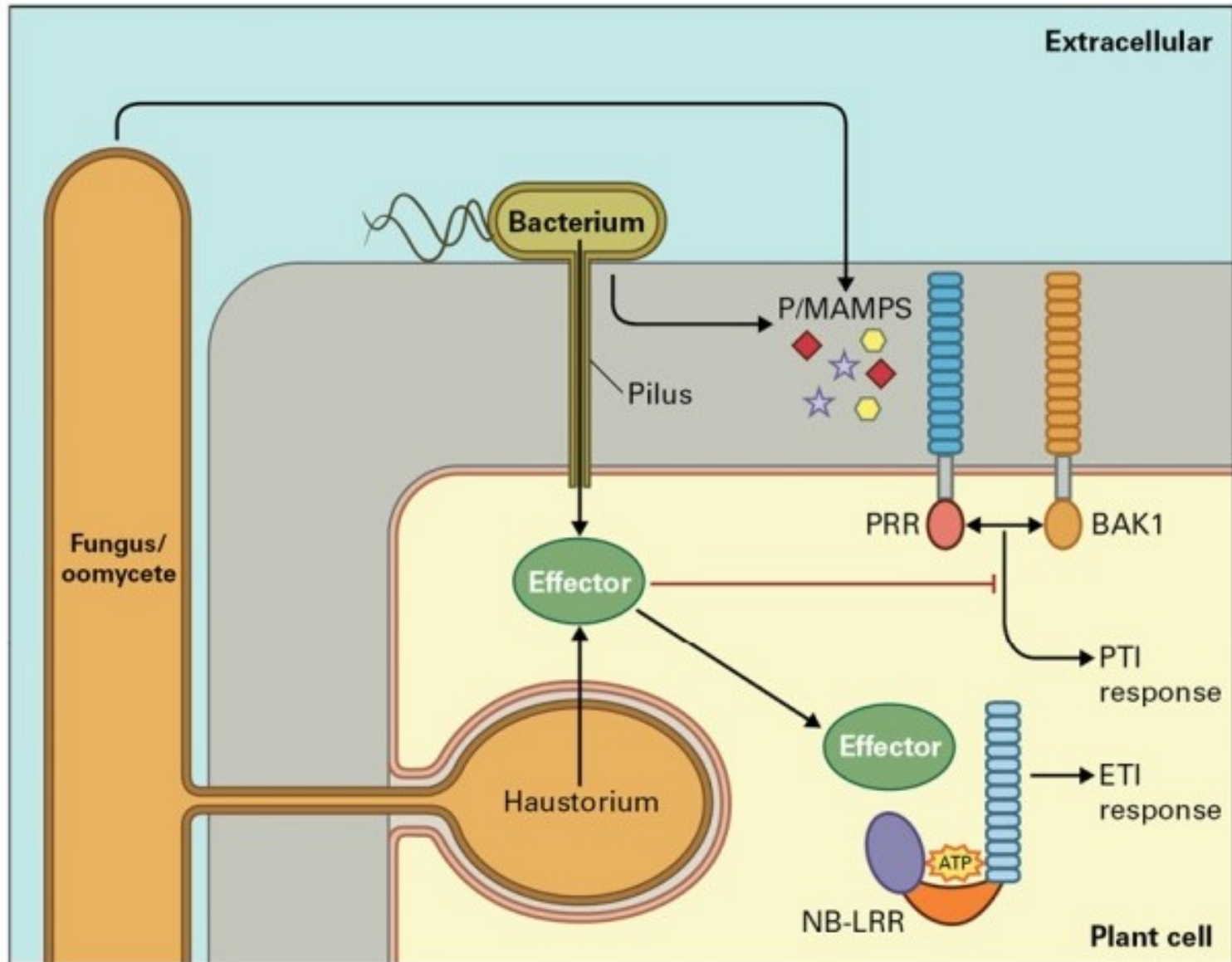


Plant-nematode interaction

Preformed defenses

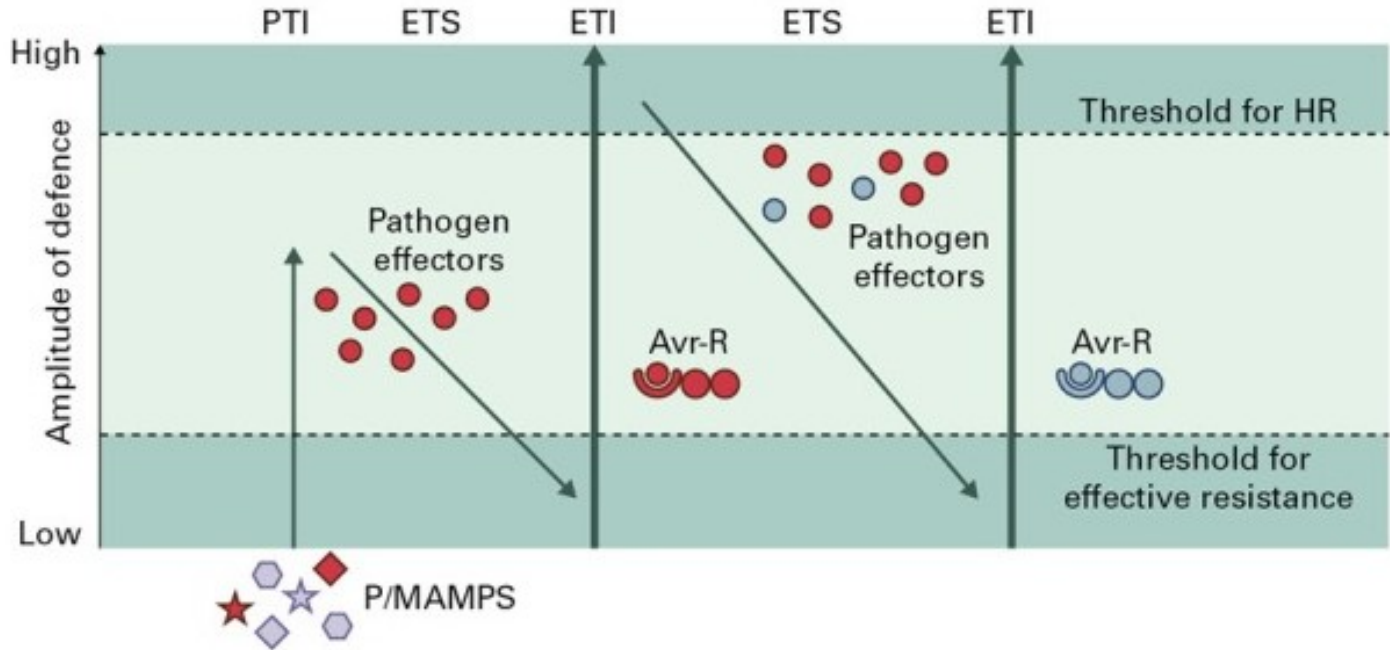


Plant immunity

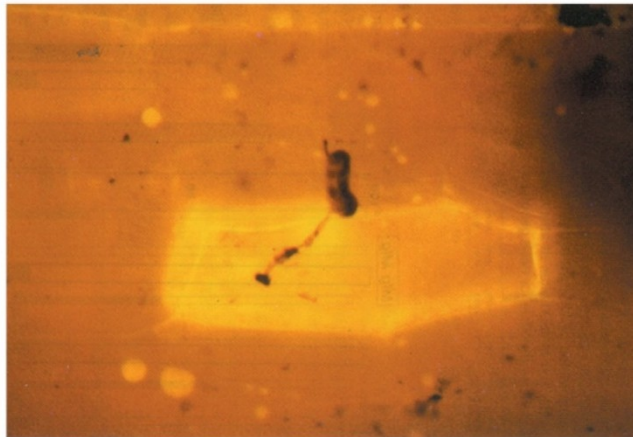
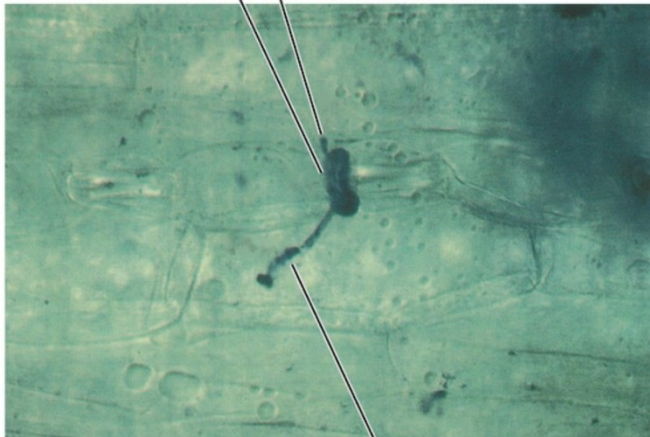


Plant immunity

Zig-zag model of the plant defense response

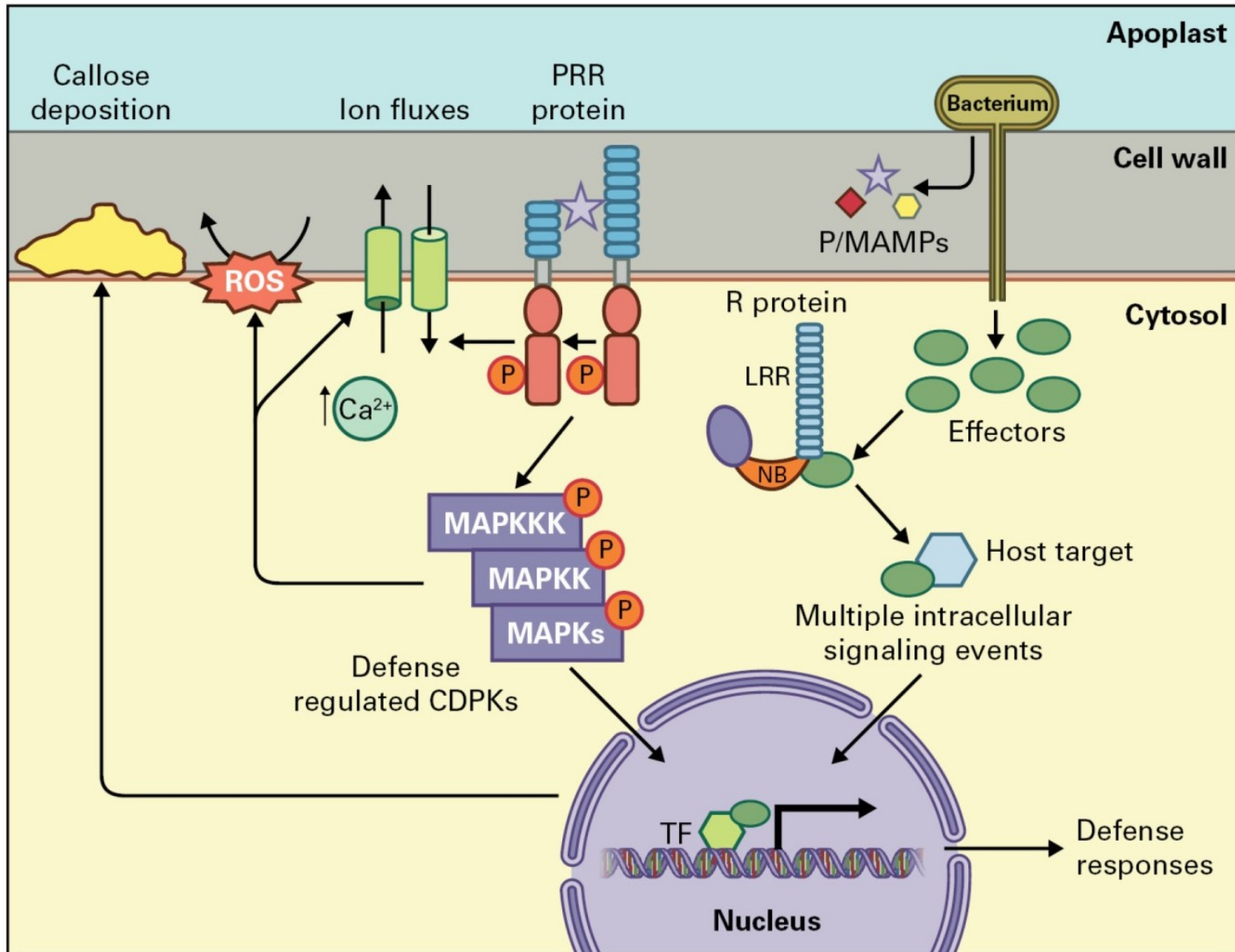


Spore
Primary germ tube

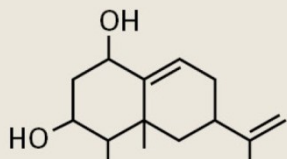


The hypersensitive cell death response

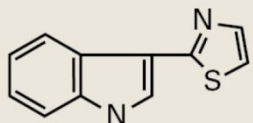
Induced defenses



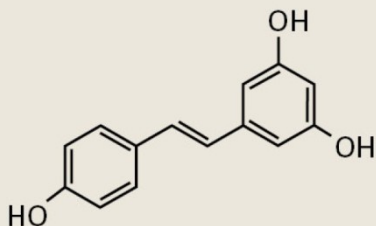
Induced defenses



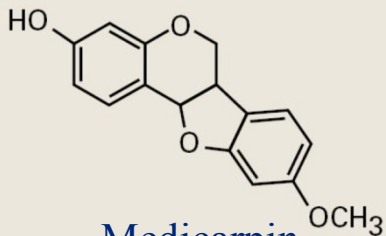
Capsidiol



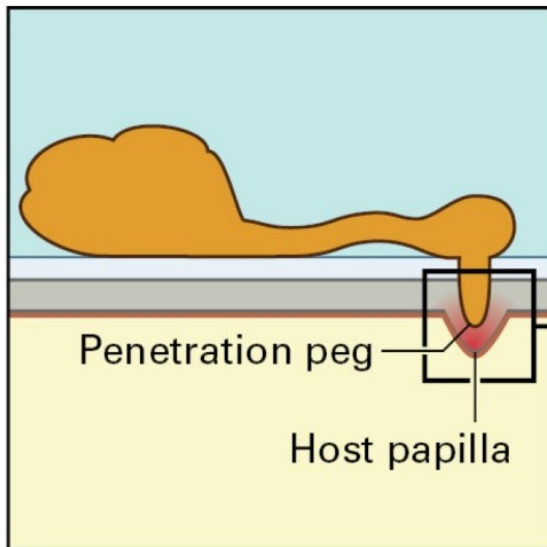
Camalexin



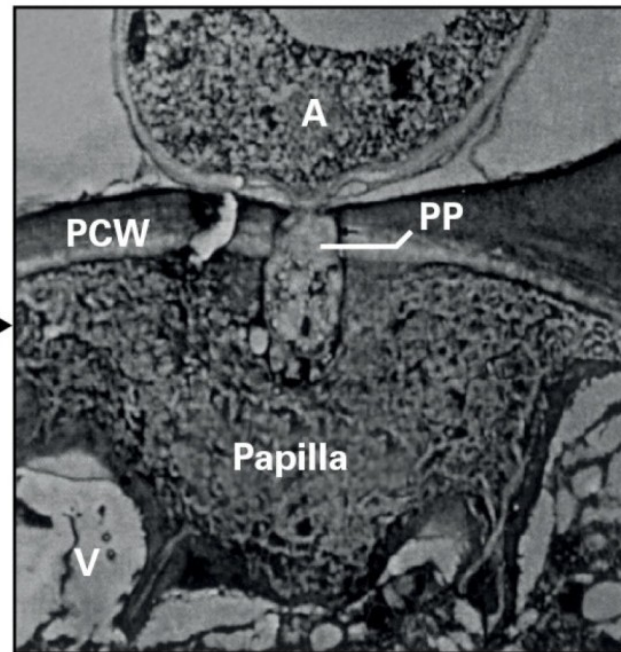
Resveratrol



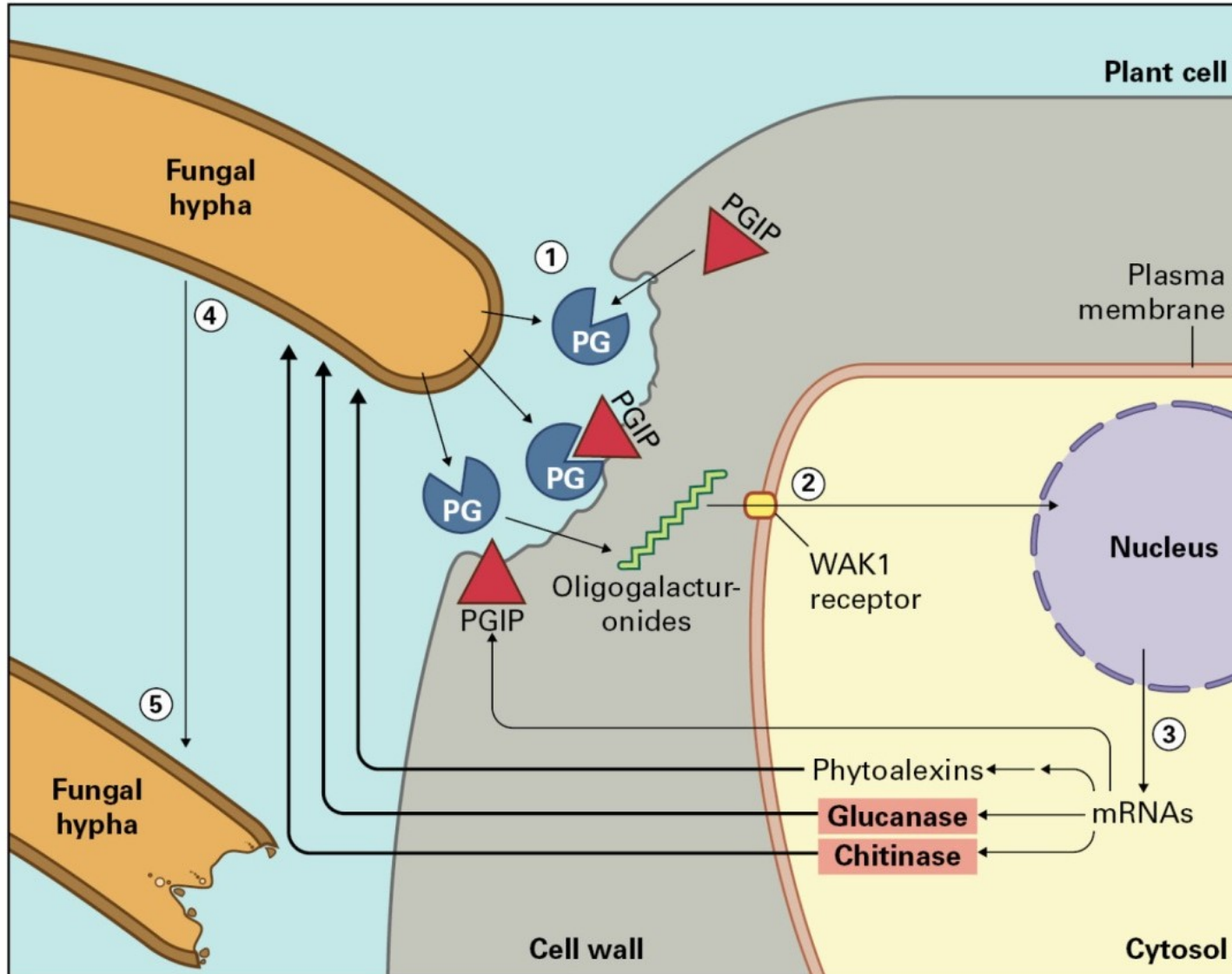
Medicarpin



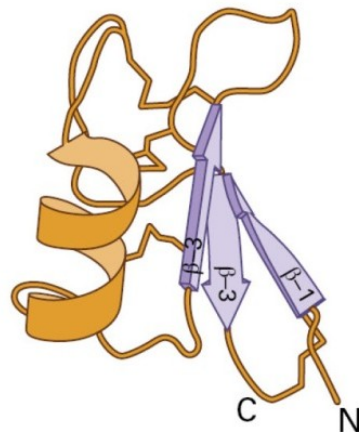
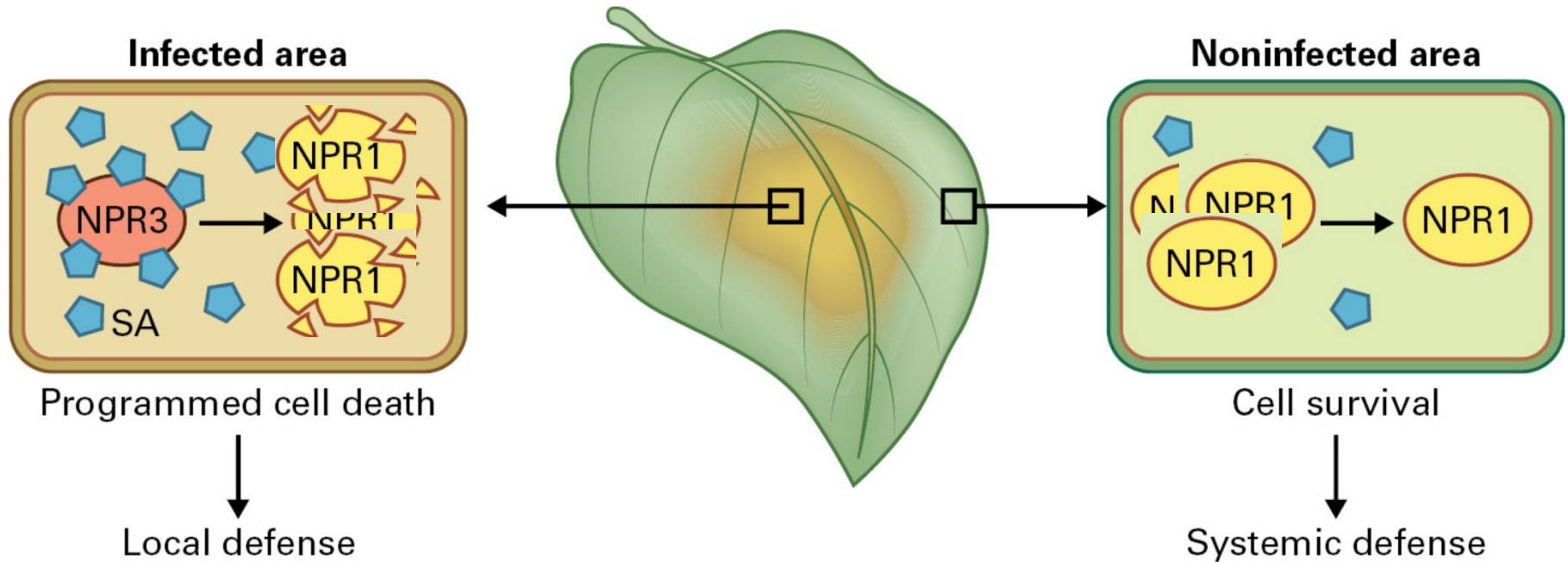
Formation of papilla below the penetration peg



Induced defenses



Systemic defenses

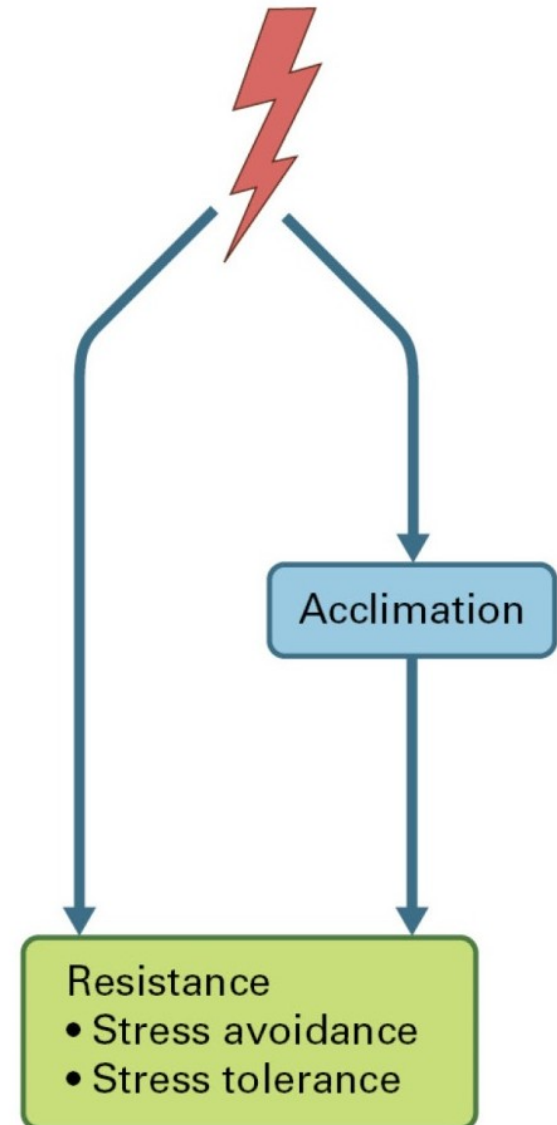


Defensin accumulation is controlled by a combination of JA and ethylene.

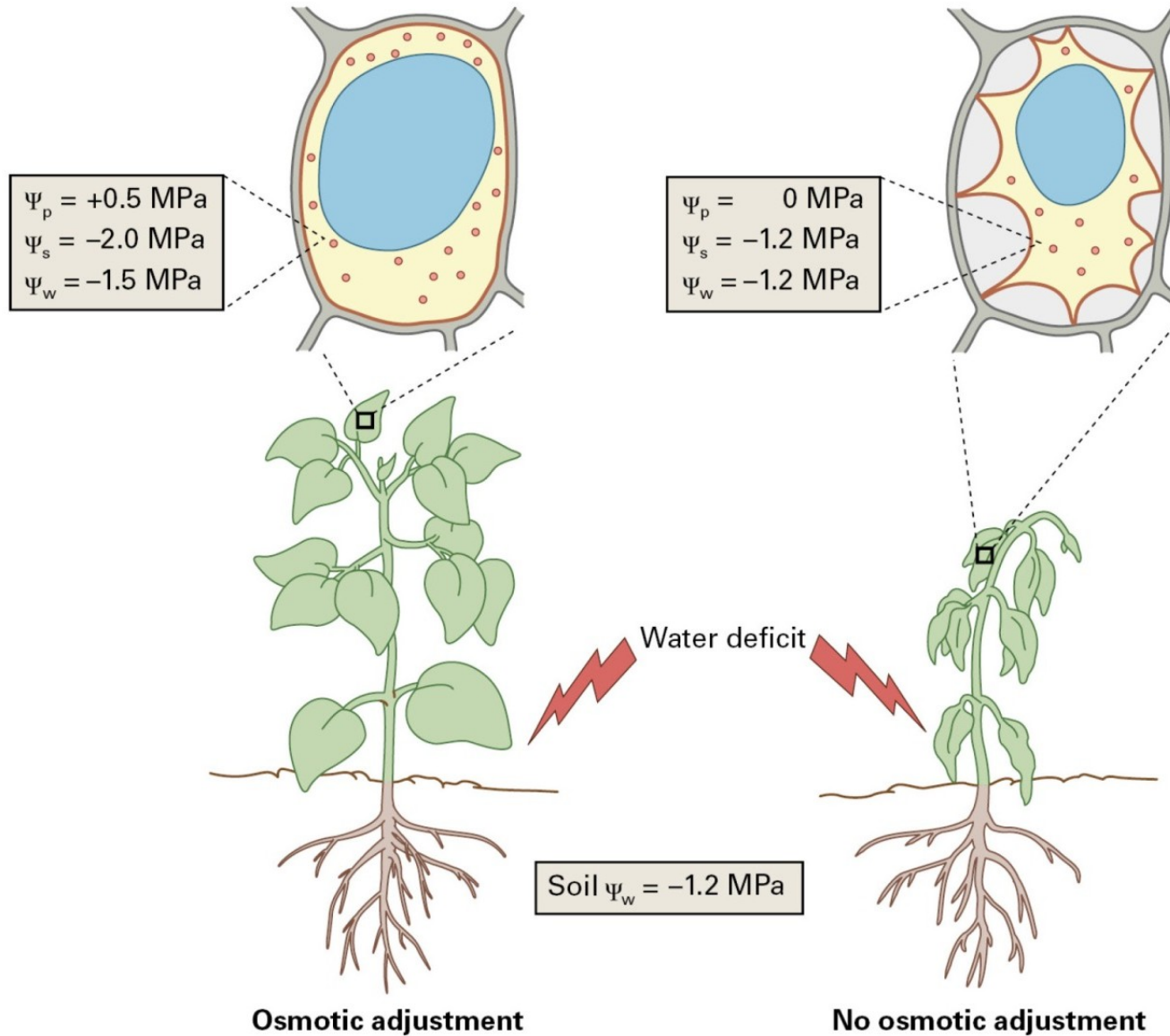
Abiotic stress



Abiotic stress

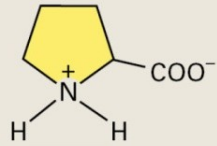


Water deficit



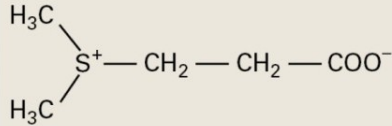
Compatible solutes

Amino acid:



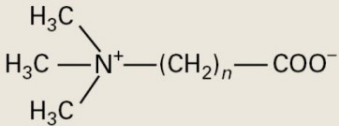
Proline

Tertiary sulfonium compound:

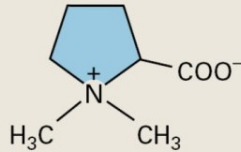


Dimethylsulfoniopropionate

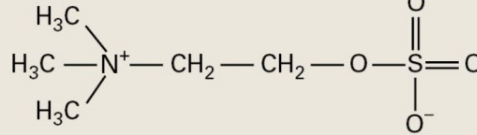
Quaternary ammonium compounds:



$n = 1$, Glycine betaine
 $n = 2$, β -Alanine betaine

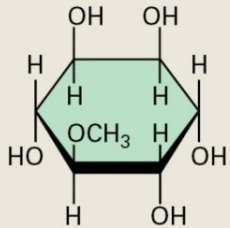


Proline betaine

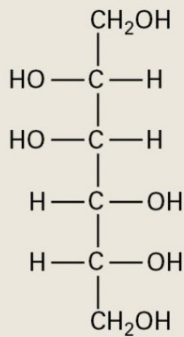


Choline-*O*-sulfate

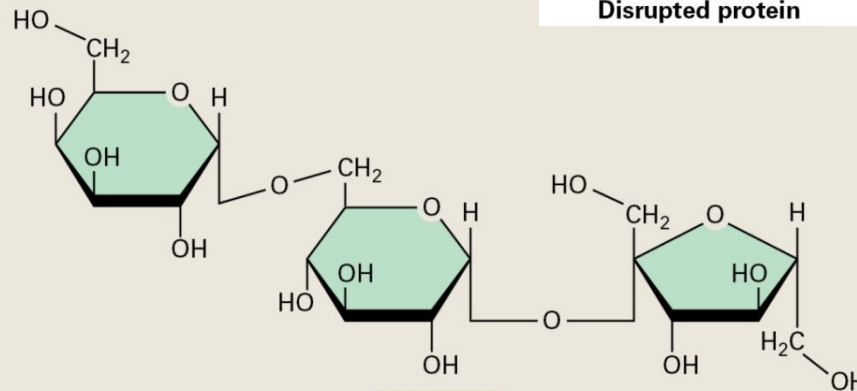
Polyhydric alcohols:



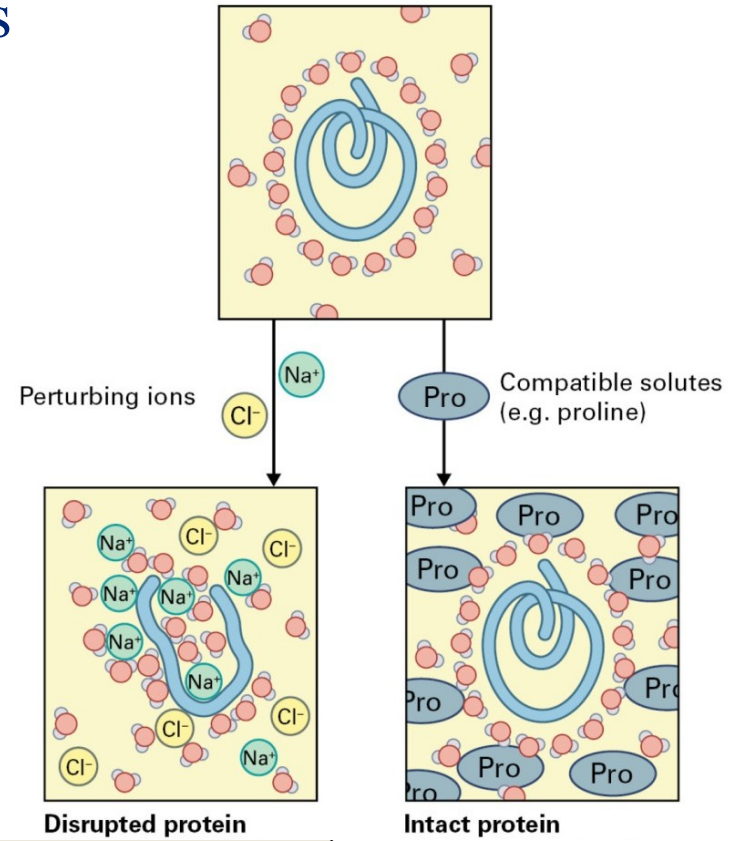
Pinitol



Mannitol

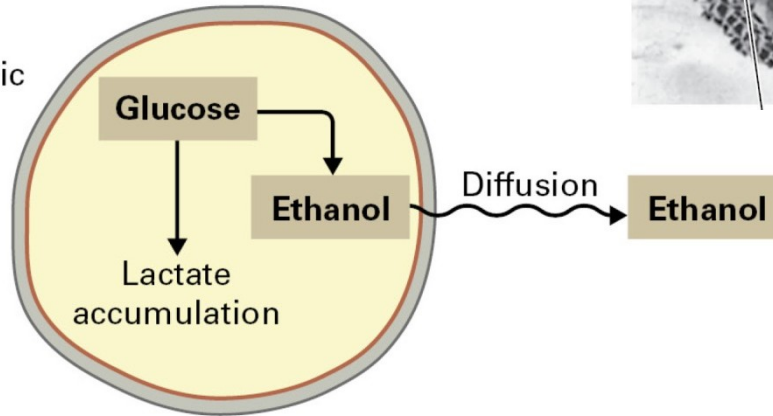
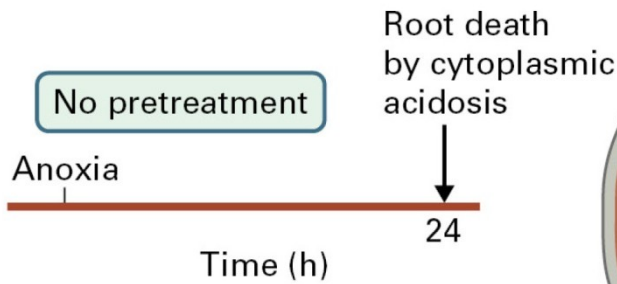
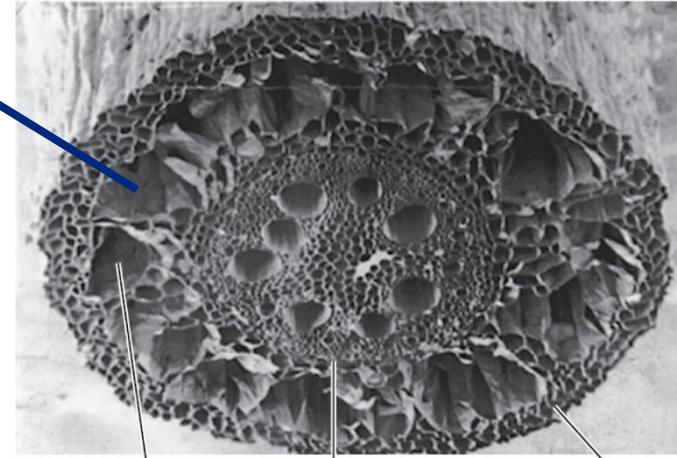


Raffinose

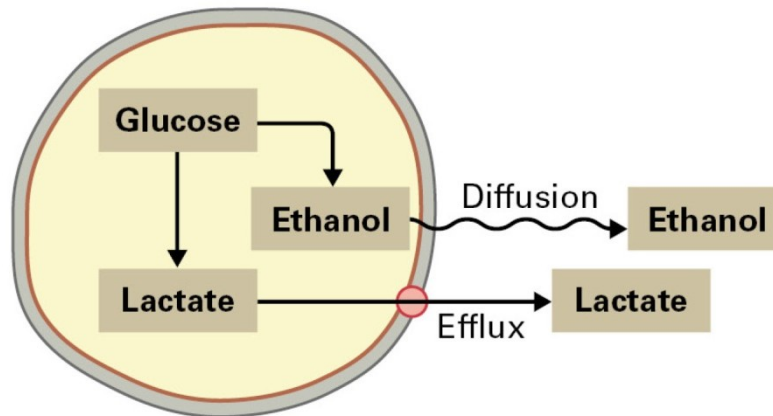
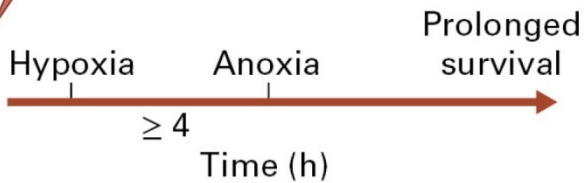


Flooding and oxygen deficit

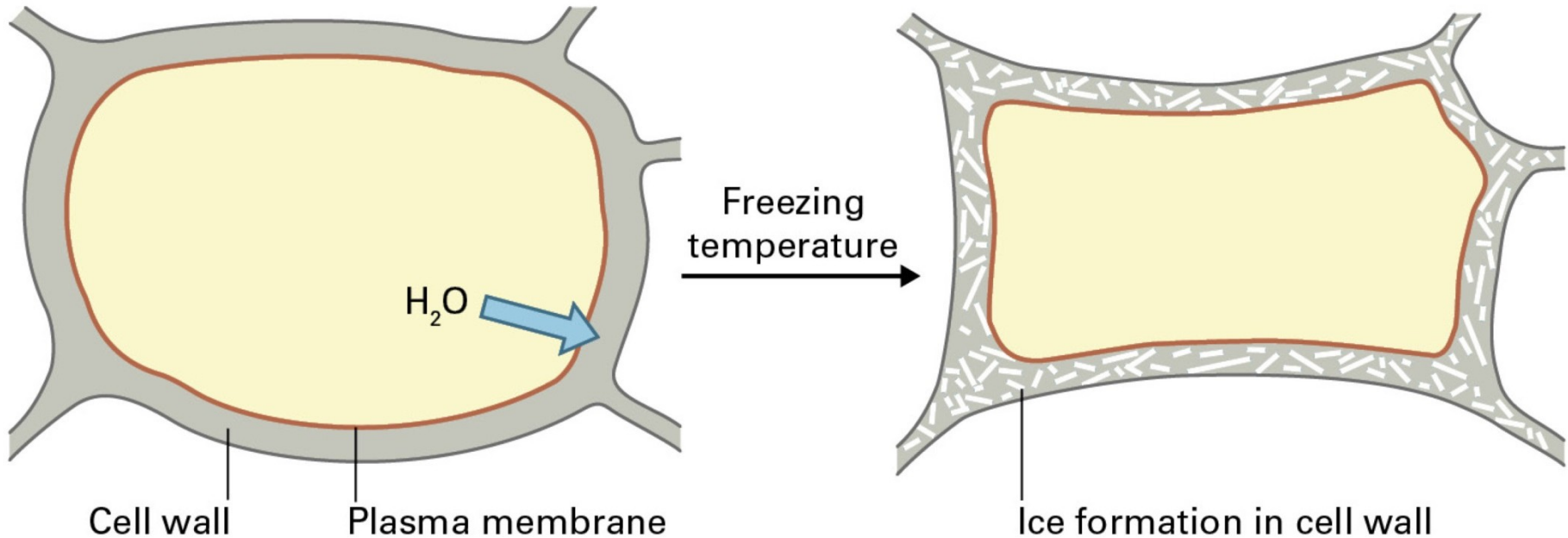
Aerenchyma



Hypoxic pretreatment



Low temperatures



Detrimental effects

- membrane solidification
- reductions in enzymatic reaction rates
- dehydration (freezing)
- mechanical stress (freezing)

Acclimation

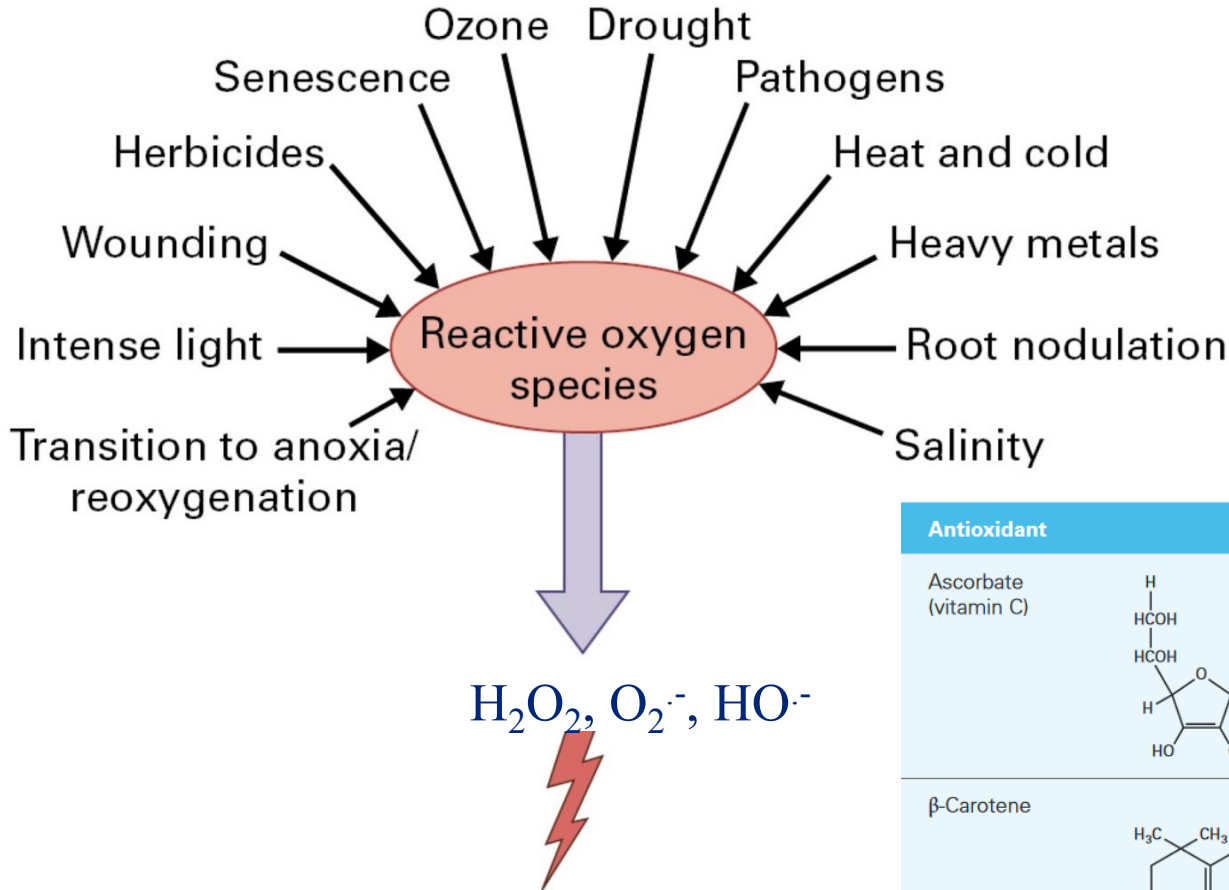
- membrane stabilization
- compatible solutes

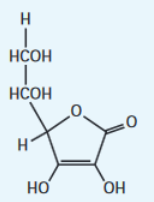
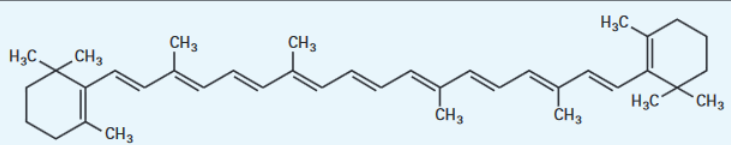
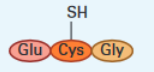
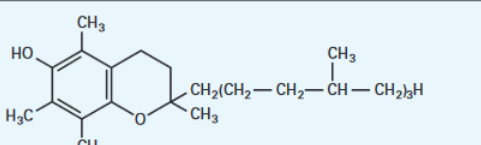


High temperatures

Protein classes	Size (kDa)	Major functions
HSP 100	100-114	Protein disaggregation, unfolding, degradation
HSP90	80-94	Maturation of signaling molecules
HSP70	69-71	Prevention of aggregation, assisting refolding, protein import and translocation, signal transduction, transcriptional activation
HSP60	60	Folding, assisting refolding
Small HSP	15-30	Prevention of aggregation, stabilization of nonnative proteins

Oxidative stress



Antioxidant	Structure
Ascorbate (vitamin C)	
β -Carotene	
Glutathione, reduced (GSH)	
α -Tocopherol (vitamin E)	

Ascorbate-glutathione cycle

