

Lecture 21:

Abiotic stresses

Chilling

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Chilling vs. Freezing

Chilling injury

Occurs at 10-15°C on plants grown at warm temperatures (25-35°C) → tropical and subtropical species are susceptible to chilling (maize, bean, rice, tomato, cucumber, cotton).

- Growth is slowed
- Discoloration or lesions
- Foliage looks soggy, as if soaked in water
- If roots are chilled, plants may wilt



Citrus leaf

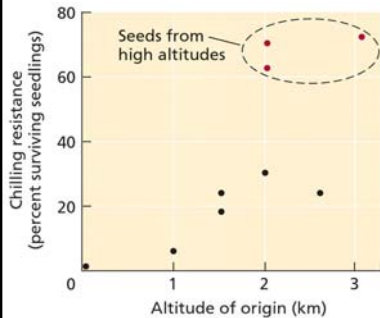
Freezing injury

Occurs at temperatures below freezing point of water.

Induction of tolerance to freezing (as with chilling) requires a period of acclimation at cold temperatures.

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Genetic adaptation to colder temperatures associated with high altitude improves chilling resistance



Survival at low temperature of seedlings of different populations of tomato collected from different altitudes in South America. Seeds collected from wild tomato (*Lycopersicon hirsutum*) and grown in the same greenhouse at 18-25°C. All seedlings were then chilled for 7 d at 0°C and kept for 7 d in a warm growth room, after which the number of survivors was counted.

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Membrane properties change in response to chilling injury

Plants injured by chilling show inhibition of photosynthesis, slower carbohydrate translocation, lower respiration rates, inhibition of protein biosynthesis, and increased degradation of existing proteins. These effects are collectively labeled as **Loss of membrane function during chilling**.

Solutes leak from leaves of chilling-sensitive *Passiflora maliformis* (conch apple) floated on water at 0°C, but not of those from chilling-resistant *Passiflora caerulea* (passionflower).

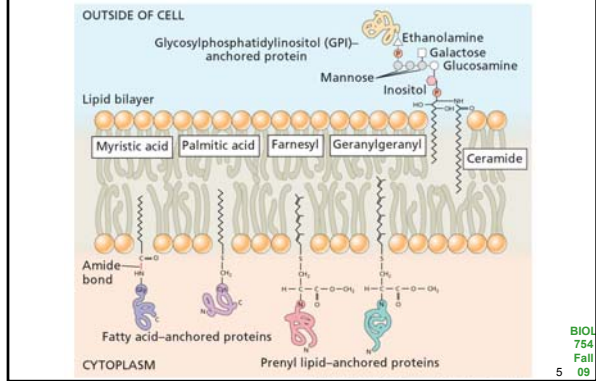
Loss of solutes to the water reflects damage to the plasma membrane and possibly also to the tonoplast.

Inhibition of photosynthesis and respiration reflects injury to chloroplast and mitochondrial membrane.

Why are membranes affected by chilling?

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Plant membranes consist of a lipid bilayer interspersed with proteins and sterols



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Membrane properties change in response to chilling injury

In chilling-sensitive plants, the lipids in the bilayer have a high percentage of saturated fatty acid chains (have no double bonds!) → tend to solidify into a semi-crystalline state at a temperature well above 0°C.

As membranes become less fluid, their protein components can no longer function normally → inhibition of H⁺-ATPase activity, solute transport in and out of cells, enzyme-dependent metabolism...

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