

## Chapter 53

# Toxic Effects of Engineered Nanoparticles on Living Cells

**Manel Bouloudenine**

*Mohamed Chérif Messaâdia University, Algeria & Badji Mokhtar University, Algeria*

**Mohamed Bououdina**

*University of Bahrain, Bahrain*

### ABSTRACT

*Measuring toxic effects of engineered nanoparticles on living cells would require a deep understanding of themselves by the mean of their composition, physical and chemical properties and exposure concentrations. Actually, high exposure concentrations are needed to generate quantifiable effects and to perceive accumulation above background. This chapter presents an overview on the assessment about the toxic effects of engineered nanoparticles on living cells. It consists of three main sections starting with a brief introduction, the current state of engineered nanoparticles in the environment, physical and chemical properties of some important engineered nanoparticles such as “Ag, Au, ZnO, TiO<sub>2</sub>” and the target organ toxicity of the engineered nanoparticles in several biological organisms.*

### INTRODUCTION

Because of their small-scale technology which means in scientific terms, ‘Nano’ where one nanometer is equivalent to one billionth of a meter, the nanoparticles (NPs) have the ability to interpose at a cellular level of living organs. They easily enter into the living cells, which may cause hostile effects on the environment and human health at their entry. Meanwhile, the potential development of nanotechnologies is expected to become new source of human or environmental risks through inhalation, ingestion, skin applications, or injection of engineered nanoparticles in factories, drugs or the use of customer foodstuffs.

In order to improve a natural development, new technologies always need an ecological balance between the benefit and risk. Understanding the toxic effects of nanoparticles on the environment is the biggest obstacle to the safe development of nanotechnology. A major challenge in understanding the environmental implications of nanotechnology lies in studying nanoparticles acceptance in organisms at environmentally truthful exposure concentrations.

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Nevertheless, little is known about how NPs affect human health and the environment. This chapter provides recent information on harmful effects of NPs particularly including their toxicity on living cells.

The objectives of this chapter are to:

1. Investigate the current state of engineered nanoparticles in the environment.
2. Provide recent information about the main properties of some innovated nanoparticles.
3. Estimate whether this data are sufficient to facilitate their comprehensive and effective influence on living cells and human health.

## **BACKGROUND**

During the last decade, the use of NPs has successfully increased in several areas such as drug delivery systems (Jin & Ye, 2007; Brannon-Peppas & Blanchette, 2012) food technology (Chaudhry et al., 2008; Tapia-Hernández et al., 2015), photovoltaic devices (Stratakis & Kymakis, 2013; Huang, De Valle, Kana Kana, Simmons-Potter, & Potter Jr, 2015), modern chemistry (Hosseinimotlagh, 2014), biomedicine (Pankhurst, Connolly, Jones, & Dobson, 2003; Canfarotta & Piletsky, 2014; Cabuzu, Cirja, Puiu, & Grumezescu, 2015) and cosmetics (Perugini et al., 2002; Wiechers & Musee, 2010; Bolzinger, Briançon, & Chevalier, 2011; Kathawala, Ng, & Joachim Loo, 2015).

However there is a crucial necessity to verify their harmlessness relative to human health and the environment. This important issue was raised in the last few years when many International Organizations (Asia Pacific Nanotechnology Forum, 2005), governmental bodies within the European Union (European commission, 2004), United States Institutions (IEEE, 2004; US National Institute of Environmental Health Sciences, 2004), learned institutions and societies (Institute of Nanotechnology, 2005; Australian Academy of Sciences, 2005; UK Royal Society & Royal Academy of Engineering, 2004) and scientists (G.Oberdörster, E. Oberdörster, & J. Oberdörster, 2005; Donaldson & Stone, 2003) reported several assessments on the current state of nanotechnology, and most attracted attention to this requirement for an exhaustive risk investigation. Nevertheless, the influence of these nanomaterials (NMs) on human and environmental health remained unclear (Maynard, 2006; Nel, 2006; Helmus, 2007).

Although a rich literature is now available, we are still surprisingly uncertain as to whether engineered nanoparticles affect the human health and the environment or not!

The organism has several semi-open interfaces for exchange some elements with the environment. The same interfaces are the principal routes of exposure of nanoparticles such as inhalation, dermal absorption and ingestion. An increasing number of researches have appeared in the last decade with an interesting goal of understanding the interactions between different types of nanoparticles and living cells of organisms as functions of size, shape, and surface chemistry of the nanomaterial (Lewinski, Colvin, & Drezek, 2008; Prinz, 2015). Unfortunately, no simple conclusions have emerged from the available studies due to the variability of parameters such as the physical and chemical properties of the particle, cell type, dosing parameters, and the biochemical assays used. Moreover, the majority of the scientific reports that investigate the cellular impact of NMs are in vitro, with far less effort to understand the real situation in vivo (Fischer & Chan, 2007).

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