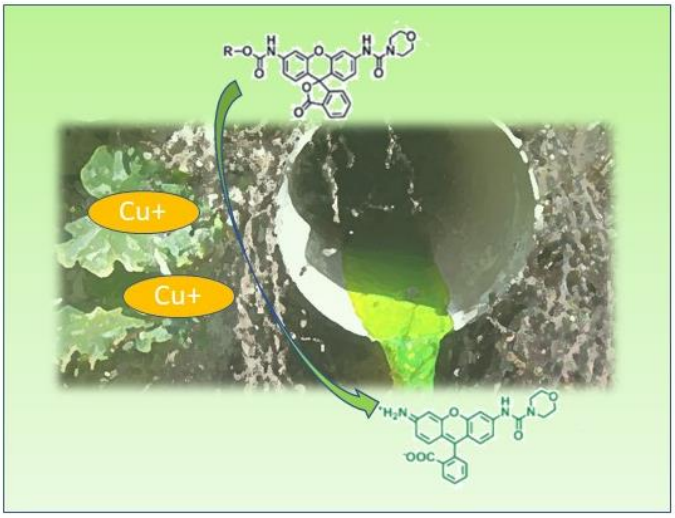
Catalytic Applications for Heavy Metals Bio-recovery

Isabella Rimoldi, Giorgio Facchetti, Raffaella Gandolfi, Milena Colombo, Sarah Zecchin, Lucia Cavalca.

Many enzymes and proteins use transition metals as cofactors, which play a key role both at allosteric and catalytic level. Some examples are Fe^{2+} in ferritin, Cu^{2+} in copper transport channels Ctr1, Zn^{2+} in carbonic anhydrase.[1] A valid approach for obtaining new hybrid catalyst consists in taking inspiration from natural origin building blocks involved in the coordination with a metal or in the possibility to evaluate new type of biomass able to coordinate a transition metal. A possible source for building this last type of catalysts should be, in the field of the circular economy, the bio-recovery of heavy metals by using heterotrophic bacteria and algae via adsorption. In particular, the role of EPS resulted fundamental in the adsorption and in the coordination to metals allowing to obtain metal-organic complexes to be used for biocatalytic application without further purification.[2]

The capability of bacterial EPS to coordinate heavy metals such copper, nickel and zinc, allowed to evaluate their application in different types of reactions such as hydrolysis and C-C bond formation.[3] This biocatalytic approach was included in the circular economy project "Heavy Metal Biorecovery and Valorization – HMBV". Here, industrial metal-contaminated wastewaters are treated by EPS-producing bacteria as first step of decontamination treatment, and the subsequent recovery of the metal-bearing biomass constitutes the metal-organic complexes to be used for biocatalytic application.



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[1] Schwizer F., Okamoto Y., Heinisch T., Gu Y., Pellizzoni M.M., Lebrun V., Reuter R., Kohler V., Lewis J.C., Ward T. R., Artificial Metalloenzymes: Reaction Scope and Optimization Strategies, Chem. Rev., 2018, 118, 142-231.

[2] Gupta P., Diwan B., Bacterial Exopolysaccharide mediated heavy metal removal: A Review On biosynthesis, mechanism and remediation strategies. Biotechnol. Rep., 2017, 13, 58–71.

[3] Liu Y., Turunen P., de Waal B.F.M., Blank K.G., Rowan A.E., Palmans A.R.A., et al. Catalytic single-chain polymeric nanoparticles at work: from ensemble towards single-particle kinetics. Molecular Systems Design & Engineering. 2018;3(4):609-18.