# Chapter 4
# Green Approaches to Environmental Sustainability

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## ABSTRACT

*The development of different eco-friendly technologies in material synthesis is playing its role to expand their biological applications. Nanoparticles are synthesized chemically, but because of their hazardous effects, the researchers have now turned to biological systems for inspiration. There is a growing concern about the possible results of effects of chemical synthesis of nanoparticles. Therefore, the aim of this chapter is to provide an overview of how nanomaterials can be synthesized using green route to play its role in environmental sustainability as green synthesis processes are considered to be a safe alternative to routine processes due to their cost effectiveness, easy to handle, and environmentally friendly nature. In fact, it opens a new scope for phyto-chemists by discouraging the use of toxic chemicals.*

## INTRODUCTION

The word environment is usually associated with the impact of human on natural system and this then differentiates it from the commonly used word ecological, which is considered as a concept of interdependence of elements within the system. Basically the ecological definition of sustainability is a biological conservation. So, ecological sustainability is basically to meet the human needs without compromising the ecosystems health (Morelli, 2013). Recently, the importance of sustainable development and environmental issues has increased both in the developing and developed nations (Sharma & Gupta, 2015). The total material health of humanity was improved over the past century (Steffen et al., 2011), but in present century we are facing the scarcity of resources, erosion of our earth capability to absorb our wastes and degradation of ecosystem services and the issue of equity is still difficult to solve and the situation is a threat to flexibility of our earth.

The advance of eco-friendly technologies in material synthesis is significantly important in order to enhance their biological applications. Today, variety of inorganic nanoparticles have been synthesized with distinct chemical composition, morphology and size using different microorganisms along-with

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their applications in various cutting edge technology have also been explored ( Li, Xu, Chen, & Chen, 2011) . Although nanomaterials maybe synthesized using different chemical methods, but now it is possible to include the use of biological materials (Mohanpuria, Rana, & Yadav, 2008). To synthesize the nanoparticles using the green route really opens a new scope for the phyto-chemist and at the same rime discourages the use of different toxic chemicals (Kumar, Smita, Cumbal, & Debut, 2017). This green synthesis is regarded as safer alternative to usual chemical, microbial and physical methods due to easy to handle, environmental friendly and cost-effective nature (Saha, Begum, Mukherjee, & Kumar, 2017). In the past few years the experimental and theoretical research on biological nanomaterials has attained all the attention with emphasis on biophysics, biochemistry, electromagnetism and thermodynamics and biomechanics of protein and nucleic acid and its composites are playing the lead role in material and life sciences. (Qin, Liu, & Dong, 2017).

In the present chapter we will discuss the environmental sustainability, factors effecting the environment, comparison between the chemical and biosynthetic route of nanoparticle synthesis, synthesis of nanoparticles using green routes with brief light on different fields of applications.

## BACKGROUND

Biosynthesis of nanoparticles by plant extracts is currently under exploitation. Nanoparticles are a class of materials with properties distinctively different from their bulk and molecular counterparts (Biswas & Wu, 2005). Plant extracts are cost effective and eco-friendly and they are the efficient alternative for the large scale production of nanoparticles (Dubey, Bhadauria, & Kushwah, 2009). With the development of different physical and chemical methods, the concern for environmental contaminations are heightened as the chemical procedures involved in the synthesis of nanomaterials generate a large amount of hazardous byproduct emphasizing a need for 'green chemistry' that includes a clean, nontoxic and environment-friendly method of nanoparticle synthesis (Mukherjee et al., 2001). Nanotechnology has become a popular technology in recent years and addresses nanoparticles that are atomic or molecular aggregates characterized by size of less than 100 nm (Fatimah, 2016). Due to the unique features and applications of the nanoparticles, they are very useful especially in the field of medical imaging, biotechnology, and catalysts (Bagherzade, Tavakoli, & Namaei, 2017).

In recent years different environmentally friendly methods have been employed in the synthesis of nanoparticles, and in this regard over the last few decades the use of plants has been growing increasingly in the world (Balayssac et al., 2009). The principles of green chemistry have been spreading since the mid-1990s, connected with advances in nanomaterial synthesis and lately these two groups have begun to significantly converge. Nanomaterial synthesis groups are developing greener, more sustainable production methods, while nanoparticle application groups are exploring sustainable energy sources and environmental remediation as end goals (Murphy, 2008).

There are different chemical and physical methods that have been exploited in the synthesis of several inorganic metal nanoparticles by using different methods like, ultraviolet irradiation, wet and dry approaches viz, lithography, aerosol technologies, laser ablation, ultrasonic fields, and photochemical reduction techniques. But these methodologies are still expensive and they involve the use of hazardous chemicals. Hence, there is a growing concern for the development of alternative environment friendly and sustainable methods. Increasing awareness towards green chemistry and biological processes has led to a necessity to develop simple, cost-effective and eco-friendly procedures (Narayanan & Sakthivel, 2011)