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7 Heavy Metal Resistance and Phytoremediation with Transgenic Trees

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7.1 Introduction

Phytoremediation is the technology that uses plants to remove or degrade various pollutants from the environment. It has received significant scientific and commercial attention during the last decades (Salt et al. 1998; Gleba et al. 1999; Meagher 2000; Dietz and Schnoor 2001; Guerinot and Salt 2001; Krämer and Chardonnens 2001; van der Lelie et al. 2001; Schwitzguébel et al. 2002; Hannink et al. 2002; McGrath and Zhao 2003; Vassilev et al. 2004; Krämer 2005; Peuke and Rennenberg 2005a,b; Pilon-Smits 2005). Salt et al. (1998) and Dietz and Schnoor (2001) distinguish between different types of phytoremediation: (1) phytoextraction, (2) phytodegradation/-transformation, (3) rhizofiltration (removal of pollutants from aqueous phases by plant roots), (4) phytostabilization, (5) phytovolatilization (using plants to volatilise pollutants), and (6) removal of pollutants from the air by plants. Most attention is focussed on phytoextraction, phytodegradation and phytostabilization (Fig. 7.1).

For phytoextraction, plants are grow on contaminated soil and harvested from time to time while the biomass can be used in different ways depending on the type of contamination. As an example, plant material can be burned for energy gain (Fig. 7.1a). The aims are to remove pollutants from the soil and to concentrate them in biomass; final combustion of plant material will concentrate contamination further by a factor of around 10 in dry matter. The resulting ashes must be deposited in conventional dumps or added to a smelter. Recovery of metals from plant tissue ("phytomining"), which was done in the case of potassium ("potash") for centuries by humans, may be economical (Meagher 2000; van der Lelie et al. 2001). Phytomining may constitute a "green" alternative to existing, environmentally destructive, opencast mining practice or to exploitation of ore bodies which are uneconomic by conventional methods (Brooks et al. 1998). Plants are also able to take up radioisotopes like ^{134}Cs and ^{137}Cs which are of environmental concern after discharges from nuclear installations (White and Broadley 2000; Schwitzguébel et al. 2002).

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Tree Transgenesis: Recent Developments