



**GONANO CITIZEN MEETINGS
FUTURE HEALTHCARE AND NANOTECHNOLOGIES
INFORMATION MATERIAL**



**UNIVERSITY
OF TWENTE.**

ABOUT THE MEETING

Thank you for participating in the GoNano citizen meeting on future health and nanotechnology! At the citizen meeting you will work together with other citizens to create an overview of your aspirations and concerns for innovations in nanotechnology by focussing on how they could affect your future everyday health and interaction with the healthcare system.



WHAT HAPPENS AFTER THE GONANO MEETING?

1. GoNano researchers will analyse the insights you have shared about nanotechnology and its application in healthcare. In their analysis they will focus on the ideas and concerns you have expressed.
2. GoNano researchers will use the analysis in the second step of the project: expert workshops. Researchers, industry partners, civil society organisations and policymakers will be asked to use your insights as a starting point for designing future nanotechnologies.
3. In spring 2019 you and other citizens across Europe will receive an invitation to evaluate the innovation ideas produced from the expert workshops through an online consultation.
4. In the second round of expert workshops, the stakeholders will re-work the design suggestion based on the citizen's evaluation.
5. GoNano researchers will present the results to EU policy-makers, and make the results available online, together with teaching material that shows how people can work with citizens to develop innovative product designs.

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WHY ARE WE FOCUSING ON HEALTHCARE FOR THE FUTURE?

Together as a society we face an increasing number of people. Healthcare has improved vastly, however we still witness an increase in the number of people living with a chronic disease. Healthcare systems are under pressure to treat the increase in numbers of chronic patients, and from the rise in cost of medicines and treatments as well. Nanotechnologies are imagined to provide new opportunities for diagnosis, prevention and treatment. If we could detect disease earlier, then we could perhaps prevent the disease from developing. Better medications would give better health outcomes, and overall reduce the cost and burden on our healthcare systems. Governments must decide on if and how much to invest in the development of nanotechnologies. It is a difficult decision.

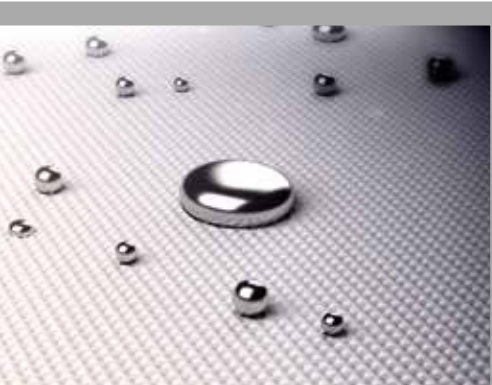
IN THE FOLLOWING SECTIONS, WE WILL:

- ♥ Provide you with a brief introduction to nanotechnology,
- ♥ Explain how nanotechnology could contribute to health and healthcare in the future,
- ♥ Introduce questions and uncertainties related to nanotechnology and health applications,
- ♥ Introduce scenarios of how everyday life could look like in 2030,
- ♥ End with a summary and information on how we will follow up on the meeting, and how you can follow the progress of the project as well as how you may get in contact with us.

WHAT IS NANO-TECHNOLOGY?

Nanotechnology is generally referred to as 'the science of the very small'. The prefix nano actually derives from the Greek νᾶνος (nanos 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?

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?

FUTURE VISIONS OF NANOTECHNOLOGY AND HEALTH IN 2030

MONITORING FOR (UN)HEALTHY CONTROL?

Sofia turns off the alarm clock, yawns and finally sits up. Time to get up. She turns off the flight mode on her phone, turns on the Bodysensor app and holds her breath for a few seconds as it updates. Then she sighs. No signs of cancer. Yet. Time to wake up the kids.

Since they installed nanorobot sensors in her breasts it has become a daily routine for Sofia to check the Bodysensor app first thing in the morning. Her mother died of breast cancer seven years ago. Apparently Sofia is also genetically predisposed to develop breast cancer. The nanorobot sensors were offered to her in order to detect eventual cancer cells as early as possible. As Sofia sets the table for breakfast, she thinks of her mother. If only her cancer had developed five years later, she would most likely have survived. Since the development of cancer treatments enhanced with nanotechnology, very few

die from breast cancer, and no-one has to suffer from the terrible side effects of the out-dated chemotherapies and radiotherapies of the past. Today, they use tiny nanorobots to transport the therapeutic agents directly to the tumour, so that patients do not need to have their entire body bombarded with chemicals and radiation. Tiny nanosensors are installed in the breast tissue of cancer patients that kept track of how they react to the treatment. In this way doctors can make adjustments as soon as it is needed – and monitor any recurrence of tumour cells.

Peter is getting the kids ready. Sofia sits down with a cup of coffee. She looks at her phone and fights the temptation to check the Bodysensor app. The app is her safety net, but also a daily reminder that one day the figures might not be as she hoped. And what if the app doesn't detect everything? What if someone hacks into her phone and changes the settings or reads her data? Before the nanosensors were installed, Sofia didn't think much about cancer. Now she thinks about it all the time. Peter comes in with the kids, and they all sit down to have breakfast. Sofia is grateful to be alive.





SMELLING DISEASE

John is sitting in front of a computer at the pharmacy for his yearly health check-up. The yearly check-up is mandatory for everyone above the age of 30. On the computer screen in front of him, he has a view of a doctor sitting in front of a desk looking into a computer screen. On John's side of the screen there is a mechanical device that looks a bit like a nose. An assistant cleans the nose-like device and asks John to open his mouth and take the device into it and blow his breath back and forth for a minute. The artificial nose can detect many types of disease. It takes 15 minutes for the doctor to return with the test results.

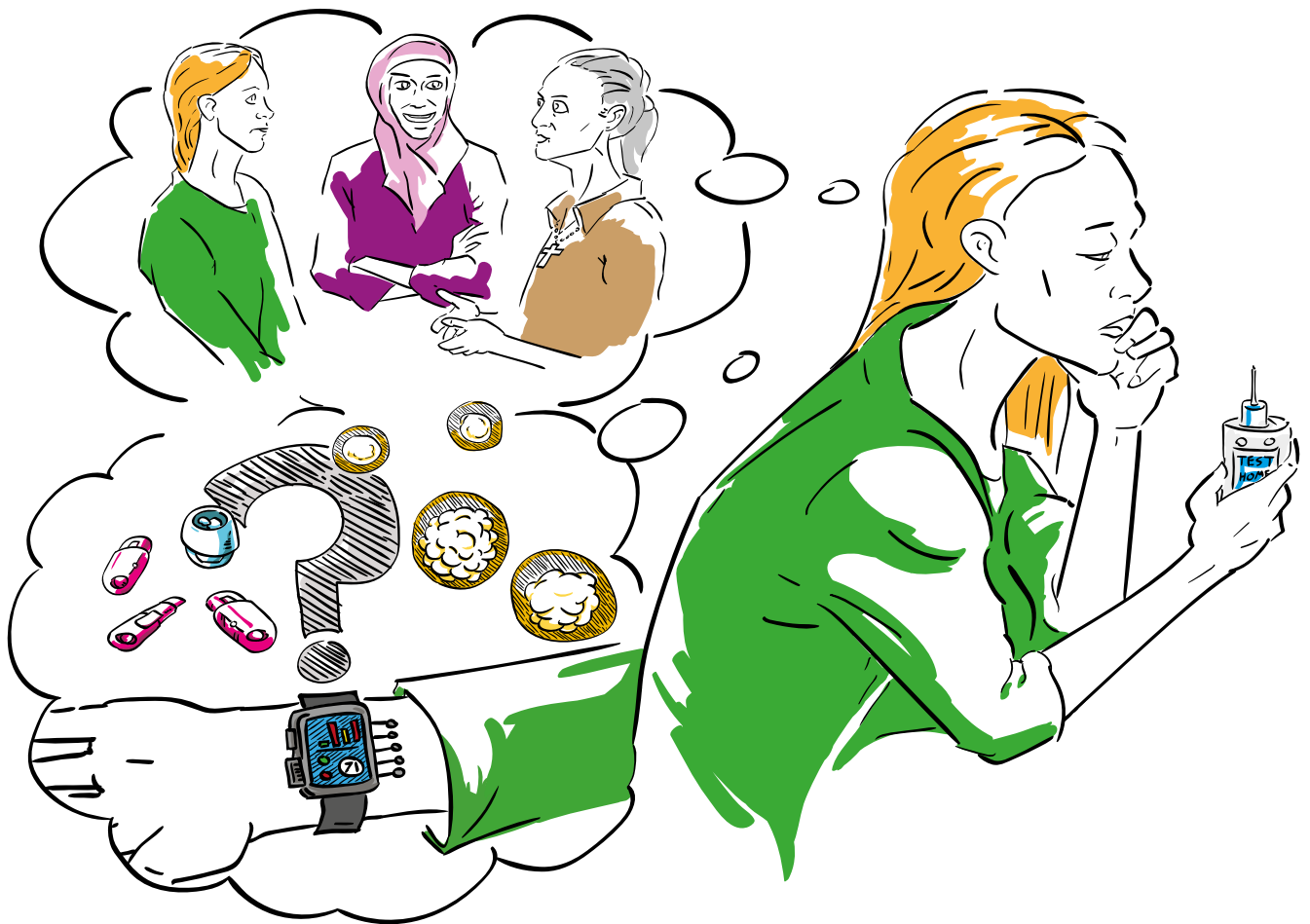
As he waits, John speculates about all the different types of diseases he might have – hasn't he been a bit more tired lately, and what about the other day when he suddenly couldn't remember the name of one of his

colleagues? He is scared he might be developing a mental health disorder like dementia or Alzheimer's disease, or neurological disease like ALS where your muscles slowly die. Imagine not knowing when or how the disease would develop. John knows that medications today are much better than they used to be – but what was it he read the other day, about some medications only working well for some people and not for others? Was it that people of African descent who had the worst coverage with the new medications? The doctor returns to the screen. John's stomach is twisted up in a hard uneasy knot as he waits for the news. John is fine.

DOCTOR AT HOME

Sofia is sitting on the toilet in her bathroom at home. She is opening the package of a new home test for diabetes. The test is a needle with a nanochip. She will need to prick her finger to provide a blood drop for analysis on the nanochip. The chip can immediately detect if Sofia suffers from diabetes 1 or 2. Recently, Sofia has felt very tired and thirsty and she constantly had to go the toilet. She searched online to check her symptoms and ended up on a webpage about diabetes. The website also described different treatment options. One option is a small wearable device developed using nanotechnology. This device constantly measures the level of insulin, and injects extra insulin when needed. Another option is to create new beta cells in the body. With diabetes type 1, beta cells in the body stop working. Using nanotechnology, doctors are able to create new beta cells from stem cells, and place those in the body. No other medication is needed.

Sofia considers her situation. She is already happy the home test for diabetes was cheap and easy to buy. Since health insurance does not cover check-ups at the general practitioner anymore, home tests are very useful. She is a little uncertain about using the needle to prick her finger. What if she has diabetes? What treatment option would she choose? She imagines having to carry around a small device for the rest of her life. What if it breaks down or has errors? How would she know she was getting the right amount of insulin? The beta cells created from her own stem cells would cure her diabetes. She would never need to think about it again. But her insurance does not cover the treatment, and it is very expensive. She also wonders how her religious community would feel about such a treatment. Would it be allowed? She takes a deep breath and pricks her finger with the needle.



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