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**Plant Senescence and Cell Death 665**

**Programmed Cell Death and Autolysis 666**
- PCD during normal development differs from that of the hypersensitive response.
- The autophagy pathway captures and degrades cellular constituents within lytic compartments.
- A subset of the autophagy-related genes controls the formation of the autophagosome.
- The autophagy pathway plays a dual role in plant development.

**The Leaf Senescence Syndrome 671**
- The developmental age of a leaf may differ from its chronological age.
- Leaf senescence may be sequential, seasonal, or stress-induced.
- Developmental leaf senescence consists of three distinct phases.
- The earliest cellular changes during leaf senescence occur in the chloroplast.
- The autolysis of chloroplast proteins occurs in multiple compartments.
- The STAY-GREEN (SGR) protein is required for both LHCP II protein recycling and chlorophyll catabolism.
- Leaf senescence is preceded by a massive reprogramming of gene expression.

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- The NAC and WRKY gene families are the most abundant transcription factors regulating leaf senescence.
- ROS serve as internal signaling agents in leaf senescence.
- Sugars accumulate during leaf senescence and may serve as a signal.
- Plant hormones interact in the regulation of leaf senescence.

**Leaf Abscission 684**
- The timing of leaf abscission is regulated by the interaction of ethylene and auxin.

**Whole Plant Senescence 686**
- Angiosperm life cycles may be annual, biennial, or perennial.
- Whole plant senescence differs from aging in animals.
- The determinacy of shoot apical meristems is developmentally regulated.
- Nutrient or hormonal redistribution may trigger senescence in monocarpic plants.
- The rate of carbon accumulation in trees increases continuously with tree size.

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**Biotic Interactions 693**

**Beneficial Interactions between Plants and Microorganisms 695**
- Nod factors are recognized by the Nod factor receptor (NFR) in legumes.
- Arbuscular mycorrhizal associations and nitrogen-fixing symbioses involve related signaling pathways.
- Rhizobacteria can increase nutrient availability, stimulate root branching, and protect against pathogens.

**Harmful Interactions between Plants, Pathogens, and Herbivores 697**
- Mechanical barriers provide a first line of defense against insect pests and pathogens.
- Plant secondary metabolites can deter insect herbivores.
- Plants store constitutive toxic compounds in specialized structures.
- Plants often store defensive chemicals as nontoxic water-soluble sugar conjugates in the vacuole.
- Constitutive levels of secondary compounds are higher in young developing leaves than in older tissues.

**Inducible Defense Responses to Insect Herbivores 705**
- Plants can recognize specific components of insect saliva.
- Modified fatty acids secreted by grasshoppers act as elicitors of jasmonic acid accumulation and ethylene emission.
- Phloem feeders activate defense signaling pathways similar to those activated by pathogen infections.
- Calcium signaling and activation of the MAP kinase pathway are early events associated with insect herbivory.
- Jasmonic acid activates defense responses against insect herbivores.
- Jasmonic acid acts through a conserved ubiquitin ligase signaling mechanism.
- Hormonal interactions contribute to plant–insect herbivore interactions.
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