



WHAT ARE NANO-BASED PRODUCTS AND WHO USES THEM?

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YOUNG REVIEWERS:



LEON

AGE: 13



NIKHIL

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Nanotechnology is a game-changer in many modern industries. Nanotechnology uses super-small particles with special characteristics to make many types of products. Nano-based products are making big waves in the medical, clothing, and electronics industries, to name a few. For example, nanomaterials can help to clean water and fight pollution. In medicine, nanotechnology is super useful for precise treatments, like delivering drugs straight to where they are needed in the body. In electronics, nanotechnology can help to make devices smaller and better. Even clothes are getting an upgrade with nanotechnology, making them “smart” and resistant to stains or germs. Overall, nanotechnology is driving innovation by making materials better, devices faster, and medical treatments more effective. This technology is shaping a future full of tiny yet powerful changes.

NANOPARTICLES

Tiny particles that range between 1–100 nanometers (nm) in diameter.

NANOTECHNOLOGY

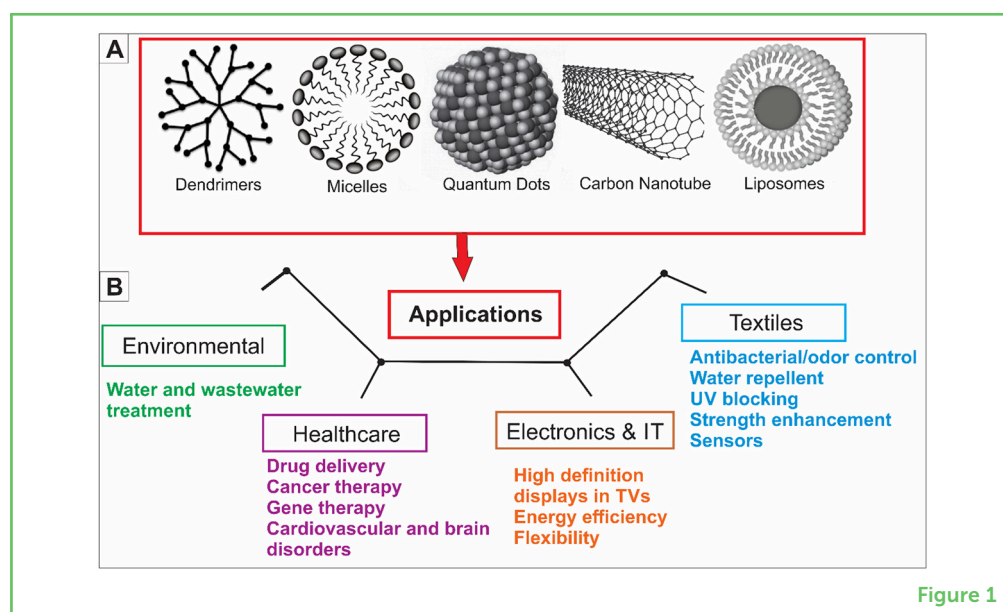
A field of science involving materials at the molecular scale smaller than 100 nm.

Figure 1

(A) Nanoparticles can have various shapes at the microscopic level. (B) Nanoparticles can be used in numerous applications in modern life.

TINY PARTICLES WITH A BIG IMPACT

Nanoparticles, both natural and manmade, are tiny structures that range between 1 and 100 nanometers (nm) in diameter. **Nanotechnology** might seem new, but did you know that it was developed way back in 1856, when a famous scientist named Michael Faraday produced nanoparticles made of gold? Today, more than 150 years later, nanotechnology is changing how many industries function, and it is producing new products we use in our daily lives. Nanoparticles are microscopic—you cannot see them with the naked eye—and this allows them to have super-cool qualities. Structures made from nanoparticles make products stronger, lighter, more durable, and better at conducting electricity, to list just a few useful qualities. Scientists are actively studying nanomaterials, trying to figure out all the many ways we can use them to improve our lives (Figure 1).



ENVIRONMENTAL USES

We can use nanoparticles to help our environment and save our ecosystems. We all understand how important freshwater resources are, and we know that they are being polluted by chemicals, sewage, oil spills, and plastic. But did you know that nanotechnology can help clean up this pollution? For example, scientists have created magnetic, water-repellent nanoparticles that can remove oil from water after oil spills [1]. This not only cleans water sources during these accidents but also saves many fish and bird species that live in and use the water. Nanoparticles can also be used in chemical reactions that change harmful chemicals that pollute groundwater into harmless substances (Figure 2A) [2]. Some filters, like the ones in airplane cabins, have tiny, nano-sized pores—these filters are used to purify the air, so that

passengers can travel safely. Because their design and the pores in the filters are so small, they can trap even the tiniest germs and other pollutants, reducing the risk of transporting harmful substances and germs from one place to another [3].

Figure 2

(A) Nanotubes made of carbon can be used to help protect the environment by treating polluted wastewater. (B) Uses of nanomaterials in electronics include quantum dots in TV screens and flexible electronics.

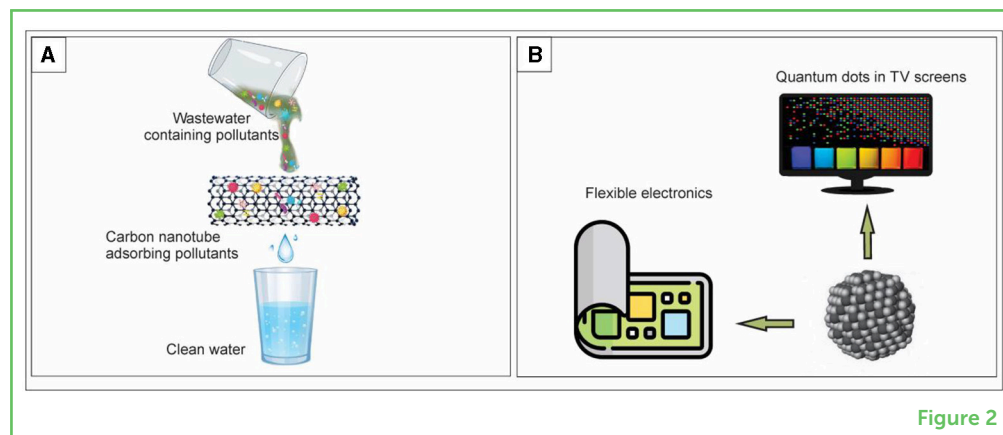


Figure 2

ELECTRONIC AND INFORMATION TECHNOLOGY USES

Nanotechnology also plays a key role in our daily lives through the ever-developing world of electronics and information technology (IT). Electronic parts are becoming smaller and smaller and gaining enhanced abilities thanks to nanomaterials. Nano-sized parts are already part of our daily lives, but often we do not even know they are there. For example, new ultra-high-definition television screens use **quantum dots** to produce more vibrant colors, thereby increasing the quality and improving the watcher's experience when viewing their favorite movie (Figure 2B) [4]. The tiny dots also reduce the amount of energy a television uses, protecting the environment and reducing our electricity bills. Nanotechnology can also be found in our smartphones, thumb drives, keyboards, and even in hearing aids—products that many depend on in the modern world [5]. Do you know that scientists have even produced flexible electronics with nanotechnology? These include wearable sensors and electronics like flexible solar panels or devices that can be sewn into clothing, and even electronic paper that can be folded and rolled up. These are just a few examples of how nanotechnology can improve electronics and IT applications.

HEALTHCARE AND MEDICAL USES

Nanotechnology also improves our lives through healthcare and medical applications (Figure 3A). Nanomaterials inside medicine-containing capsules can help the medicine to be more effective, by getting it exactly where it is needed after it is swallowed. Nanomaterials can also be used in nose sprays that are inhaled. Scientists have even used "clever" nanoparticles to deliver

QUANTUM DOTS

Extremely tiny particles that glow in different colors when light shines on them. Scientists use them to make bright reds, greens, and blues in screens and other technologies.

CHEMOTHERAPY

A type of cancer treatment that uses chemical substances to destroy abnormal cells.

Figure 3

(A) Applications of nanoparticles in the medical industry. (B) Uses of nanomaterials in fabrics in the textile industry.

chemotherapy medication directly to cancer cells, minimizing the damage to healthy tissues nearby and thereby greatly improving cancer treatments. This breakthrough could reshape cancer treatment approaches, significantly reducing the toxic effects of chemotherapy on healthy cells and potentially saving lives in the future.

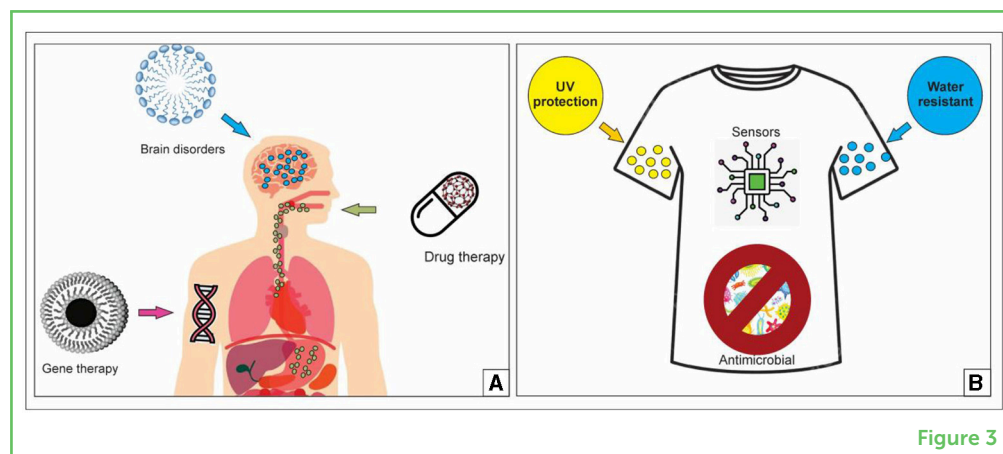


Figure 3

GRAPHENE

A form of carbon consisting of sheets with the atoms arranged in a honeycomb shape.

Scientists have also produced nanoribbons made from **graphene**, and early studies show that nerve cells can thrive on these graphene surfaces. In the future, such technologies might be used to help repair spinal cord injuries in paralyzed patients [6]. Such innovative uses highlight the impact of nanotechnology in modernizing healthcare and medical research [7]. Scientists all over the world are recognizing nanotechnologies and nanoscience as important fields. In 2023, the **Nobel Prize in Chemistry** was awarded to Moungi Bawendi, Louis Brus, and Alexei Ekimov for their discoveries and contributions in the field of nanotechnology.

TEXTILE AND CLOTHING USES

Have you considered that you might be covered in nanomaterials right now? The textile and clothing industry is changing drastically as it begins to use nanomaterials. Incorporation of nanomaterials into clothing could have uses in many fields, including health, pharmaceuticals, fashion, sports, military, and transportation. Some nanofiber-containing clothes are already being sold, and they have incredible properties like resistance to stains or to the sun's dangerous UV rays. Fabrics can also be designed to contain antimicrobial features that kill germs (Figure 3B). This application can already be seen in socks that kill the bacteria that produce the odor from sweaty feet. Nanotechnology can also be used to create fabrics that are resistant to flames. Incredibly, scientists have also produced "smart" textiles that can change color in response to changes in the surrounding environment, such as changing color when the temperature changes; some of these items are already available in speciality shops [8].

In conclusion, although nanotechnology might sound like a futuristic field of study, it is already part of our everyday lives. Nanomaterials help us to protect our environment by cleaning the water and air that we all depend on. They have also led to modern advances in electronics and healthcare practices. Nanomaterials are even changing how we see ourselves, becoming part of the clothes we wear daily. New advances in nanotechnology are happening rapidly, so the examples we described in this article are only a small fraction of the advancements that we are likely to see in the near future!

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YOUNG REVIEWERS

LEON, AGE: 13

Leon is a curious 13-year-old with a passion for science, especially astronomy, biology, and physics. He loves exploring science fiction, particularly *The Remembrance of Earth's Past Trilogy*. Leon enjoys trying new foods from around the world, including Thai, Chinese, Italian, and Japanese cuisines.



NIKHIL, AGE: 13

Nikhil is fascinated by the world of science, specifically astrophysics and microbiology. He is a funny kid who loves goofing around and being silly as well as geeking out on black holes and warp drives in equal measures.



AUTHORS

LUTFIYYA LATIEF

Hai, my name is Lutfiyya, I am a PhD student studying tiny particles called nanoparticles in fish and tiny creatures that live on these fish, called parasites. Nanoparticles are so small that we need special tools to see them. I am trying to understand how these nanoparticles affect the fish and the parasites. By learning about this, we can help keep the fish healthy and find new ways to fight parasites that make these fish sick.





HEINRICH THEODOR JACOB DAHMS

My name is Heinrich, and I am a post doc researcher in the Institute of Alpine Environment in Eurac Research. I specialize in microplastics, which are tiny, microscopic pieces of plastic smaller than 5 mm. I am trying to understand how microplastics behave in rivers, to understand how they might impact ecosystems. I have detected microplastics in five rivers across South Africa, including the Vaal and Limpopo Rivers. I have always had a passion for the environment, and I firmly believe that a life where you contribute to a better world is the greatest life you can live.



ANNEMARIË AVENANT-OLDEWAGE

I study the effect of environmental substances on parasites of various fish species. Many of the parasites are very sensitive to these substances and their numbers become reduced and eventually they even become locally extinct. This is an early warning to humans that the water may also not be safe for human consumption. I work with a group of postgraduate students and postdoctoral fellows, and we are interested in applying this knowledge in water quality monitoring.

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