

## **CONIFER DEFENSE AGAINST INFECTION BY *OPHIOSTOMA* AND *CERATOCYSTIS***

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Conifers are large and long-lived organisms that have evolved a wide range of defense mechanisms to deal with Ophiostomatoid fungi and a large diversity of other potential attackers. The basic defense strategy is one of constitutive mechanical and chemical defenses that overlap in space and time. Prominent constitutive defenses in conifers are sclerenchyma in the form of stone cells or fiber rows, cells with phenolic bodies, resin producing structures, and calcium oxalate crystals. Because defense is costly in terms of energy and material, not all defenses are expressed constitutively under normal growth. Overlaid with the basic defense strategy is therefore the capacity to up-regulate additional, inducible defenses, such as the formation of wound periderms and traumatic resin ducts. The combination of constitutive and inducible defense systems provides a potent defense against attack; the constitutive defenses inhibit initial attacks, whereas inducible defenses ensure that initial invasions are perceived and dealt with effectively. Acquired or systemic defense can be considered as a variation of inducible defense that acts at some distance from the initial attack, is delayed in time, and has persistent properties. The basic function of stem defenses in conifers is to protect the nutrient- and energy-rich phloem, the vascular cambium, and the transpiration stream in the sapwood. Independent of the attacking organism, there are four basic steps or phases of defense systems in conifers. The first phase is an effective constitutive defense that repels or inhibits invasion. If this fails, the next phase is to kill or compartmentalize the invading organism. The third phase is to seal and repair damage to ensure that the plant can continue to function normally and prevent opportunistic infections. Finally, acquired or systemic resistance may be induced so that future attacks can be dealt with more effectively.