# Basic information about nanotechnologies for health

GoNano

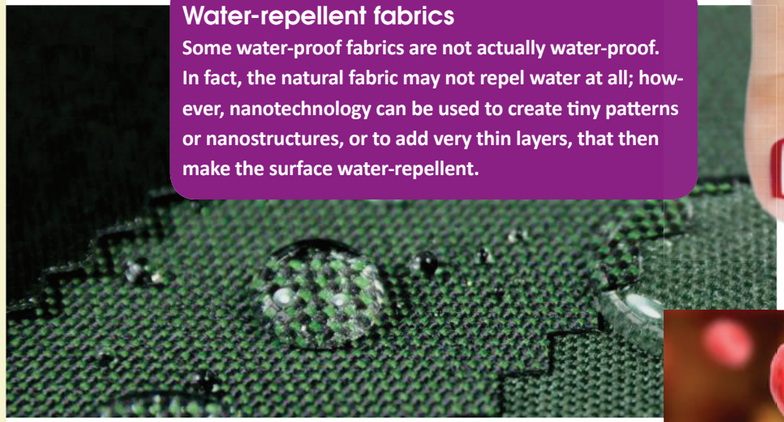
# What is nanotechnology?

Nanotechnology is generally referred to as ‘the science of the very small’. The prefix nano actually derives from the Greek νᾶνος (nanus in Latin), meaning dwarf.

A human hair can be used to illustrate size at the nanoscale. A human hair is approximately 80,000-100,000 nanometres wide. Another way to illustrate how small this is could be to say that comparing a nanoparticle to a basketball is roughly the same as comparing a basketball to planet earth. Nanomaterials can be found to occur “naturally” e.g. in dust or volcanic ash, in car exhaust fumes or in the smoke produced by a burning candle, or can be designed and fabricated artificially.



# Nanotechnology today



## Water-repellent fabrics

**Some water-proof fabrics are not actually water-proof. In fact, the natural fabric may not repel water at all; however, nanotechnology can be used to create tiny patterns or nanostructures, or to add very thin layers, that then make the surface water-repellent.**

## Nano-cure for nail fungus

**A new treatment for nail fungus is under development that combines nanoparticles with anti-fungal medication to deliver the drugs more effectively to affected area of the nail.**


## Nano-robots clear away bacteria and toxins

**Researchers are developing tiny nano-robots (made from gold nanowires) that can be controlled with ultrasound. The nano-robots can be used to quickly clear bacteria and toxins from biological fluids like blood.**

# Risks and regulations nanotechnology, human and environmental health

There are many types of engineered nanomaterials; some are potentially hazardous but can be used safely under controlled circumstances. Most concerns relate to nanoparticles in free form, where they are harder to control and are not particles bound up in solid materials or fluids. But even then, are we able to control them?
Are they toxic? Do they evade the natural defences of the body, and what are the implications of this? Do they damage cells? Could nanotechnologies have different effects on men than women, and could there be differences in effects across ethnicities?

Some people argue that we already use many dangerous technologies and substances in our everyday life (e.g. gasoline). They think we should talk about how we regulate and use dangerous technologies and substances, instead of talking about if we should use them. Others worry that the very properties that make nanomaterials desirable, are the very properties that make them hard to control and regulate. They therefore think that we should talk about whether or not we should be developing nanotechnologies as all.

## *Your sunblock could contain nanoparticles*

Many products already contain nanoparticles. E.g. A sunblock that rubs in clear on your skin could contain nanoparticles. Producers of sunblock are obliged to indicate on the label if your sunblock contains nanoparticles.

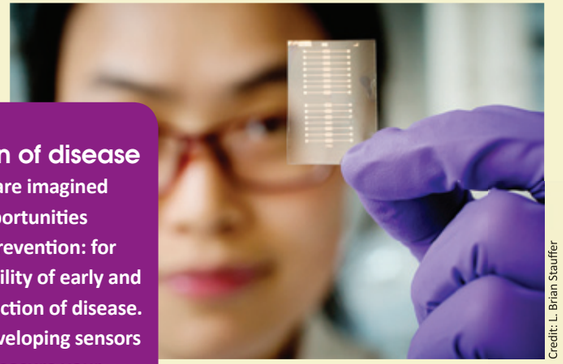
A lot of research has been carried out to confirm that sunblock containing nanoparticles is safe to use for humans, but what about when we wash the sunblock off our skin? Has enough evidence been gathered about the possible environmental impacts of such products before allowing their use?



## How is nanotechnology regulated?

The question of whether and how to regulate nanomaterials has been ongoing in the European Union (EU) for over a decade. The EU was the first jurisdiction in the world to provide nano-specific legal provisions to address health and safety concerns of nanomaterials. Implementation of the EU legislation has, however, proven challenging. The various EU agencies need time to figure out who has the responsibility to implement oversight and regulation. Regulators need time to keep up with scientific developments. Industry and business need time to understand how to categorise and index their products.

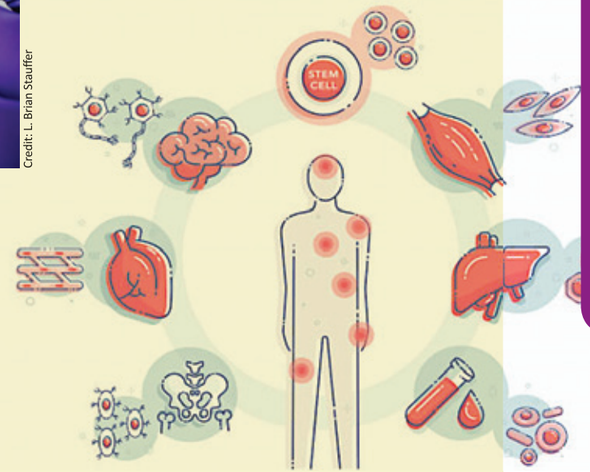
# Nanotechnology and health: what are the visions?

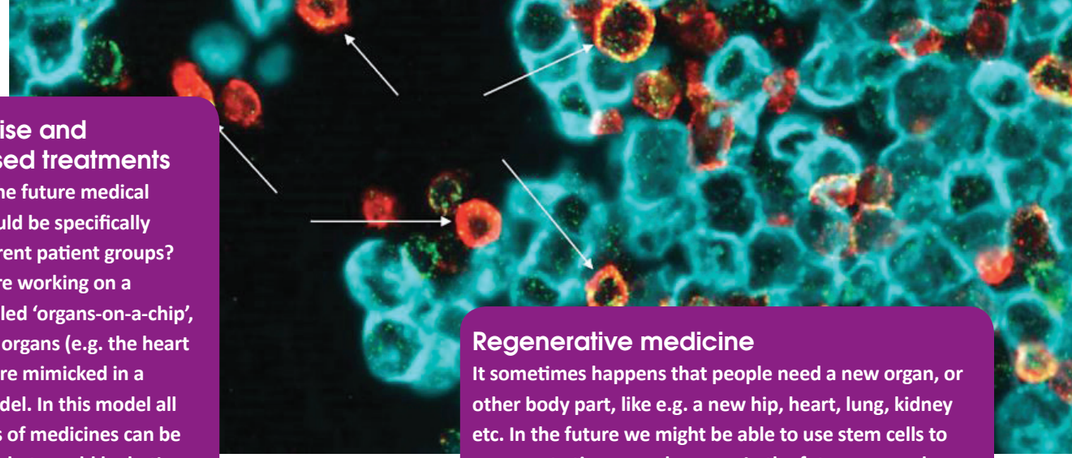


Credit: L. Brian Stauffer

## Early detection of disease

Nanotechnologies are imagined to provide new opportunities for diagnosis and prevention: for example the possibility of early and more accurate detection of disease. Researchers are developing sensors that for example measure your urine or breath. Imagine you would carry such a sensor you with you all the time. The sensors would collect data about our health condition throughout the day and night. In the future, they might even allow people to monitor their own health without the need of a doctor.



## More precise and personalised treatments

Imagine if in the future medical treatment would be specifically suited to different patient groups? Researchers are working on a technology called 'organs-on-a-chip', where human organs (e.g. the heart or the lungs) are mimicked in a laboratory model. In this model all different types of medicines can be tested to see what would be better for what group of patients. Other examples include nano-robots that could be made to trace down e.g. cancer cells and release medication in the diseased area of your body. The mechanism is for example promising in cancer treatment.

## Regenerative medicine

It sometimes happens that people need a new organ, or other body part, like e.g. a new hip, heart, lung, kidney etc. In the future we might be able to use stem cells to regenerate tissues and organs. In the future, a new lung or hip, or skin-patches for wound healing could be made from your own cells. Organs or skin patches made from your own cells could help to ensure the body accepts the new replacement better.

# How should we design nanotechnologies?

## Will nanotechnology lead to differences in treatment and access to treatment?

In order to work, nanotechnology innovations need to be implemented in our societies, everyday lives and (inter)national systems. We are not sure how nanotechnology applications would affect the organisation of our healthcare systems, or how they could affect your privacy. We don't know if nanotechnology will deepen the divide between 'rich' and 'poor' patients, consumers and countries. We also do not know if better individual treatments would favour some groups over others? Could we see more treatments available for men than for women, or for some ethnic groups above others?

Many healthcare applications involve the development of sensors. Nanotechnology sensors could be used to detect early signs of disease, and combine data on your biology with your eating habits to support a healthy lifestyle. It could prevent intoxicated person from driving, by detecting traces of alcohol in the air. One could imagine that insurance companies, businesses, employers or others would also like to have such information. Could the collection of such information change the way we perceive ourselves and others? Who should own your data?.



# How could nanotechnologies be developed to suit your needs?

### How do we make sure that

- We design nanotechnologies that fit with the wishes of citizens across the world?
- We avoid the risks and enjoy the benefits of nanotechnologies?

Research has shown that because nanoscience is dominated by men, ideas of future nanotechnology products are also male oriented. Men and women also think differently about risk. Perceptions of risk vary between some ethnic groups, with some men having a lower perception of risk. Women are more likely to think nanotechnologies are dangerous, and are less likely to engage with nanotechnologies because of this.

Research has also shown that religious beliefs and differences in culture can play a role in how we judge the potential of nanotechnologies, as well as how we believe nanotechnologies should or should not be used.

## What do you think?

- **Do you think culture, gender or religion influence how you think about using nanotechnologies for applications in healthcare and to support healthy living?**
- **Do you think there are some traditional and cultural values we should support with new technologies for in healthcare and to support healthy living?**
- **How should nanotechnologies for health and healthcare be developed?**

# Summary

- **Nanoparticles are very small.**
- **Nanomaterials have different properties than the materials we are used to.**
- **Nanotechnologies are imagined to provide new opportunities for diagnosis, prevention and treatment.**
- **There is uncertainty on how dangerous nanotechnologies could be to humans, animals and the environment.**
- **It is difficult to implement regulation and control of nanotechnologies.**
- **(inter)national Healthcare systems, governments and the healthcare industry industry is likely to influence the implementation of nanotechnologies.**
- **Culture, gender and other societal traditions (e.g. religion) are like to influence how nanotechnologies will be implemented in our societies.**

This material was developed for the GoNano citizen meeting in fall of 2018 on future nanotechnolgy for health in the Netherlands. The aim of the information material was to: present the citizen participants with short and easy-to-understand information about nanotechnology; align the discussion in the meetings with the research and innovation priorities with professional stakeholders; introduce visions of future nanotechnology in Health; and to introduce societal, cultural, legal and ethical questions and uncertainties.

GoNano

www.gonano-project.eu

GoNano is a Coordination and Support Action funded by the European Union under the NMBP Programme of Horizon 2020, Grant Agreement n° 768622.