

School of Basic and Applied Sciences

Course Code : MSBS6002

Course Name: Plant Physiology

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Plant defense response

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Name of the Faculty: Dr. Manish Kumar Dubey

Program Name: M.Sc. Biological Science Sem III

INSECT PESTS AND DISEASE REPRESENT POTENTIAL BIOTIC STRESSES

- ✓ Typically, a plant challenged by insects or potentially pathogenic microorganisms responds with changes in the composition and physical properties of **cell walls**, the biosynthesis of **secondary metabolites** that serve to isolate and limit the spread of the invading pathogen.
- ✓ These responses are collectively known as a **hypersensitive reaction**.
- ✓ The hypersensitive reaction is commonly activated by viruses, bacteria, fungi, and nematodes and occurs principally in plants outside the pathogen's normal specificity range.
- ✓ Although the hypersensitive reaction is **complex** and can vary depending on the **nature of the causal agent**, there are common features that generally apply.
- ✓ An early event in this **sensing/signaling pathway** is the activation of **defense-related genes** and synthesis of their products, **pathogenesis-related (PR) proteins**.

INSECT PESTS AND DISEASE REPRESENT POTENTIAL BIOTIC STRESSES

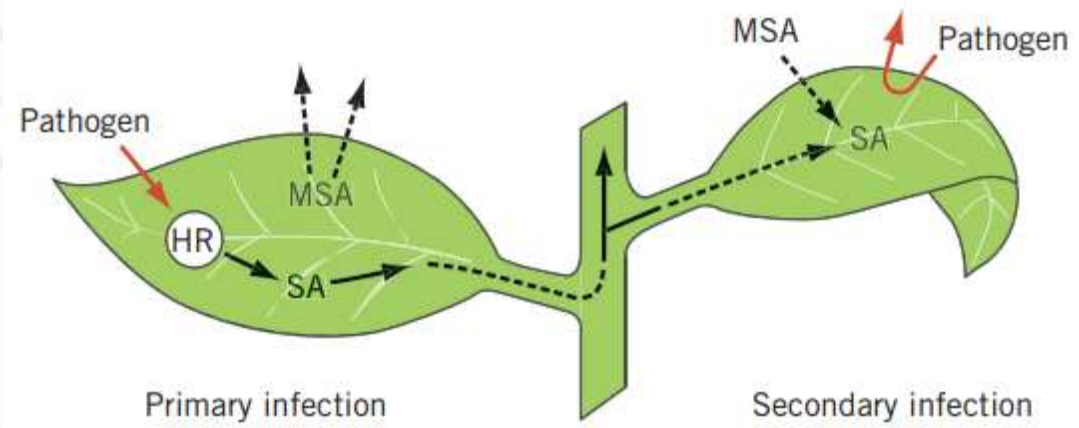
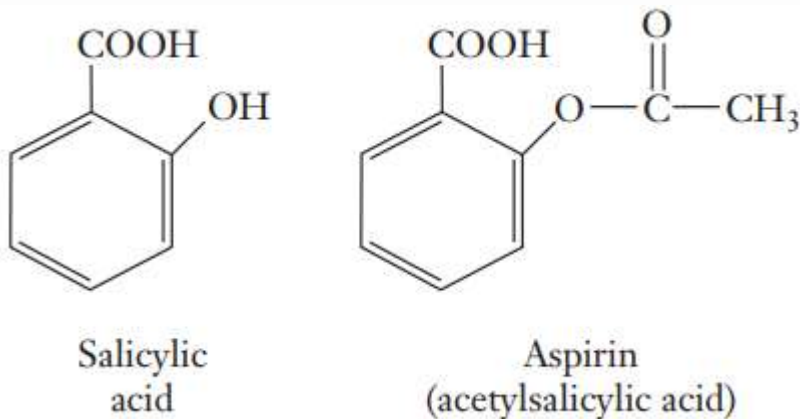
- ✓ PR proteins include **proteinase inhibitors** that disarm proteolytic enzymes secreted by the pathogen and **lytic enzymes** such as β -1,3-glucanase and chitinase that degrade microbial cell walls.
- ✓ Also activated are genes that encode enzymes for biosynthesis of **isoflavonoids and other phytoalexins** to limit the growth of pathogens.
- ✓ **Lignin, callose, and suberin** accumulated in cell walls along with **hydroxyproline-rich glycoproteins** that provide structural support to wall.
- ✓ These deposits strengthen the cell wall and render it less susceptible to attack by the invading pathogen.
- ✓ Finally, the invaded cells initiate **programmed cell death**, a process that results in the formation of **necrotic lesions** at the infection site.
- ✓ Cell necrosis isolates the pathogen, slowing both its development and its spread throughout the plant.

SYSTEMIC ACQUIRED RESISTANCE REPRESENTS A PLANT IMMUNE RESPONSE

- ✓ Some secondary metabolites associated with the hypersensitive reaction appear to constitute **signal transduction pathways** that prepare other cells and tissues to resist secondary infections.
- ✓ Initially the hypersensitive reaction is limited to the few cells at the point of invasion, but over a period of time, ranging from hours to days, the capacity to resist pathogens gradually becomes distributed throughout the entire plant.
- ✓ In effect, the plant reacts to the initial infection by slowly developing a general immune capacity.
- ✓ This phenomenon is known as **systemic acquired resistance (SAR)**.
- ✓ The development of SAR is still not completely understood, but one component of the signaling pathway appears to be **salicylic acid**.
- ✓ Salicylic acid (2-hydroxybenzoic acid) is a naturally occurring secondary metabolite with analgesic properties.

SYSTEMIC ACQUIRED RESISTANCE REPRESENTS A PLANT IMMUNE RESPONSE

- ✓ Native North Americans and Eurasians have long used **willow bark** (*Salix sps.*), a source of the salicylic acid glycoside, **salicin**, to obtain generalized relief from aches and pains.
- ✓ **Role**- The appearance of PR proteins rises **in parallel** with salicylic acid. The rise in salicylic acid levels usually precedes the development of SAR.
- ✓ Salicylic acid levels can also be reduced by direct inhibition of the enzyme **phenylalanine-ammonia lyase (PAL)**, which catalyzes the first step in the biosynthesis of salicylic acid.



JASMONATES MEDIATE INSECT AND DISEASE RESISTANCE

- ✓ On the basis of recent experiments, it appears that **jasmonates**, especially **jasmonic acid** and its methyl ester (**methyljasmonate**), also mediate insect and disease resistance.
- ✓ Jasmonates have been found to occur throughout plants, with **highest** concentrations in **young, actively growing tissues**.
- ✓ Methyljasmonate is the principal constituent of the **essential oil** of *Jasminium* and high concentrations of jasmonic acid have been isolated from fungal culture filtrates.
- ✓ There are some similarities in the action of salicylic acid and jasmonates with respect to insect and disease resistance, but there are also some important distinctions.
- ✓ In a study of two fungal resistance genes in *Arabidopsis*, for example, it was found that expression of one gene was induced by salicylic acid, but **not jasmonic acid**, while the second gene was induced by jasmonic acid but not salicylic acid.

JASMONATES MEDIATE INSECT AND DISEASE RESISTANCE

- ✓ Apparently there are at least **two defensive pathways**, one mediated by salicylic acid and one mediated by jasmonates.
- ✓ Jasmonic acid is synthesized from the **unsaturated fatty acid**, linolenic acid, which has led to the proposal that jasmonic acid functions as a type of **second messenger**.
- ✓ Seed and pollen germination, vegetative protein storage, root development, and tendrils coil in concert with ethylene.

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References

- ✓ Hopkins, W.G. and Hüner, N.P.A. 2009. Introduction to plant physiology, 4th ed. John Wiley & Sons, Inc.
- ✓ Taiz, L. and Zeiger, E. 2002. Plant Physiology, 3rd ed. Sinauer Associates.

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