Microplastics & Health

Fifteen unique research projects will start investigating the health effects of micro- and nanoplastics on our health. This research is possible through funding by NWO commissioned by the topsector Life Sciences & Health and the topsector Water, the Gieskes-Strijbis Fund, and the Ministry of Infrastructure and Water Management.

Focus area: uptake and risks from food

Non-animal testing of human risks of plastic associated chemicals – Dr. ir. Hans Bouwmeester
Humans are exposed to plastics life-long. During weathering, plastics release chemicals like plasticisers, phthalates, and other organic compounds to which humans may be exposed. The aim of this proposal is to identify possible health threats and the underlying biological mechanisms related to oral exposure to chemicals associated to plastic. We first aim to quantify the release of plasticisers, metals and organic pollutants upon passing the human digestive tract. Subsequently, we will study the potential toxicity of micro-plastic associated chemicals on the human intestinal epithelium in vitro. For this, we will use environmental relevant micro-plastics, cryo-milled from marine derived plastics that may be ingested via seafood, and plastics derived from plastic bottles. We aim to deliver a non-animal based, explorative risk assessment of micro-plastic associated organic contaminants for the human health.

Consortium: Wageningen University, King’s College London (UK)

Uptake, translocation and toxicity of microplastics isolated from shellfish in human gut cells – Dr. Frank van Belleghem
The occurrence of microplastics in the marine environment can pose a risk to human health via the consumption of seafood. However, because of the heterogeneous character of environmental microplastics and lacking toxicity data, a robust risk assessment for human health is difficult. The aim of this project is to find out whether and how different types of marine microplastics that are currently detected in blood cockle, an Indo-Pacific shellfish, can cause biological effects in humans. The study commences with a thorough determination of the physical and chemical characteristics of three different microplastic types (fibres, fragments and films), followed by an analysis of the uptake and transfer of these particles in the gut and is concluded with an in-depth assessment of potential adverse effects. The uptake, translocation and toxicity data gathered in the present project will support the assessment of human risks.

Consortium: Open University, Wageningen University, Unika (Indonesia), Hasselt University (B)

Potential Local And Systemic effects of microplastics upon ingestion (acronym: PLASTICS) – Dr. Evita van de Steeg
Microplastics are a new type of environmental pollutant and are very prevalent in our environment. Microplastics may affect human health through multiple routes e.g. by the food chain or by inhalation. It is unclear as to what extent human exposure to environmental small plastic particles of varying shape, size and composition is a health threat. As microplastics are easily ingested, the intestinal mucosa is continuously being exposed to the microplastics. Our projects aims to determine the potential hazard of consuming small plastic particles of varying shape, size and composition by studying the potential systemic exposure of these small plastic particles by determining intestinal absorption and transport. A subset of microplastics will be exposed to the physiologically relevant InTESTine system and intestinal absorption will be determined as well as toxicologic parameters will be measured by studying the viability and integrity as well as the local inflammatory responses.

Consortium: TNO, UMC Utrecht, VU Amsterdam, Deltares

Fate, kinetics and impact of small plastic particles after intestinal exposure – Dr. Joost Smit
The human intestine is daily exposed to diverse micro- and nano-sized plastics via food, drinking water and consumer products. However, it is still unclear if these particles affect the intestinal surface and the intestinal immune system. Moreover, it is unknown if these plastic particles can cross the intestinal barrier and reach other organs via the lymph or blood. In this proposal we will use differently sized plastic reference particles as well as mixtures of environmentally relevant plastic particles with diverse chemical composition. These particles will be implied in experiments where we will look at their
effects on the intestinal barrier function and intestinal immune system. In addition, this proposal will investigate if, where, and how (mechanistically) these particles are transferred across the gastrointestinal barrier. Hereby this proposal will help to identify the potential risk of plastic particles after intestinal exposure.

Consortium: University Utrecht, Deltares, VU Amsterdam

Focus area: uptake and effects of microplastics inhalation

What is the impact of microplastic fibers on our lungs? – Prof. dr. Barbro Melgert

Indoor dust contains vast amounts of small plastic fibers. These microfibers are small enough to be inhaled and plastic fibers have been detected in all samples of lung tissue of patients investigated for lung cancer. Owing to their size, shape and resistance to biological degradation, these microfibers have the potential to cause respiratory disease. Other types of air pollution (diesel exhaust, cigarette smoke) can adhere to microfibers and these chemicals may cause additional stress or toxicity to lung cells, making it harder for these patients to fight respiratory infections. At present, no studies have explored whether microfibers can affect cells in lung tissue. In this project, we aim to investigate the effects of microfibers, with and without adhered pollutants, on the cells that line the airways, because these are the first to come into contact with inhaled microfibers.

Consortium: Groningen University, Plymouth Marine Laboratory (UK)

Effect of eXposure of environmental weathered microPLAstIcs on LuNg epithelial cells (acronym: EXPLAIN) – Dr. Ingeborg Kooter

Humans are likely to be exposed to environmental plastic particles via the air they breathe, water they drink and food they eat. Information on the presence of these plastic particles in the air (emissions, transformation, concentration) is currently very limited. As a result the inhalation exposure route as potential health effect route for plastic particles has not been studied in much detail either. In spite of that, fortunately there is a lot of information available about the toxicological effects of other particles that exist in the air, i.e. particulate matter and (asbestos) fibers. Our project aims to deliver comprehensive data for the prediction of the impact of environmentally weathered microplastic on human health using the inhalation route. To this aim, we will study the hazard of pristine and environmentally weathered microplastics using realistic in vitro lung epithelial cell models to mimic the inhalation route and a suit of exposure variables.

Consortium: TNO, LIST (Luxemburg), Epithelix (Ch), UMC Utrecht, VU Amsterdam, Deltares

Microfluidics-based alveolar barrier model to evaluate nanoplastic translocation – Dr. Bastien Venzac

Representing over 150 million tonnes, plastic pollution in oceans is acknowledged as a serious threat for the sea fauna and flora. Plastic debris exist as micro and nanoparticles, which are either generated through the decomposition of larger plastic pieces, or already present in consumer products like cosmetics, food packaging and clothes. These plastic particles can be harmful for human beings, in particular through their ingestion and inhalation, although little is known about their effects on human health and whether they can reach more sensitive organs via the blood stream. With our expertise in building organ models and inhalation nanotoxicology, we will develop a miniaturized artificial human lung, which recapitulates the architecture of the organ and includes breathing-like motions. The passage of model and real-life nanoparticles through this artificial lung barrier will be evaluated, avoiding thereby the use of animal testing.

Consortium: Twente University, RIVM
Focus area: can microplastics affect our immune system?

IMMUNOPLAST: Human immunotoxicological consequences of plastic particulate pollution – Dr. Heather Leslie

Our health is intrinsically related to the quality of the environment. Humans are exposed to unknown quantities of plastic particulate debris on a daily basis via air, water, and food. That’s why it is important to determine what adverse health outcomes may arise out of plastic particle pollution. One of the important mechanisms we think is involved in the toxicity of these particles is an interference with homeostatic immune function. This study seeks to answer the question if human blood actually contains plastic fragments. And if so, what kind of hazardous immune system effects can we expect? Using a human blood in vitro exposure model, we seek to understand the immunological signals that show us how small plastic particles may be interfering with homeostatic immune function.

FISHH: First Immunotox Screening of microplastics on Human Health – Dr. Nick Beijer

The amount of minute plastic particles in our food is growing, raising uncertainties on the effect they may have on our health. We intend to address these uncertainties by investigating whether microplastics (both derived from environmental samples and industrially produced) will accumulate in our bodies and cause undesired effects to our immune system. To do this, we will employ simple but well-established and state-of-the-art tests using macrophages – important immune cells whose function is to clear our body of unwanted particulate matter such as microplastics. We will investigate to what extent macrophages take up plastic particles, where in these cells the microplastics will end-up, what effects they may have there, and what happens to them over time. This information will help us to understand whether the presence of microplastics in our food and water is a cause of concern.

Consortium: RIVM, NIOZ, ANSES (French Agency for Food, Environmental and Occupational Health and Safety)

On miCroplAstic Penetration in vivo and The mammalian innate immUne REsponse: the CAPTURE study – Dr. Nienke Vrisekoop

Microplastics are very prevalent in our environment and can enter the human body via inhalation, our drinking water, food, cosmetics and medical appliances. The awareness that microplastics originating from industrial and household emission are a threat for human and animal health is only recently emerging. It has already been shown that microplastics decrease survival in water fleas and cause embryo toxicity in sea urchins. Nevertheless, research into health effects in mammals is still limited. We will study how the microplastics penetrate our intestines and subsequently interact with circulating immune cells called neutrophils that are normally recruited to sites of infection to engulf and kill bacteria. Our preliminary data show that microplastics are taken up by these immune cells and that they are not digested. We will study whether engulfment of plastics negatively affects critical neutrophil functions leading to compromised bacterial killing in high-throughput assays developed in our laboratory.

Consortium: UMC Utrecht, VU Amsterdam, Deltares, TNO
Focus area: can microplastics reach the brain or placenta?

Optical nanoscopy investigation of plastic nanoparticle and nanofiber uptake in zebrafish – Dr. Nicolò Ceffa
Plastic pollution is a global problem, particularly in aquatic environments. Plastic waste disintegrates into microscopic and nanoscopic debris that may be ingested or absorbed by fauna. Nanoplastics not only affect the health of aquatic ecosystems, but their possible bioaccumulation in the food chain could pose dangers for humans. To assess this health hazards, it is imperative to trace the pathway of nanoplastics through living organisms.
We propose a form of light microscopy sensitive enough to detect single fluorescent plastic nanoparticles deep inside living small marine fauna. We will focus on achieving the high spatial resolution and ultra-stable imaging conditions needed to track nanoplastics inside cells and between cells into different organs. We will apply our new method to unravel how nanoplastics are distributed in developing fish embryos, and if distribution depends on whether nanoplastics enter through the respiratory system, gut, or skin.
Consortium: TU Delft, Leiden University

Neurotoxic effects of small plastic particles? – Dr. Remco Westerink
Humans are exposed to different micro- and nanoplastics on a daily basis via the food chain, (drinking) water and consumer products. Yet, it is unclear if exposure to these plastic particles has any adverse effects on human health. Despite its protection by the blood-brain-barrier, the brain is known to be vulnerable to metal nanoparticles. This proposal will therefore investigate if and to what extent small plastic particles can also reach the brain using a human in vitro cell model for the blood-brain-barrier. Additionally, this proposal will investigate if plastic particles have any adverse effects on brain function and brain development in vitro. This proposal relies on differently sized plastic reference particles as well as mixtures of environmentally relevant plastic particles with diverse chemical composition. As such, this proposal will identify the potential of plastic particles to induce neurotoxicity in relation to size, chemical composition and ability to reach the brain.
Consortium: Utrecht University, Deltares, Université d’Artois (Lens, France), VU Amsterdam

Small plastic particles in the human foetal environment: novel studies on exposure and hazard – Prof. dr. Juliette Legler
Although plastic pollution has received worldwide attention, the health risks associated with human exposure, including possible adverse effects during pregnancy, remain largely unexplored. Contradictory to old beliefs, the placenta is not an impenetrable barrier between the mother and the unborn child. Many exogenous compounds, including chemicals present in plastics, can pass the placenta and reach the baby, where they may cause negative effects on development. Some studies have shown that small plastic particles (SPPs) of micro- and nanometer size can accumulate in human placenta cultures. However, the presence of SPPs in real human placental samples has never been confirmed, and the cross-placental transport of SPPs into foetal amniotic fluid has never been studied. Using real-life samples of human placenta and amniotic fluid, this proposal will characterize the exposure of SPPs as well as examine the potential toxic effects of SPPs and chemicals associated with them.
Consortium: Utrecht Universiteit, Deltares, VU Amsterdam, Westfriesgasthuis, Icahn School of Medicine at Mount Sinai (US)
Focus area: are microplastics a source of pathogens?

PLASTICBUG: potential health risks of microplastics contaminated with pathogens from the environment – Dr. Bas van der Zaan
There is ample evidence that (micro)plastic in the environment can be colonized by microorganisms, including potential human pathogens, that are not or less frequently observed on natural substrates. The formation of these microbial biofilms on microplastics will be highly dependent on the specific ambient environmental conditions. However, information is lacking on the distribution and composition of microbial contamination of microplastics humans are exposed to via inhalation and ingestion, and if microbial contaminated microplastics pose an additional health risk compared to sterile microplastic or plastic particles. Therefore, the current project (PLASTICBUG) proposes to expose microplastic particles in a controlled way in the environment, and to identify the microbial community after exposure using Nanopore sequencing techniques to identify the presence of potential human pathogens. Then we will use isolated neutrophils from human blood to test the immune response upon exposure to the most contaminated microplastics to better understand their potential health risks.
Consortium: Deltares, VU Amsterdam, UMC Utrecht, New York Military Academy (US)

MIASMAS - Microplastic Associated Spread of Microbial Assemblages in Aquatic (eco)Systems – Prof. dr. Ana Maria de Roda Husman
Millions of tonnes of plastic end up in aquatic ecosystems globally every year. There is increasing concern about ‘microplastics’, small plastic fragments created when larger items break apart, or manufactured for industrial products and packaging materials. Microplastics are long-lived and accumulate in food chains, being potentially harmful to lifeforms, including humans. Besides toxic effects of plastic chemicals, microplastics provide substrates for microbial colonization, forming ‘biofilms’ that can host human pathogens, enable virulence and antimicrobial resistance gene exchange among microorganisms, and enhance microplastic buoyancy, which favours their long-distance dispersal. While most microplastic research focuses on marine environments, microplastic dynamics in freshwater are under-researched. Freshwater accumulates microplastics from several sources, and rivers transport microplastics to seas/oceans. This project will determine microplastic concentrations, their chemical properties and microbial assemblages along a major European river (Rhine), investigating possible microbiological hazards in microplastic-associated biofilms favouring the global spread of waterborne diseases and antimicrobial resistance.
Consortium: RIVM, Utrecht University, KWR Watercycle Research Institute

More information
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