Abstract: Extensive industrial activities have led to an increase in the content of chromium in the environment, which causes serious pollution to the surrounding water, soil and atmosphere. The enrichment of chromium in the environment through the food chain ultimately affects human health. Therefore, the remediation of chromium pollution is crucial to the development of human society. A lot of scholars have paid attention to bioremediation technology owing to its environmentally friendly and low cost. Previous reviews mostly involved the pure culture of microorganisms and rarely discussed the optimization of bioreduction conditions. To make up for these shortcomings, we not only introduced in detail the conditions that affect microbial reduction but also innovatively introduced consortium which may be the cornerstone for future treatment of complex field environments. The aim of this study is to summary chromium toxicity, factors affecting microbial remediation, and methods for enhancing bioremediation. However, the actual application of bioremediation technology is still facing a major challenge.

The detoxification process is inclusive of bioreduction and biosorption. When microorganisms are exposed to Cr( ), related genes will be up-regulated (Chr promoter and copZ) to prevent intracellular molecules from being destroyed. Microorganisms provide electrons to reduce Cr( ) through autogenous enzymes or externally added reducing substances. The pH, temperature, concentration, and electron donor are the major factors affecting the bioreduction owing to their close correlation with enzyme activity. Biosorption is mainly based on electrostatic force, combined with chromium oxide anions through functional groups (hydroxyl, carboxyl, amino, etc. on the cell surface. Bioaccumulation is the active uptake of Cr(VI) by living cells, a process that usually depends on the forms and bioavailability of Cr(VI) and is also dependent on nutrients such as energy and carbon sources. The combination of these exogenous additives and mixed culture microorganisms greatly improves the tolerance and reduction efficiency of microorganisms.

In previous reports on bioremediation technology, the main object of remediation was water bodies, and arable land is currently facing severe heavy metal pollution, so future microbial remediation technology should also target the soil and atmosphere. In response to the research, deficiencies have been proposed, the following suggestions are put forward: 1. Due to the complex actual environmental conditions, especially the soil, it is difficult to achieve the purpose of governance using purely cultured microorganisms. The use of the mixed culture of microorganisms can improve the adaptability to the environment and the efficiency of treatment through the synergy between microorganisms. For the complex medium of soil, the effect of using microorganisms alone may not be obvious. Therefore, combining plants and microorganisms can promote the application of microorganisms in soil and improve the viability of microorganisms. At the same time, the evolution of microorganisms under different soil media and geochemical conditions can also be considered. 3. Polluted sites contain more than one type of heavy metal, so it is necessary to screen microorganisms that can reduce or adsorb multiple heavy metals. 4. The efficiency of bioremediation is lower than that of physical and chemical materials and it also takes a long time to remove heavy metals. Future research can focus on the combination of microbes and nanomaterials or consortium to improve treatment efficiency.