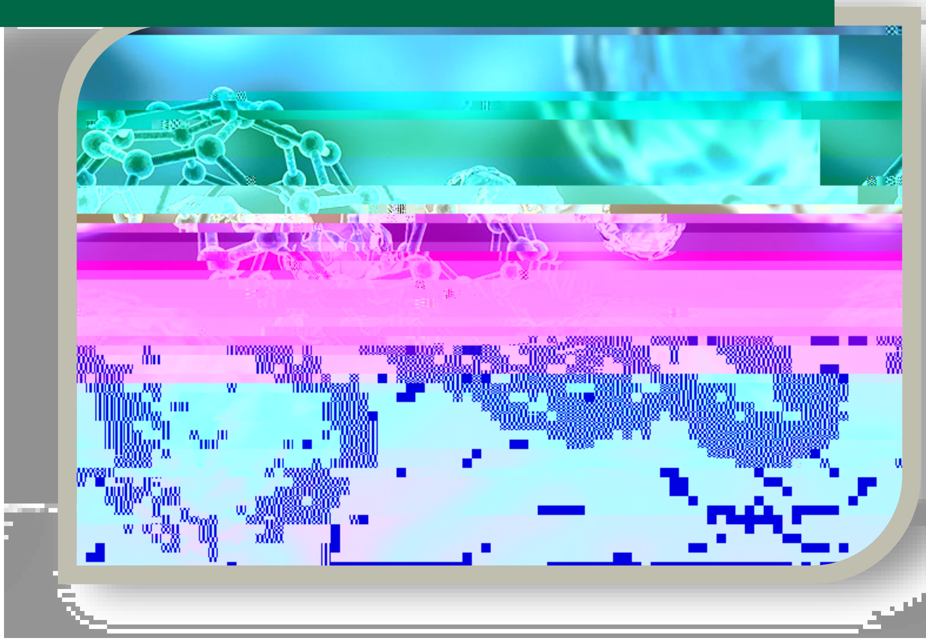
Nanomaterial Safety Guide



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- The US Food and Drug Administration (FDA) evaluates products containing NMs, including drug delivery devices, cosmetics, and food ingredients.
- Pesticides containing NMs are subject to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).
- NMs may be regulated under programs such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), or Clean Air Act on a site-specific basis depending on their use and byproducts.

The Occupational Safety and Health Administration (OSHA) currently has no regulations or occupational exposure limits (OELs) for NMs. However, existing OSHA regulations may be relevant, including the Hazard Communication, Respiratory Protection, or Laboratory Standards. Several agencies, including the National Institute for Occupational Safety and Health (NIOSH), FDA, and the National Institute of Health (NIH), have produced guidance documents regarding the safe use of nanotechnology.

At USF, all labs utilizing NMs must follow the policies, procedures, and standards listed in the Chemical Hygiene Plan. Contact USF Environmental Health & Safety (EH&S) with any specific questions.

It should be noted that the full extent of the adverse effects of many NMs are not yet known. As the field of nanotechnology rapidly evolves, so too will the understanding of the risks and appropriate management techniques. Researchers are strongly encouraged to remain aware of these developments.

Forms of Nanomaterials

In regards to safety, the various types of NMs may be discussed in three different forms. These forms, in order of increasing exposure hazard, are as follows:

1. Physically bound or encapsulated in solid materials
2. Liquid Suspension
3. Dry Powders

Dry NM powders possess the highest potential for aerosolization and therefore require the highest level of containment. Aerosolization not only poses a risk of inhalation, but may also lead to dust formation on tools, benches, and equipment, thereby presenting a further hazard of skin absorption or ingestion from later handling. Suspending these powders in liquid reduces the likelihood of aerosolization. Physically embedded NMs are least likely to produce aerosols, and therefore pose the lowest risk of exposure.

Health Hazards

The toxicological effects of NMs are not fully understood. It is known that the toxicity of NMs is dependent on the NM's physical and chemical properties, the route of exposure, and the duration and frequency of exposure.

Nanomaterial Properties

NMs exhibit properties different from the same materials in macroscale. For instance, gold is red in color at the nanoscale level. This means it can be hard to predict the effect an NM will have on the body. Studies in animals and tissue cultures have shown that NMs are more toxic than the same mass of larger particles. Studies have shown that the following properties of NMs have an effect on their toxicity:

(d)-4 (i)-(a)-4 (u)6.1 10.1 (t)-2 27 ac(1)4-(t)46 (w)7.83]TJ (v)72.0.[(t)54 (h)-4 00(e)10.3 4(7)-72 0 Td[(the)13 (-

contrast, insoluble nanoparticles of ceria, titania, and zirconia demonstrated no measurable toxicity in vitro.

Degradability

NMs that degrade or are metabolized quickly by the body experience brief interactions with cells. Therefore, degradable NMs have short exposure times and are generally less toxic. Other NMs stay in the body for a prolonged period of time. Little is known regarding the chronic effects of these persistent NMs, and they should therefore be handled with caution.

Exposure Routes

Though some exposures are intentional (i.e. injection of drug delivery devices, application of skin products, etc.), unintentional exposures to NMs can lead to serious adverse health effects. There are four routes by which NMs may enter the body; inhalation, ingestion, absorption, and injection.

Inhalation

Inhalation is the most common route of exposure to NMs. Inhalation of NMs causes inflammation, which may in turn cause asthma, fibrosis, cancer, or necrosis of lung tissues. This inflammation may also allow NMs to reach nearby lymph nodes, where they may accumulate or translocate to other organs. Other studies have shown that NMs may travel to the brain via the nasal passages upon inhalation.

Ingestion

Ingestion may occur in conjunction with inhalation or may occur as a result of hand-to-mouth transfer or contamination of food and drinks. Ensure no food or drinks are present in the laboratory and enforce handwashing to avoid ingestion of NMs. After ingestion, some NMs are absorbed by the digestive system and transported to lymphatic tissues. Others may accumulate in the digestive system, potentially leading to gastrointestinal blockages.

SkinAbsorption

The permeability of the skin to many NMs is currently unknown. Dermal exposure to NMs may occur during manufacturing or via application of consumer products like cosmetics and sunscreens. Some NMs may penetrate the skin through sweat glands or hair follicles. Titanium dioxide nanoparticles, for instance, have been shown to cause cell death (apoptosis).

Skin absorption is a major route of exposure to incidental nanomaterials produced by welding, waste incineration, or NM manufacturing. If they penetrate the skin, incidental nanomaterials may cause DNA damage or apoptosis.

Stony Brook University. Nanomaterials Safety Guidelines. https://ehs.stonybrook.edu/programs/laboratory-safety/general-laboratory-safety/nanomaterials-safety-guidelines.php Accessed 12/14/2021.

University of Texas at Austin. Nanomaterials https://ehs.utexas.edu/working-safely/chemical-safety/nanomaterials Accessed 12/14/2021.

U.S. Environmental Protection Agency (EPA). Technical Fact Sheet – Nanomaterials. https://www.epa.gov/sites/default/files/2014-03/documents/ffrrofactsheet_emergingcontaminant_nanomaterials_jan2014_final.pdf