# NANOWARE Curriculum

## MODULE 5: NANOTECHNOLOGY IN OUR LIVES

## DELIVERABLE: R1/T1.1

NANOWARE

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Learning Seed

Authored by: Eleni Vasdoka

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# 1. Introduction to the Module

This module aims to help understand nanotechnology, its use and applications through every day - simple - examples. Important references are made to everyday objects in use such as sunglasses and sun cream to the use and assistance of nanotechnology in scientific fields such as medicine and aerodynamics.

**Description**

Nanotechnology is an inescapable part of modern everyday life and is an expanding field. The nanoscale is 1,000 times smaller than the microscopic level and a billion times smaller than the typical world of metres that we're used to measuring things in (Bernard Marr, n.d). The average person already encounters nanotechnology in a range of everyday consumer products (Dispatch, 2019). Many everyday products are made using nanotechnology. For instance, sunscreens, clothing, furniture, adhesives, tennis balls, and computers are some of the products that use nanotechnology (Bernard Marr, 2020). Moreover, the average office worker has improved display screens on desktops and portable electronic devices, products that use nanotechnology. The same goes for memory chips with increased density (Finbar Galligan, 2017).

**Module Goals**

The goal of this module is to help learners understand how nanotechnology is used daily by all of us and what is the contribution of nanotechnology to other scientific disciplines.

**Learning Objectives**

This module aims to understand the technology through everyday and simple examples so that regardless of age the learners can understand the importance of nanotechnology and how it is used every day. At the same time, they will learn about the impact of nanotechnology in other scientific fields while they will also learn about the enormous potential it has for improving our living conditions, from sustainability to drinking water for developing regions on our planet.

**Learning Outcomes**

On successful completion of this module, learners should be able to:

- Understand the importance of nanotechnology in daily life

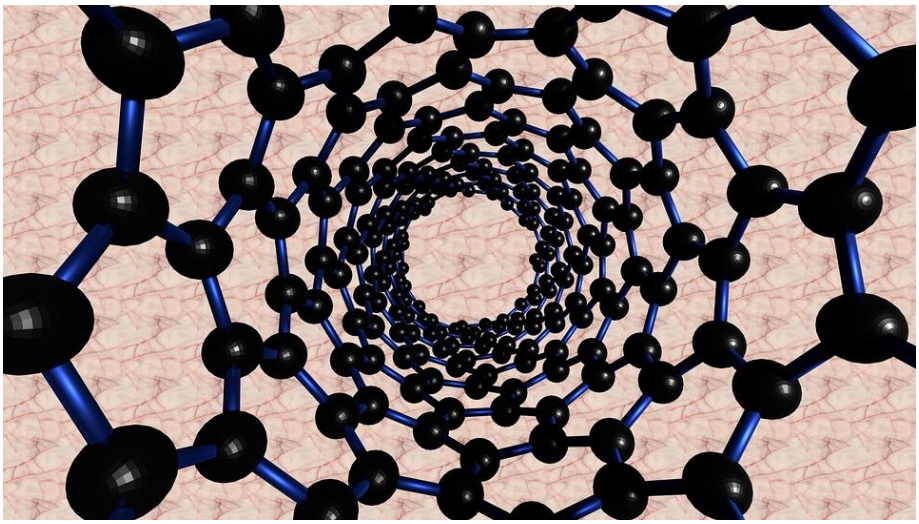
- Identify the different uses of nanotechnology
- Apply basic principles of nanotechnology use within different contexts/industries

**Estimated seat time**

The completion of the module along with the implementation of the knowledge provided will last 3 hours.

# 2. The Importance of Nanotechnology

Nanotechnology refers extensively to a field of implemented technology and era where research on nanoparticles may be used in all scientific fields, along with physics, chemistry, biology, materials technology, and engineering (The Scientific World, 2019). Nanotechnology is considered an integral part of "Science, Technology, Engineering, and Mathematics (STEM) education". Just as engineering practice is no longer limited to university students, so also nanotechnology. Everyone - including children, teachers, and graduate students - can benefit from, enjoy, and learn this technology (The Scientific World, 2019).



*Source:Pixabay*

*Title: Atomic*

Nanotechnology can increase energy efficiency and consumption, clean the environment, and solve major health problems. It is said to be able to massively increase manufacturing production at significantly reduced costs. Products of nanotechnology will be smaller, cheaper, lighter yet more functional and require less energy and fewer raw materials to manufacture, claim nanotech advocates (SciDev, 2008).

Nanotechnology education is an urgent necessity in the 21st century, in light of technical and scientific acceleration and great competition among nations. Many conferences and seminars have pointed to the need to introduce nanotechnology in the curriculum so that students do not feel the gap between the school and the reality they live in (The Scientific World, 2019).

It topped the listing of medical and studies interests in most international locations of the world. Many nations during the past few years installed programs and studies gadgets, instructional and research institutes however the consistent growth of nanotechnology is an undertaking for the clinical network interested by universities and technical faculties to prepare the workforce to offer destiny career possibilities in this subject (The Scientific World, 2019).

In June 1999, Richard Smalley, Nobel laureate in chemistry, addressed the US House Committee on Science on the benefits of nanotechnology. "The impact of nanotechnology on the health, wealth, and lives of people," he said, "will be at least the equivalent of the combined influences of microelectronics, medical imaging, computer-aided engineering and man-made polymers developed in this century." (Catherine Brahic and Mike Shanahan, 2005)

## 2.1 How to use Nanotechnology in daily activities

According to the Scientific World, nanotechnology has a great impact on our lives daily and is certainly essential in improving products, treating diseases, and serving humanity in all areas of life. Much of the normal commercial merchandise available on the market rely on nanotechnology. The obvious nanoparticles or membranes on computer monitors, cameras, glasses, home windows, and different surfaces can help make them water-resistant, anti-reflective, proof against UV or IR radiation, scratch-resistant, or conducive to power. Nanotechnology has additionally entered into purchaser products, where billions of microscopic nanowhiskers - each approximately 10 nanometers long - have been molecularly connected to natural and synthetic fibres to add stain resistance to clothing and fabric (The Scientific World, 2019).

But how do we use nanotechnology in daily activities?

### 2.1.1 Sunscreens

Modern sunscreens, which are made from nanoparticles, absorb light more efficiently, including the dangerous ultraviolet range. (The NYU Dispatch, 2020. You can find more here). Most sunscreens today are made from nanoparticles that effectively absorb light, including the more dangerous ultraviolet range. They also spread more easily over the skin. These same nanoparticles are also used in food packaging to reduce UV exposure and prolong shelf life (Mark Crawford, 2016)

### 2.1.2 Computers

Nanotechnology also plays an important role in computers: faster and more powerful computers, which consume less power. Modern computers have longer-lasting batteries. Circuits, which are made from carbon nanotubes (they are tubes made of carbon with diameters typically measured in nanometers), aim to maintain computer power (The NYU Dispatch, 2020. You can find more here). Circuits made from carbon nanotubes could be vital in maintaining the growth of computer power, allowing Moore's Law to continue.

### 2.1.3 Medical equipment

People get access to much faster, more accurate, and more functional medical diagnostic equipment. Have you heard about the technology called “Lab-on-a-chip”, which enables testing in real-time and speeds up delivery of urgent medical care? All nanomaterial surfaces, which are used for producing modern implants resist any kind of infection (The NYU Dispatch, 2020. You can find more here). Additionally, nanomaterial surfaces on implants improve wear and resist infection.

*Source:Pixabay*

*Title: Medical Equipment*

### 2.1.4 Pharmaceutical products

Pharmaceutical products contain nanoparticles, which improve their absorption within our bodies. (The NYU Dispatch, 2020. You can find more here). The use of nanoparticles in pharmaceutical products makes them easier for the body to absorb—and easier to deliver, often through combination medical devices.

### 2.1.5 Medicines

In medicine, nanosensors help to identify particular cells/substances in the body (The NYU Dispatch, 2020. You can find more here). Nanoparticles can also deliver chemotherapy drugs to specific cells, such as cancer cells.

*Source:Pixabay*

*Title: Medicine*

### 2.1.6 Vehicle fuel efficiency

Nanotechnology helps to improve vehicle fuel efficiency. The vehicle parts which are made from nanocomposite materials are lighter, stronger, and more chemically resistant compared to metal (The NYU Dispatch, 2020. You can find more here).

### 2.1.7 Fabrics

Nanoparticles in fabrics are stain, water, and flame-resistant. They do not increase such properties of fabrics as weight, thickness, or stiffness (The NYU Dispatch, 2020. You can find more here).

*Source:Pixabay*
*Title: Waterproof T-shirt*

### 2.1.8 Water quality

Water filters (15-20 nanometers) can remove all viruses and bacteria. This is an innovative cost-efficient water treatment system. Many countries need urgently to get the quality of drinking water improved. These cost-efficient, portable water treatment systems are ideal for improving the quality of drinking water in emerging countries. Filters that are structured on the nanoscale offer the promise of better water purification systems that are cheap to manufacture, long-lasting and can be cleaned. Other similar technologies could absorb or neutralise toxic materials, such as arsenic, that poison the water table in many countries including India and Bangladesh.

*Source: Pixabay*

*Title: Water bacteria*

### 2.1.9 Sports equipment

Carbon nanotubes make our sports equipment stronger and its weight of it lighter. Carbon nanotubes have a variety of commercial uses, such as improving the design of sports equipment. For example, a tennis racket made with carbon nanotubes bends less during impact and increases the force and accuracy of the delivery. Nanoparticle-treated tennis balls can keep bouncing twice as long as standard tennis balls

### 2.1.10 Cosmetics

The cosmetics industry suspends and encapsulates various ingredients into nanospheres (nanospheres are small vesicles used to transport drugs) and nanoemulsions (nanoemulsions are nano-sized emulsions, which are manufactured for improving the delivery of active pharmaceutical ingredients). Specialists claim that they help increase their penetration into our skin. You might not know but many cosmetic products use nanomaterials in some forms. For example, L'Oreal has developed an anti-wrinkle cream, which contains polymer nanocapsules for better delivery of active ingredients into deeper layers of skin. (The NYU Dispatch, 2020. You can find more here).

*Source: Pixabay*

*Title: Cosmetics*

### 2.1.11 Drink bottles

Drink bottles are also made from plastics, which contain nanoclays. It gives good resistance to permeation by oxygen and moisture (The NYU Dispatch, 2020. You can find more here). This helps retain carbonation and pressure and increases shelf life by several months.

### 2.1.12 Enhanced surveillance and security systems

Thanks to nanotechnology, a huge variety of chemical sensors can be programmed to detect a particular chemical at amazingly low levels—for example, a single molecule out of billions. This capability is ideal for surveillance and security systems at labs, industrial sites, and airports. On the medical front, nanosensors can also be used to accurately identify particular cells or substances in the body. Non-reflective materials have been improved by imitating the nanostructures found in the wings of cicada insects. Their wings contain small projections, spaced about 200 nanometres (a nanometre is equivalent to one billionth of a metre) apart, which allow 98% of light to pass through them. Nanostructures are also responsible for the brilliant white colouring of the cyphochilus beetle. The

arrangement of molecules within the beetle's scales scatter almost all incoming light. Mimicking this molecular arrangement in made-made materials would eliminate the need for potentially toxic pigments, which are often currently used to create white paint and paper. (Colin Stuart, 2011)

# 3. Success stories, examples & best practices

According to The Scientific World:

**Nanotechnology in Medicine**

Scientists have been able to make accurate machines of the size of blood cells to treat many diseases that require surgery such as blockages within the arteries, as well as tumors. Moreover, nanotechnology has helped to detect some diseases through a "Nanobiotix" sensor. In addition, it has been used in the treatment of cancer, where gold-plated nanoparticles are used to destroy cancer cells. An excellent example is the Italian researcher Silvano Dragonieri from the University of Bari who invented an electronic nose using carbon nanotubes that diagnose cancer tablets by analyzing the air coming out of the lungs during the exhalation process (Catherine Brahic and Mike Shanahan, 2005).

**Nanotechnology in the industry (The Scientific World, 2019).**

Nanotechnology is used in the smart clothing industry that produces energy or removes dirt and germs by itself, as well as in the manufacture of solid materials that outweighs the hardness of steel with a lightweight. Nanotechnology is also used in the manufacture of dust-repellent and non-conductive glass so-called 'active glass' or 'self-cleaning glass' capable of cleaning itself from dust and water droplets and the manufacture of three-dimensional screens characterized by transparency and flexibility (The Scientific World, 2019).

## Nanotechnology and the aircraft and automobile industry

Nanotechnology has also helped to improve the aircraft and automobile industry through the use of more powerful, flexible, lighter, and less fuel-efficient nanostructures as well as making lighter, flexible and powerful sports products such as tennis and hockey rackets. Nanotechnology has also been involved in the manufacture of refrigerators, washing machines, and water-resistant microbes with decomposition and rust resistance (The Scientific World, 2019).


*Source: Pixabay*

*Title: Tennis Racket*

## Nanotechnology in Agriculture

Nanotechnology can revolutionize agriculture by innovating new methods and techniques.

It can be used to improve accurate farming techniques, withstand environmental pressures and enhance plant capacity to absorb nutrients and detect and control forming processes (The Scientific World, 2019).

*Source:Pixabay*

*Title:Harvest*

**Nanotechnology for sustainable energy**

Nanotechnology allows us to sustain our growing appetite for energy, which increases with the number of people joining advanced economies and our demand per capita.

This must be done in a way that encompasses the environment in the wealth production equation where we collect more evidence of human impact on biodiversity, climate, air quality, water quality, and soil. Nanotechnology is also used in the production of storage batteries that store large amounts of energy for long periods. Consequently, clean-energy cars are produced at a lower cost and are not oil-dependent (The Scientific World, 2019).

Researchers at George Washington University have discovered a way to draw carbon dioxide from the atmosphere and convert it into high-yield carbon nanofibers that can be used in manufacturing. "Such nanofibers are used to make strong carbon composites, such as those used in the Boeing Dreamliner, as well as in high-end sports equipment, wind turbine blades, and a host of other products," says chemistry professor Stuart Licht, who led the research team.

The process is powered by a hybrid system consisting of solar cells and a thermal energy collector that draws very little energy. Licht estimates that if the process were scaled up to cover a physical area less than ten percent of the size of the Sahara Desert, within a decade, it would reduce carbon dioxide in the atmosphere to pre-industrial levels. (Mark Crawford, 2016) You can find more info here.

Tiny wastewater filters, for example, could sift emissions from industrial plants, eliminating even the smallest residues before they are released into the environment. Similar filters could clean up emissions from industrial combustion plants. And nanoparticles could be used to clean up oil spills, separating the oil from sand, and removing it from rocks and the feathers of birds caught in a spill (Catherine Brahic and Mike Shanahan, 2005).

**Nanotechnology in Aeronautics**

The National Aeronautics and Space Administration (NASA) has created ultra-precision nanotechnology machines for injection into the astronaut bodies to monitor health conditions (Catherine Brahic and Mike Shanahan, 2005).


*Source: Pixabay*

*Title: Aircraft*

### Health and Sanitation

Nanotechnology is already useful as a tool in healthcare research. In January 2005, researchers at the US Massachusetts Institute of Technology used 'optical tweezers' - pairs of tiny glass beads are brought together or moved apart using laser beams - to study the elasticity of red blood cells that are infected with the malaria parasite technique is helping researchers to better understand how malaria spreads through the body (Catherine Brahic and Mike Shanahan, 2005).

### Drug Delivery

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Nanotechnology is expected to enter many vital aspects such as nutrition and the military sector. In May 2004, the Thai government announced plans to use nanotechnology in one per cent of all consumer products by 2013. Their market value by then is predicted to be 13 trillion baht (more than US$320 billion at contemporary exchange rates). Indeed, Thailand has wholeheartedly embraced nanotechnology and its development is a major commitment of the Thai government. Likewise, China announced in May 2004 that nanotechnology is central to its long-term national science and technology plan (Sci.Dev,2008)

### Nanotechnology and Fertilisers

Tiny sensors offer the possibility of monitoring pathogens on crops and livestock as well as measuring crop productivity. In addition, nanoparticles could increase the efficiency of fertilisers. However, the Swiss insurance company SwissRe warned in a report in 2004 that they could also increase the ability of potentially toxic substances, such as fertilisers, to penetrate deep layers of the soil and travel over greater distances (Catherine Brahic and Mike Shanahan, 2005).

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