Abstract
Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental pollutants reaching particularly high concentrations in industrial soils. Concern about PAHs stems from their high recalcitrance and (geno)toxicity, posing a serious risk for both humans and ecosystems. Bioremediation, which exploits the natural microbially-mediated degradation of organic compounds, is the most cost-effective and sustainable clean-up technology, causing relatively minor impact on key natural soil functions. However, its success is still constrained by several factors, including i) the unpredictable endpoint concentrations; ii) the lack of adequate monitoring tools to accurately assess \textit{in situ} biodegradation processes; and iii) inadequate risk assessment policies that overlook the co-occurrence and fate of other toxicologically relevant compounds, such as oxygenated PAHs (oxy-PAHs) and nitrogen-containing heterocyclics (azaarenes). To overcome these limitations and optimize the outcome of this biotechnology, it is necessary to understand the underlying microbial degradation processes. To achieve this goal, a progressive approach of increasing complexity is used that expands from the study of the metabolic pathways for PAH biodegradation by pure cultures to the application of \textit{omic} tools to identify the actual processes occurring during the active bioremediation of a PAH-polluted soil.