

Besides the reduced fitness costs explained above, other mechanisms are believed to contribute to antibiotic resistance persistence even in the absence of selective pressures. The toxin–antitoxin system has been suggested as an important factor for the stabilization of ARGs and metal or biocide resistance genes that are co-transferred by conjugative plasmids. It is supposed that these plasmids would be more persistent when vertically transferred from one generation to the next, even in the absence of selective pressure, since the toxin–antitoxin systems stabilize plasmids in their hosts by killing daughter cells that do not inherit the plasmid (Pal et al. 2015). The toxin–antitoxin system is responsible for the production of a toxin and of an antidote for that toxin (antitoxin). If the plasmid is absent in a daughter cell, the unstable antitoxin is degraded and the stable toxic protein kills the new cell; this is known as post-segregation killing (Van Melderer and De Bast 2009).

Besides exposure to antimicrobials, many other adaptive stress responses may influence the susceptibility to antibiotics since they may impact many of the same components and processes that are targeted by antimicrobials. Some non-antimicrobial agents have been described as potential selectors for antibiotic resistance. Some examples are feed or food preservation agents, such as phenazopyridine or sepiolite, or sub-lethal concentrations of salt and acidic pH as well as herbicides, such as glyphosate, widely used in agriculture and gardening (McGowan et al. 2006; Amabile-Cuevas and Arredondo-Garcia 2013; Rodriguez-Beltran et al. 2013; Kurenbach et al. 2015). In addition, nutrient starvation, oxidative stress, thermal shock, and cell envelope damage are among the factors compromising the cell growth by stimulating protective changes in cell physiology or in lifestyle (biofilm formation) or inducing mutations (Poole 2012).

In summary, a wide range of conditions, including those promoted by micro-pollutants, prevailing in the different ecological niches (animal and human hosts, feed and food products, anthropogenic impacted environments) may contribute to the overall increase and dissemination of antibiotic resistance.

10.8 Paths of Antibiotic Resistance Dissemination

The human and animal intestinal tracts favor the occurrence of antibiotic resistance selection and/or HGT (Shoemaker et al. 2001; Sommer et al. 2010), as these are considered important reservoirs of ARB and ARG (Salysers et al. 2004) as well as livestock and aquaculture as other reservoirs in the environment (Landers et al. 2012; CDC 2013; Woolhouse et al. 2015). All these sources have the potential to supply ARB and ARG to the environment, where they can accumulate and spread through aquatic systems and soils (Figure 10.2). The use of animal manure or compost to amend agriculture soils, a practice that is in line with the nowadays so appreciated organic farming, is another potential