

# Dual Use Concerns of Nanotechnology

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# Expertise and Current Projects

## Green synthesis of metal/metal oxide/composite nanoparticles for diverse applications

### • Nanomedicinal applications

- Antimicrobial (Antibacterial, Antifungal, Antileishmanial)
- Anticancer (HepG2)
- Antiviral (antipolio)
- Enzyme inhibition (Protein kinase inhibition. Cholinesterase inhibition etc.)
- Antioxidant nature
- Anti-Alzheimer
- Nanocosmeceuticals/dermal applications

### • Biocompatibility and Toxicity

- In vitro cytotoxicity assessment
- Hemolytic assay
- In vivo toxicity assessment

**Energy Storage /  
Super capacitors**

**Degradation of dyes**

## Nanoparticles

- ZnO
- NiO
- Fe<sub>2</sub>O<sub>3</sub>
- Co<sub>3</sub>O<sub>4</sub>
- CrO
- CeO
- Ag
- Au
- BiVO<sub>4</sub>
- Ag-ZnO

## Medicinal plants

- *Sageretia thea*
- *Olax nana*
- *Callistemon viminalis*
- *Silybum marianum*
- *Fagonia indica*
- *Momordica charantia*
- *Tecoma stans*
- *Hyphaene thebaica*
- *Incarvillea*
- *Buxus*
- etc.*

## Microorganisms

- *Streptomyces*
- *Rhodococcus rhodochrous*

Research Article  
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**Nanomedicine**

**Greener synthesis of ZnO and Ag-ZnO nanoparticles using *Silybum marianum* for diverse biomedical applications**

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**AIM:** To investigate the physical and biological properties of *Silybum marianum* inspired ZnO nanoparticles (NPs), Ag-ZnO heterostructures. **EXPERIMENT:** Nanoparticles were characterized using ultraviolet-visible and infrared spectroscopy, x-ray diffraction, high resolution electron microscopy, z-potential and thermogravimetric analysis etc. **RESULTS:** Ag-ZnO-NPs indicated slightly higher antimicrobial potential than ZnO-NPs. Good antifouling activity ( $IC_{50} = 246 \mu\text{g/ml}$  for Ag-ZnO, 341  $\mu\text{g/ml}$  for ZnO) and antioxidant potential while moderate enzyme inhibition is reported. 2, 2-Diphenyl 1-picrylhydrazyl radical scavenging of Ag-ZnO was higher relative to ZnO-NPs. **CONCLUSION:** Nanosynthesised nanoparticles indicated stable antimicrobial performance. **CONCLUSIONS:** Biogenetically synthesized nanoparticles indicated interesting biological properties and should be subjected to further research to establish their pharmacological relevance.

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INDIAN AND ANO-INDIAN CHEMISTRY  
<https://doi.org/10.1002/indc.12011>

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**In vitro cholinesterase enzymes inhibitory potential and in silico molecular docking studies of biogenic metal oxides nanoparticles**

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**ABSTRACT**  
The inhibition of Acetylcholinesterase (AChE) and Butyrylcholinesterase (BChE) enzymes represents a potential target in the treatment of Alzheimer disease. AChE and BChE inhibition was studied by biogenic metal oxide nanoparticles (ZnO, NiO, Fe<sub>2</sub>O<sub>3</sub>, Co<sub>3</sub>O<sub>4</sub>, and PbO) synthesized using aqueous extracts of *Sageretia thea* (Osbeck). The results demonstrated that the highest inhibition was shown by PbO nanoparticles with the IC<sub>50</sub> values of 101.9  $\mu\text{g/ml}$  for AChE and 119.8  $\mu\text{g/ml}$  for BChE. Furthermore, the results obtained from molecular docking studies analyzing the interaction of nanoparticles with enzymes, were in good agreement with the experimental data.

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**KEYWORDS**  
*Sageretia thea*; nanoparticles; inhibition; cholinesterase; molecular docking

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**WILEY** Applied Organometallic Chemistry

**FULL PAPER**

**Physiochemical properties and novel biological applications of *Callistemon viminalis*-mediated  $\alpha\text{-Cr}_2\text{O}_3$  nanoparticles**

Dilawar Hassan<sup>1,2,3</sup> | Ali Talha Khalil<sup>2,3,4</sup> | Amber Rehana Solangi<sup>1</sup> | Ahmed El-Mallou<sup>5</sup> | Zabta Khan Shinwari<sup>6</sup> | Malik Maaza<sup>2,3</sup>

<sup>1</sup>National Centre of Excellence in Analytical Chemistry, University of Sindh, We report an eco-friendly synthesis of  $\alpha\text{-Cr}_2\text{O}_3$  nanoparticles (NPs) using

Applied Microbiology and Biotechnology  
<https://doi.org/10.1007/s00253-019-09061-1>

**MINI-REVIEW**

**Endophyte-mediated synthesis of silver nanoparticles and their biological applications**

Sadia Rahman<sup>1</sup>, Lubna Rahman<sup>1</sup>, Ali Talha Khalil<sup>2</sup>, Nasir Ali<sup>3</sup>, Danis Zia<sup>4</sup>, Muhammad Ali<sup>5</sup>, Zabta Khan Shinwari<sup>1,6</sup>

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**Abstract**  
Bioremediation has emerged as a frontier technology for fabrication of functionally diverse nanoparticles that possess tremendous therapeutic applications. Various biological resources have already demonstrated their potential to produce nanoparticles with interesting features. Endophytic microbes live in a symbiotic relationship with plants possessing a unique and remarkably resistant or potentially biocompatible secondary metabolites having the tendency to reduce metallic ions into nanoparticles. In-situ synthesis of AgNPs using endophytic organisms has already been reported. However, the overall picture about its synthesis and applications is still not clear. In the current article, a comprehensive review of literature was performed by comparing different physical and biological properties of endophytic microbe-derived AgNPs. In addition, the present paper mechanistically explains the synthesis of AgNPs and their diverse pharmacological properties. Further studies are encouraged to understand the mechanism of biopharmaceutical effects of these endophyte-mediated NPs.

**Keywords** Endophytes · Endophytic bacteria · Endophytic fungi · Nanotechnology · Silver nanoparticles · Antimicrobial activity

**28 research/review articles in Green Nanotechnology**  
**6 review articles/chapters in biosecurity**  
**Medicinal plants research**

**Green Chemistry Letters and Reviews**

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***Daphne mucronata*-mediated phytosynthesis of silver nanoparticles and their novel biological applications, compatibility and toxicity studies**

Asma Shah, Ghosia Lutfullah, Kafeel Ahmad, Ali Talha Khalil & Malik Maaza

ARTIFICIAL CELLS, NANOMEDICINE, AND BIOTECHNOLOGY, 2019  
<https://doi.org/10.1080/21691401.2019.1634634>

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**Biosynthesis of pure hematite phase magnetic iron oxide nanoparticles using floral extracts of *Callistemon viminalis* (bottlebrush): their physical properties and novel biological applications**

Dilawar Hassan<sup>1,2,3</sup>, Ali Talha Khalil<sup>2,3,4</sup>, Jabran Saleem<sup>5,6</sup>, Abdullah Djalil<sup>2,3,4</sup>, Saleh Khamlich<sup>2,3,4</sup>, Zabta Khan Shinwari<sup>2,3,4</sup> and Malik Maaza<sup>2,3</sup>

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***Sageretia thea* (Osbeck.) modulated biosynthesis of NiO nanoparticles and their in vitro pharmacognostic, antioxidant and cytotoxic potential**

Ali Talha Khalil, Muhammad Ovais, Ikram Ullah, Muhammad Ali, Zabta Khan Shinwari, Dilawar Hassan & Malik Maaza

**Green Chemistry Letters and Reviews**

ISSN: 1751-8253 (Print) 1751-7192 (Online) journal homepage: <http://www.tandfonline.com/loi/tgrl20>

**Biosynthesis of iron oxide (Fe<sub>2</sub>O<sub>3</sub>) nanoparticles via aqueous extracts of *Sageretia thea* (Osbeck.) and their pharmacognostic properties**

Ali Talha Khalil, Muhammad Ovais, Ikram Ullah, Muhammad Ali, Zabta Khan Shinwari & Malik Maaza

# Need of Ethics

- Although exciting, but has a **Dual Use Dilemma**
- **Social injustice, Personnel enhancements, Toxicological concerns, End of the World Scenarios**
- **Nano-ethics** is already used in literature to single out and emphasize the potential concerns nanotechnology
- Dual-use potential is increasing along with the rapid pace of advances in nanotechnology and other **converging technologies** (Biotechnology, Information Technology, and Cognitive Science)

# Questions to Answer

- Are their dual use research concerns related to the use of nanomaterials?
- What should be the ethical standards to judge?
- How to determine potential benefits verses potential harms?
- Societal impact?
- Environmental safety issues?
- Nano-technological or the nano divide?
- Regulations ?
- Where to draw the line?



## Deaths, lung damage linked to nanoparticles in China

Tan Ee Lyn

4 MIN READ



HONG KONG (Reuters) - Seven young Chinese women suffered permanent lung damage and two of them died after working for months without proper protection in a paint factory using nanoparticles, Chinese researchers reported on Wednesday.

They said the study is the first to document health effects of nanotechnology in humans, although animal studies in the past have shown nanoparticles could damage the lungs of rats.

"These cases arouse concern that long term exposure to nanoparticles without protective measures may be related to serious damage to human lungs," Yuguo Song

- The women breathed in fumes and smoke that contained nanoparticles while working in the factory
- Their lung tissues and fluids contained nanoparticles about 30 nanometers in diameter

<https://www.reuters.com/article/us-china-nanoparticles/deaths-lung-damage-linked-to-nanoparticles-in-china-idUSTRE57I1Y720090819>

nature > scientific reports > articles > article

## SCIENTIFIC REPORTS

Article | Open Access | Published: 05 February 2018

### Silver nanoparticles have lethal and sublethal adverse effects on development and longevity by inducing ROS-mediated stress responses

Bin-Hsu Mao, Zi-Yu Chen, Ying-Jang Wang & Shian-Jang Yan

Scientific Reports 8, Article number: 2445 (2018) | Download Citation

## Air pollution contains nanoparticles that slip into the lungs

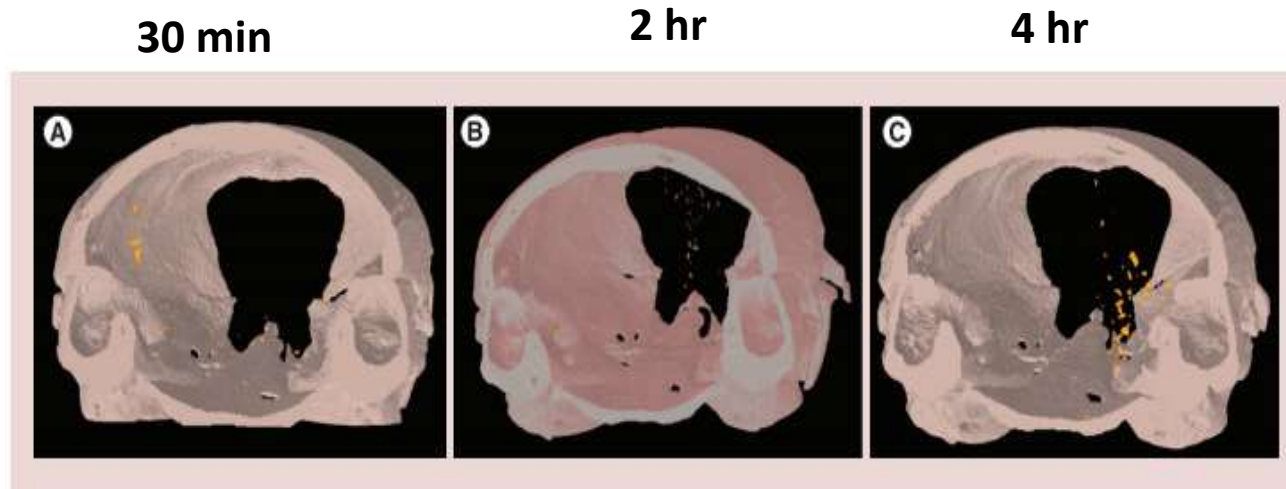


In mice and humans, air-pollution-sized nanoparticles slipped from the lungs and into the blood stream. There, they glommed onto plaques in the arteries of both species, directly contributing to atherosclerosis and deadly cardiovascular diseases  
Air pollution has been implicated in neuropathology.

<https://www.ishn.com/articles/109142-air-pollution-contains-nanoparticles-that-slip-into-the-lungs>



# Nanomaterials can penetrate the BBB



Hippocampus



Cerebellum



Cortex

Betzer, Oshra, Malka Shilo, Renana Opoichinsky, Eran Barnoy, Menachem Motiei, Eitan Okun, Gal Yadid, and Rachela Popovtzer. "The effect of nanoparticle size on the ability to cross the blood–brain barrier: an in vivo study." *Nanomedicine*12, no. 13 (2017): 1533-1546.

## Size and duration wise accumulation in brain

42,044 views | Sep 16, 2018, 11:52pm

# Smart Dust Is Coming. Are You Ready?



**Bernard Marr** Contributor   
Enterprise & Cloud

**f** Imagine a world where wireless devices are as small as a grain of salt. These miniaturized devices have sensors, cameras and communication mechanisms to transmit the data they collect back to a base in order to process. Today, you no longer have to imagine it: microelectromechanical systems (MEMS), often called motes, are real and they very well could be coming to a neighborhood near you. Whether this fact excites or strikes fear in you it's good to know what it's all about.

- The nanoscaled military devices for surveillance like nanocameras, nanosensors could enable observations at unprecedented levels
- Same can be used to abuse the privacy
- Nano-engineered agent in “a crowded indoor space” could cause serious harm to many people at once

# Integrity of environment

- The inhaled nanoparticles bears the risk of heart disease, crossing blood brain barrier or accumulation in the liver
- Their entry in the food chain is another debate. Accumulative evidence already suggest bioaccumulation of metal nanoparticles in food

# Dual Use Dilemma

- Nano bioweapons
  - What if the delivery mechanisms are used for delivering toxins/bioweapons?
  - Unseen, unmanned aerial and aerosolized nano-bioweapons?
  - Nanoparticles keep accumulating in the body and environment?
  - No adequate research? Unseen of Nanotechnology
- Nano race
  - Nuclear arms race?
  - Race for smart materials, smart weapons
  - Molecular nanotechnology will limit the cost of producing armaments
  - Quantitative arms control?

# Grey goo; Science fiction or Reality?

- The programmable nanomachines and nanorobots presents another concerns of the hypothetical end of the world scenario called the grey goo
- This concern is based on the programming of such nanomachines in a way that will allow them to replicate and eventually will evolve in to self-replicating entities which may take the control of the world
- Global autophagy

# Enhanced physical beings

- Nanoscaled sensors can be designed to improve the vision and hearing.
- Nanotechnology, will be an important driver in the so called post humanism
- When is the human being no longer a human?
- The distinction between human and robot?
- Access to the technology? Another division

# Take Away / Conclusion

- Knife can be used to cut an apple or to cut a throat.
- Progress in science cannot be stopped. If you are not doing it, someone else will.
- Responsibly and awareness
- Science Communication

Thanks .....

