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A Review of Green Synthesis of Metal Nanoparticles Using Algae

*Abhishek Mukherjee[1], Dhruba Sarkar[2] and Soumya Sasmal[3]**

[1] Department of Biotechnology, Heritage Institute of Technology, Kolkata, India, [2] Department of Biochemistry, School of Medicine, Vanderbilt University, Nashville, TN, United States, [3] Department of Biological Sciences and Engineering, Netaji Subhas University of Technology, New Delhi, India

The ability of algae to accumulate metals and reduce metal ions make them a superior contender for the biosynthesis of nanoparticles and hence they are called bio-nano factories as both the live and dead dried biomass are used for the synthesis of metallic nanoparticles. Microalgae, forming a substantial part of the planet's biodiversity, are usually single-celled colony-forming or filamentous photosynthetic microorganisms, including several legal divisions like Chlorophyta, Charophyta, and Bacillariophyta. Whole cells of *Plectonema boryanum* (filamentous cyanobacteria) proved efficient in promoting the production of Au, Ag, and Pt nanoparticles. The cyanobacterial strains of Anabaena flos-aquae and *Calothrix pulvinate* were used to implement the biosynthesis of Au, Ag, and Pt nanoparticles. Once synthesized within the cells, the nanoparticles were released into the culture media where they formed stable colloids easing their recovery. *Lyngbya majuscule* and *Chlorella vulgaris* have been reported to be used as a cost-effective method for Ag nanoparticle synthesis. Dried edible algae (*Spirulina platensis*) was reported to be used for the extracellular synthesis of Au, Ag, and Au/Ag bimetallic nanoparticles. Synthesis of extracellular metal bio-nanoparticles using *Sargassum wightii* and *Kappaphycus alvarezi* has also been reported. Bioreduction of Au (III)-Au (0) using the biomass of brown alga, *Fucus vesiculosus*, and biosynthesis of Au nanoparticles using red algal (*Chondrus crispus*) and green algal (*Spyrogira insignis*) biomass have also been reported. Algae are relatively convenient to handle, less toxic, and less harmful to the environment; synthesis can be carried out at ambient temperature and pressure and in simple aqueous media at a normal pH value. Therefore, the study of algae-mediated biosynthesis of metallic nanoparticles can be taken toward a new branch, termed phyco-nanotechnology.

Keywords: nanoparticles, biosynthesis, algae, bio-nano factories, environment-friendly, psycho nanotechnology

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****Correspondence:***
Soumya Sasmal
sasmal@nsut.ac.in

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INTRODUCTION

Green synthesis has become a reliable, sustainable, and ecological protocol for the synthesis of numerous nanomaterials such as metal oxides, hybrids, and bio-inspired materials in the field of materials science (Singh et al., 2018). Metallic nanoparticles are already intriguing scientists for more than a century and are now utilized widely in biomedical sciences and engineering