maize required for cell death during sex determination are closed down in this species. Sex determination involves the selective killing of female reproductive structures for the survival of male floral arrangements that may develop in the tassel.

Recent work by Cheung and colleagues has suggested that PCD also occurs in the transduction tissue through which pollen tubes grow. The process is selective since the tissues surrounding the transduction tissue in the pistil remain intact. Cell activity appears to be correlated with pollen tube growth, since incompatible pollen does not elicit cell death. PCD also occurs during reproductive development in plants. The cells of the tapetum, the cell layer that surrounds the developing pollen grains in the anthers, undergo a precise programme of breakdown that results in the release of their content, providing nutrients for the plant. The best-studied examples of ROS-derived PCD are those following the typical biphasic oxidative burst during both HR and the response to ozone stress. The ensuing cell death is characterized by discrete cellular lesions that are preceded by the appearance of several hallmarks of PCD, such as chromatin condensation, DNA laddering, and cytochrome c release (Lam, 2004).

Additional evidence for ROS dependent PCD in plants has been provided by transgenic plants deficient in catalase (Cat1AS), which is the major H_2O_2 scavenging enzyme. In plants, in addition to mitochondria, chloroplasts are also necessary for supplying ROS and can generate intermediate signals involved in PCD. For example, during cryptogenic induced PCD, H_2O_2 dependent activation of lipoxygenases targets chloroplastic polyunsaturated fatty acids, thus releasing oxylipins that are sufficient for inducing PCD (Montillet et al., 2005). Therefore, redox dependent plant PCD involves a range of signaling molecules, but this interactive regulatory network is only now starting to be elucidated [**39**].

Functions

PCD performs an essential function in plants, although its role remains to be determined in a number of cases. PCD, in its most dramatic occurrence in plants, results in the development of the vascular system. Secondly, if vascular bundles are severely wounded such that parenchyma cells are induced to redifferentiate into xylem, then PCD results in tracheary xylem elements functioning as long conducting tubes to transport water from the roots to the rest of the plant and providing mechanical support. Third, many tissues experience damage caused by pathogen invasion, resulting in

the disruption of normal function. In such cases, PCD protects the tissues from pathogen attack. Fourth, though its role during pollen tube elongation has not been firmly established, PCD results in the provision of nutrients to growing cells. Fifth, pollen tubes require many nutritional elements during their growth. In some instances, the other elements needed to support normal function.

As such, PCD allows the physical accommodation of growing pollen tubes. Sixth, a dramatic hallmark of the resistance response of plants is the induction of a localized cell death response at the site of infection. A hypersensitive reaction is a widespread phenomenon that is responsible for the activation and establishment of plant immunity to certain diseases. Hence, the HR is an excellent example of programmed cell death, leading to rapid, localized cell death at infection sites. It contributes to the limitation of growth and the spread of the invading pathogen.

The functions and necessity of PCD for plant development and defense determine the underlying regulatory mechanism and process by which PCD is executed. Without its occurrence, in some instances, plants would be unable to perform their normal functions and would struggle to survive [**40**]. It leads to the revival of different parts of the plant body and regenerates them accordingly. Cell death occurs predictably at specific sites and time points throughout the life history of flowering plants. For example, the cells of the suspensor, the embryonic organs that attach the embryo proper to the maternal tissues and supply it with nutrients, die before the embryo matures. In particular examples, such as that of *Monstera* sp., PCD plays a vital role in the generation of leaf shape. PCD also plays an essential role during reproductive development in plants. As a result of PCD, in many unisexual flowers, male and female organ growth is initiated and inappropriate organs are aborted during floral development. Moreover, the H_2O_2 hypersensitive response (HR) activates PCD, which is essential for limiting a plant pathogen's nutrient supply.