MICROPLASTICS AND PUBLIC HEALTH

ACKNOWLEDGED RISKS AND EU POLICY ACTION

A REPORT OF

PLASTIC SOUP FOUNDATION

IN COLLABORATION WITH

GREEN IMPACT
Transformative Thinking

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1. Executive Summary

Microplastics and nanoplastics represent an escalating public health and environmental crisis, with a growing body of peer-reviewed evidence demonstrating their presence in human blood, breast milk, lungs, brain tissue, placenta, and even in children's urine. These particles, once released into the environment, seem virtually impossible to remove and act as vectors for toxic substances, including endocrine disruptors, heavy metals, persistent organic pollutants (POPs), and antibiotic resistance genes. Exposure occurs via ingestion, inhalation, and dermal contact, with documented effects ranging from inflammation and oxidative stress to neurotoxicity, reproductive toxicity, developmental disorders, and carcinogenicity. Especially vulnerable populations - including children, pregnant women, and frontline communities - face disproportionate health risks, while environmental accumulation threatens ecosystems and biodiversity.

The 2024–2029 EU political cycle offers a historic window to implement systemic, science-based, and enforceable measures to mitigate these risks. This Policy Brief provides a comprehensive overview of the latest toxicological research and identifies strategic actions for policymakers to accelerate the phase-out of hazardous polymers, strengthen producer responsibility, and enhance health protection under key EU frameworks. It underscores the urgent need to embed microplastic prevention within the forthcoming Circular Economy Act, the Action Plan for the Chemicals Industry, the EU Bioeconomy Strategy, and the European Water Resilience Strategy. While recent legislative steps—such as the REACH restriction on intentionally added microplastics and the proposed regulation on pellet loss—are commendable, major regulatory gaps remain in addressing secondary microplastic formation, harmonised monitoring, and substitution incentives for safer materials.

Europe must lead by example: The EU has the mandate and the moral responsibility to champion legally binding international provisions on microplastic control, product redesign, and health monitoring. Coordinated action across Member States, robust investment in research and innovation, and the adoption of common standards for detection, risk assessment, and remediation will be critical to prevent irreversible damage to public health and the environment. The time to act is now - and the EU must be bold, ambitious, and uncompromising in its commitment to protect current and future generations from the pervasive threat of microplastics.

2. Recommendations for Policymakers

- A substantial review of the **Waste Framework Directive** should be a priority during this European mandate and be part of the announced Circular Economy Act. Particularly, **the Act should include a review the Environmental Producer Responsibility (EPR)** schemes to make producers responsible for the whole life cycle of the product, not only the end-of-life - including the release of microplastics during use and degradation phases. Therefore, EPR schemes need to actively finance waste prevention, reuse, repair, and substitution of of polymer-based materials, through dedicated repair and reuse funds and infrastructure, and targeted support for microplastic-free design, and aligned policy measures.

- The **European Chemicals Industry Action Plan** should include as urgent priority fiscal incentives and tax measures to boost demand for clean chemicals and to accelerate the substitution of hazardous and persistent polymers. The upcoming EU Innovation and Substitution Hubs as well as the program Horizon Europe should make available increased funds to accelerate the development of safer, more sustainable chemical substitutes and to support R&D on safer, sustainable, and microplastic-free chemical substitutes.
- The workplan on textiles/apparel to be adopted by 2027 under the **Ecodesign for Sustainable Products Regulation (ESPR)** should include concrete measures to prevent microplastics pollution of both waste streams and water, including concrete and binding measures to mitigate **microplastic shedding throughout the textile lifecycle** — from fibre production to washing and disposal. These measures must include standards for microfibre release, durability criteria, mandatory filtration technologies, and design-for-recyclability protocols.
- The flagship actions included in the **EU Water Resilience Strategy**, including the revision of the **Marine Waters Directive** (by 2027), should urgently address the microplastics pollution of water bodies, treating it as a major health and environmental risk, embedding urgent and enforceable targets across **freshwater and marine policies**.
- Specifically, when discussing the above initiatives or other relevant proposals, these actions should be proposed and supported:
    - Accelerating bans on high-risk microplastic sources
    - Removing market barriers for alternative materials and systems, including **bio-based and biodegradable materials** (e.g. packaging from agri-waste or natural fibres), through harmonised standards and support under the **Bioeconomy Strategy**.
    - **Avoid regressive waste management costs** on EU citizens by shifting towards **producer-responsibility-based funding** under the WFD, rather than general plastic taxes on consumers (e.g. rethink the implementation of the **Single Use Plastics Directive** in this light).
    - **Strengthen research funding** under the **post-2027 Multiannual Financial Framework**, with a specific call under Horizon successor programmes for cross-disciplinary health-environment microplastics research.
    - **Ensure strong EU leadership in the Global Plastic Treaty**, with a mandate to pursue legally binding provisions on microplastic production, release, and monitoring — particularly in the lead-up to **INC-5.2 in Geneva (August 2025)**.

- ○ **Improve public awareness and education** campaigns on health and environmental risks of microplastics, especially for vulnerable groups.

3. EU Legislative Landscape

Microplastics are addressed via the EU's **Circular Economy Action Plan**, and the **Zero Pollution Action Plan**, aiming to cut releases by 2030.
The **Zero Pollution Action Plan** continues to serve as a foundational framework to reach pollution levels "no longer harmful" by 2050. By 2030, the Commission's aim is to reduce microplastic emissions by at least **30 %**, alongside a **50 % reduction in plastic litter at sea** - targets explicitly anchored within this renewed political mandate. In 2023, the EU enacted a **REACH restriction** banning intentionally added microplastics in products and proposed a Regulation on **pellet loss prevention**, targeting unintentional releases, both contributing to the 30% reduction goal by 2030. Key legislative shifts include updates to the **Urban Wastewater Treatment Directive** and **Drinking Water Directive** to introduce monitoring and mitigation of microplastics in water sources. Collectively, these measures are designed not only to curb environmental leakage but also to advance public health—recognizing emerging evidence of microplastics in human tissues (e.g. blood, breast milk, organs) and calling for preventive action across product lifecycles.

3.1 Other Adopted Laws and Their Implementation Status

Further existing legislative tools addressing microplastics are:

- **Marine Strategy Framework Directive**: Adopted in 2008, the Marine Strategy Framework Directive (MSFD) plays a key role in addressing marine pollution, including the growing threat of microplastics. As the EU's primary legal framework for protecting marine ecosystems, the MSFD aims to achieve Good Environmental Status (GES) of marine waters through coordinated national strategies. Among its 11 environmental descriptors, Descriptor 10 (D10) focuses specifically on marine litter, making it directly relevant to the issue of microplastics. The Directive, reinforced by Commission Decision (EU) 2017/848, sets clear monitoring requirements for microplastics (D10C2), alongside macroplastics and their impact on marine life. This structured and harmonized approach provides a vital foundation for EU Member States to assess, monitor, and implement effective measures to reduce microplastic pollution across European seas.
- **Fertilising Products Regulation**: The EU Commission's Circular Economy Action Plan (2015) and subsequent Plastics Strategy prioritize reducing microplastics, including those in fertilizers, to address environmental and health

risks. In fertilizers, microplastics serve as technical additives (e.g., anti-caking agents) or in Controlled Release Fertilizers (CRFs), where polymer coatings enable targeted nutrient delivery. While CRFs are exempt under the EU Fertilizing Products Regulation (FPR - which entered into force on 16 July 2022), technical additives must meet biodegradability criteria by 2026, after the end of a transition period allowing industry adaptation. Specifically, the FPR aims to standardize the safe use and trade of fertilizers across the EU while addressing microplastic and plastic pollution. It sets strict limits on impurities in fertilizers, capping macroscopic plastics, glass, and metals at 3 g/kg dry matter (with individual plastics limited to 5 g/kg). These thresholds will tighten further, dropping to 2.5 g/kg by July 2026. By 16 July 2029 the limit-value of 2,5 g/kg dry matter for plastics above 2 mm shall be re-assessed in order to take into account the progress made with regards to separate collection of bio-waste (Component Material Category - CMC - 2). Furthermore, under the FPR, manufacturers must implement rigorous quality checks, rejecting any fertilizer inputs suspected of exceeding plastic limits. Staff training is mandatory to identify hazardous materials and ensure compliance. The regulation underscores the EU's commitment to reducing plastic contamination in agriculture while maintaining product safety and environmental standards.Fertilizing products not falling under EU Fertilizing Products Regulation are regulated under REACH (see below).

- **REACH restrictions on intentionally added microplastics and the extension of liquid polymers**: The REACH regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) is the main EU law to protect human health and the environment from the risks that can be posed by chemicals. The EU Commission introduced restriction on microplastics, adopted on 25 September 2023 (Regulation 2023/2055), bans intentionally added synthetic polymer microparticles in products, including cosmetics. These microplastics—defined as particles under 5mm or meeting specific size and concentration criteria (≥0.01% by weight)—persist in the environment, threatening ecosystems and human health. The regulation aims to prevent 500,000 tons of microplastic pollution over 20 years, aligning with the EU's Zero Pollution Plan and Circular Economy goals. The ban applies to microplastics used in cosmetics (e.g., microbeads, glitter) and other consumer goods, with staggered compliance deadlines. For example, rinse-off products must comply by 2027, while makeup and nail products have until 2035, provided they carry warning labels from 2031. Exemptions include natural, biodegradable, or highly soluble polymers, as well as those permanently embedded in solid matrices.
- **Single-Use Plastics Directive (SUPD)**: Single-use plastics (SUPs) are designed for brief use before disposal, yet their environmental and health consequences are severe and far-reaching. These items—ranging from food packaging to disposable cutlery—are a major contributor to marine pollution, with studies showing they are significantly more likely to pollute oceans

compared to reusable alternatives. In the EU, the top 10 most frequently discarded SUPs, along with abandoned fishing gear, account for 70% of all marine litter, underscoring their outsized role in the global plastic crisis. The EU's Single-Use Plastics Directive implements targeted measures tailored to specific products, ensuring proportional and effective action while considering the availability of sustainable alternatives. The Directive focuses on 10 key items responsible for significant plastic pollution, including cotton bud sticks, cutlery, plates, straws, stirrers, balloon sticks, food and beverage containers, cigarette butts, plastic bags, packets, wrappers, wet wipes, and sanitary items. By addressing these high-impact products, the regulation aims to reduce plastic waste at its source and drive the transition toward reusable and eco-friendly solutions. The EU's measures targeting single-use plastics (SUPs) can play an important role in reducing microplastic pollution by addressing the main sources of marine litter. By banning or restricting high-impact items like cotton buds, cutlery, and food containers - which, as said, account for 70% of beach waste - the Single-Use Plastics Directive prevents these products from breaking down into persistent microplastics. Additional strategies, such as design requirements (e.g., tethered bottle caps), recycling targets (90% for bottles by 2029), and producer responsibility schemes, can further curb plastic leakage into ecosystems. These rules not only mitigate direct environmental harm but could also accelerate the shift toward a circular economy, reducing the long-term generation of microplastics from degraded plastic waste. The Commission will evaluate the SUPD by 3 July 2027, using available data and evidence to determine if its objectives and measures have been effectively implemented across Member States.

- **Microplastics Restriction Regulation**: Regulation (EU) 2023/2055, effective from 17 October 2023, aims to restrict synthetic polymer microparticles, commonly known as microplastics, which are intentionally added to products. These particles are found in a wide range of everyday items, including cosmetics, detergents, fertilisers, medical devices, and synthetic sports surfaces. The regulation aims to reduce environmental emissions of microplastics by banning their use in these products. The regulation establishes staggered transitional periods for different product categories to allow industries time to adapt. For instance, rinse-off cosmetics without microbeads face a ban from October 2027, while detergents and similar products have until October 2028. Longer deadlines apply to agricultural products (October 2029), synthetic sports surfaces (October 2031), and certain makeup products (October 2035). These timelines ensure a phased approach to compliance while maintaining environmental protection goals. The EU adopted the Regulation specifically to address microplastic pollution, following recommendations from the European Chemicals Agency (ECHA), which concluded that the intentional use of "synthetic polymer microparticles" (SPM), resulting in releases to the environment, poses a risk to the environment that is not adequately controlled. The SPM which are banned from being intentionally added need to be solid and either synthetic polymers, or natural polymers that have been chemically modified, not degradable and not soluble, plus containing carbon atoms. Therefore, are excluded: liquid polymers, natural polymers, degradable and soluble polymers or polymers not containing carbon atoms. Furthermore, to be regarded as SPM, the solid polymers must be either: contained in particles in concentration equal or greater than 1% f the total weight of the particle containing the polymer(s), or build a continuous coating around particles (including particles with a liquid core, such as vesicles); no concentration limit applies in this case.

3.2 Pipeline Laws & Proposals

This section outlines key proposals and regulatory developments that target microplastic emissions across water systems and industrial supply chains, with a particular focus on safeguarding human health and delivering on the EU's Zero Pollution and Green Deal objectives:

- **Microplastics in drinking water (revisions to EU Drinking Water Directive)**: The **Directive (EU) 2020/2184**, also known as the **Drinking Water Directive (DWD)**, is the **response to the European Citizens' Initiative "Right2Water"** and it was adopted in December 2020. It aims to ensure safe drinking water for all, particularly vulnerable groups, by updating water quality standards and addressing pollutants like endocrine disruptors. Member States were required to transpose the directive into national law by January 2023, applying it to all water intended for drinking, domestic use, or food production, regardless of its source or distribution method. The reforms strengthen public health protections and promote equitable access to clean water across the EU. In accordance with article 13 (Monitoring) of the Directive, the Commission, on 16 May 2024, notified a Delegated Decision on a methodology to measure microplastics in water intended for human consumption to the Member States. It will allow Member States to measure microplastics in drinking water in a harmonised way, since the use of different methods for measuring microplastics in drinking water have made it very difficult to compare and interpret monitoring results. The establishment of an EU harmonised methodology by the Commission has the objective to support Member States in gaining knowledge about the presence of microplastics in their water supply chain. This methodology was developed with a view to including microplastics in the DWD watch list, as stated again in article 13. The watch list addresses substances or compounds of concern to the public or the scientific community on health grounds, such as pharmaceuticals, endocrine-disrupting compounds and microplastics. Article 19 (Evaluation), also states that the "Commission shall, no later than 12 January 2029, and thereafter where appropriate, submit a report to the European Parliament and to the Council on the potential threat to sources of water intended for human consumption from microplastics, pharmaceuticals and, if necessary, other contaminants of emerging concern, and on the relevant associated potential health risks".

- **Proposal for a Regulation on preventing pellet losses to reduce microplastics pollution**: The European Commission, on the 16th of October 2023, presented a proposal for a new regulation which aims to prevent plastic pellet losses, a major source of microplastic pollution, by introducing mandatory measures across the supply chain. Plastic pellets, which account for a significant share of unintentional microplastic releases (52,000–184,000 tonnes annually), harm ecosystems and potentially human health. The preferred policy combines standardized loss measurement (Option 1) with mandatory prevention requirements (Option 2b), offering lighter rules for micro and small businesses to ease compliance. This approach was chosen to be aligned with stakeholder feedback, including industry support for harmonized EU rules, while targeting a 60–83% reduction in pellet losses—contributing to the EU's broader goal of cutting microplastic emissions by 30% by 2030. The regulation balances environmental benefits with economic considerations, expecting to save cleanup costs and boost sectors like tourism and fisheries, while imposing annual costs of €376–491 million on businesses. SMEs, which dominate parts of the supply chain, will face reduced burdens through tailored requirements and potential financial support. Public authorities will incur minor enforcement costs, offset by avoided environmental damages. The proposal ensures proportionality by focusing on preventable losses and maintaining EU competitiveness, with minimal impact on plastic sector turnover (0.13%). Progress will be tracked biennially via the Zero Pollution monitoring report, leading to a post-2030 review. The regulation addresses transboundary pellet pollution more effectively than national measures, ensuring a level playing field and reinforcing the EU's commitments under the Green Deal and Circular Economy Action Plan. By targeting a critical pollution source, the initiative underscores the EU's leadership in tackling microplastics while safeguarding SMEs and industry coherence.
- The Global Plastic Treaty is an international agreement currently being negotiated between 175 countries after the conclusion of the United Nations Environment Assembly in March 2022, with the aim to develop an international legally binding instrument on plastic pollution, including in the marine environment. The position of the EU during the negotiations, with specific regards to microplastics, is that these particles pose a significant environmental threat, also considering that they absorb toxic pollutants and contaminate marine life, impacting human health and biodiversity. It clearly stated that intentionally added microplastics in products should be banned, in order to prevent plastic pollution in the marine and other environments, which is key to addressing biodiversity loss.

3.3 Gaps in current legislation regarding microplastics

The EU has made significant strides in addressing microplastic pollution through a range of legislative measures. However, critical gaps persist across the existing framework, limiting the effectiveness of these efforts:

- Under the **Marine Strategy Framework Directive (MSFD)**, challenges remain in harmonizing detection methods for particles below 300 microns and in establishing scientifically robust GES thresholds for plastic pollution. The ultimate goal is to align monitoring data with policy actions to effectively reduce marine litter impacts. Furthermore, studies have underlined: analytical limitations, specifically contamination and lack of standardized protocols hinder accurate measurement, especially for particles <300 µm; data gaps, especially limited monitoring of microplastics in sediments and beaches, despite their role as long-term sinks; finally, heterogeneity, i.e. spatial and temporal variability complicates trend analysis and requires robust sampling designs (F. Galgani et al., 2024[1]).
- The **Fertilising Products Regulation (FPR)** addresses microplastics in fertilizers but includes exemptions for Controlled Release Fertilizers (CRFs), which continue to release polymers into the environment. While technical additives must meet biodegradability criteria by 2026, enforcement relies heavily on industry self-regulation and staff training, raising concerns about consistent compliance. Moreover, the regulation's focus on macroscopic plastics (≥2 mm) overlooks smaller particles that may still pose ecological risks.
- The **REACH** restrictions on intentionally added microplastics represent a major step forward, yet gaps arise from staggered compliance deadlines (extending to 2035 for some cosmetics) and exemptions for certain polymers (e.g., biodegradable or soluble ones). These loopholes delay full implementation and allow continued environmental release in the interim.
- The **Single-Use Plastics Directive (SUPD)** targets macroplastic waste but lacks specific provisions to address secondary microplastics generated from the degradation of banned items. While design requirements and recycling targets help reduce leakage, the directive does not explicitly mandate measures to prevent fragmentation into microplastics.
- The **Microplastics Restriction Regulation (EU 2023/2055)** bans intentionally added microplastics but excludes liquid polymers and natural polymers, which may still contribute to pollution. The phased timelines, though pragmatic for industry adaptation, prolong environmental exposure and subsequent health consequences.

Pipeline proposals, such as the harmonized methodology for measuring microplastics in drinking water and the pellet loss regulation, are promising but not yet operational.

[1] See: https://ricerca.ogs.it/retrieve/af038e31-78d9-4e3e-8f87-9d04a399a227/1-s2.0-S0964569124002394-main.pdf

Delays in adoption and uneven transposition across Member States could undermine their impact.
Enforcement challenges further exacerbate these gaps. Divergent compliance levels among Member States, coupled with insufficient monitoring and reporting mechanisms, weaken the overall regulatory framework. Addressing these gaps requires stronger harmonization, accelerated timelines, and expanded scope to cover all microplastic sources, including secondary fragmentation and exempted polymers.

4. EU Commission's Political Guidelines 2024–2029

4.1 Key Priorities

The seven strategic political priorities of the European Commission under the second Von der Leyen Commission, as presented in her Political Guidelines and subsequent work programmes aim to reinforce the EU's vision of a robust, sustainable economy underpinned by public health and environmental resilience.
Although not a standalone headline, **microplastics action** is embedded under the environmental and circular economy ambitions of the Green Deal and *quality of life* priority.
These measures align with the priority to sustain quality of life by protecting **water, food and nature** ecosystems—and are integral to the broader Green Deal and circular transformation embedded within the Commission's priorities.
All of them offer the opportunity of adopting concrete solutions to prevent microplastics at source, adopting common standards for measuring pollution levels, and ensuring the safe use and reuse of agricultural irrigation water:

- **Circular Economy Act**: Central to this objective will be a **Circular Economy Act**, a forthcoming piece of legislation aimed at accelerating the transition to a circular economy in Europe. It's expected to be introduced in 2026, building upon existing initiatives and strategies. The Act aims to enhance resource efficiency, reduce waste, and promote the reuse, recycling, and remanufacturing of materials, ultimately boosting the EU's competitiveness and sustainability. The Act will likely address waste reduction, recycling, and resource recovery, potentially including mandatory waste sorting systems and improved waste management practices. Stricter requirements on product design, including durability, recyclability, and the use of recycled content are also expected.
- **Action Plan for the Chemicals Industry**: According to the Action Plan, the Commission will establish together with Member States and stakeholders a Critical Chemical Alliance to address the risks of capacity closures in the sector.

The Alliance will identify critical production sites needing policy support and tackle trade issues like supply chain dependencies and distortions. It will align investment priorities, coordinate EU and national projects, including Important Projects of Common European Interest (IPCEIs) and support EU critical production sites to boost innovation and regional growth.

- **The European Water Resilience Strategy**: Some of the key objectives of the strategy, to be achieved through the implementation of several flagship initiatives, should address microplastics, notably:
  - **Restore and Protect the Water Cycle:** This involves actions like improving water retention on land, tackling pollutants such as PFAS and microplastics, and ensuring water flows from source to sea.
  - **Secure Clean and Affordable Water for All**: This objective includes ensuring access to safe drinking water and sanitation, improving water treatment, and addressing water scarcity in vulnerable regions.
- **Bioeconomy Strategy**: The **EU Bioeconomy Strategy** offers a critical pathway to reduce dependency on fossil-based materials and curb microplastic pollution by promoting the **sustainable use of biological resources**. By advancing the production and deployment of **bio-based, biodegradable, and non-toxic alternatives** to conventional plastics, the strategy directly supports the EU's efforts to phase out persistent and polluting materials across sectors like packaging, textiles, and agriculture. Updated in 2018 and currently under review, the strategy emphasizes circularity, resource efficiency, and innovation, aligning with broader EU goals such as climate neutrality by 2050, the Green Deal, and Zero Pollution targets. As part of this vision, the bioeconomy plays a key role in developing safe substitutes to microplastic-emitting products, supporting rural economies, and accelerating biotechnology-driven solutions that are compatible with environmental and human health objectives. The ongoing consultation process and upcoming targeted stakeholder workshops will further shape how the strategy can best unlock the bioeconomy full potential — not only as an engine for green growth, but also as a strategic lever to tackle microplastic pollution at its source.

4.2 Funding & Research Initiatives

Understanding and addressing the **health impacts of microplastic pollution** requires a strong and coordinated research agenda across the EU. Through **Horizon Europe** and complementary Member State frameworks, the EU is investing in scientific initiatives that explore microplastic exposure pathways, toxicological effects, and ecosystem-level impacts, while also strengthening data harmonisation and cross-border cooperation. These efforts are critical to inform evidence-based policymaking and support innovation. In particular, the research on these topics is expressed through:

- **Horizon Europe Projects on Microplastics & Health**:

- Under the **Horizon Europe** research programme, significant emphasis is placed on projects addressing microplastic pathways and associated health risks. Notable ongoing initiatives include:**PlastHealth**, which investigates the transfer and effects of microplastic exposure at ecosystem levels using mesocosm experiments on model species (e.g. mussels, fish, crustaceans), incorporating biochemical, histopathological, and microbiome analyses—offering new insight into biomarkers of toxicity and ecosystem disturbance.[2]
  - Horizon calls under the 2025 **"Towards comprehensive aquatic litter pollution assessment"** topic, focused on bridging data gaps across riverine, freshwater, coastal, and marine compartments; standardising analytical protocols; improving autonomous sampling; and integrating data into FAIR-enabled platforms like EMODnet and the European Data Twin of the Ocean.[3]
  - These projects are supported by increasing calls for **citizen science** and open, participatory data infrastructures, consistent with broader EU objectives for a **European Data Union**, to enable cross-border research collaboration and public transparency.
- **Member State Collaboration Framework**:
  - Complementing the central EU-level research effort is a **Member State collaboration framework**, envisioned to align national research infrastructures—such as environmental monitoring networks, health surveillance systems, and R&D funding streams—to enable cross-border pilot studies. This includes mechanisms for data sharing, reference material standardisation, and interoperability of analytical methodologies across national laboratories, aligned with zero pollution and circular economy goals.
  - Projected funding through these channels is substantial: for example, the Clean Oceans Initiative[4] (though not EU-budgetary), mobilised € 4 billion for macro- and microplastics projects in the global south - demonstrating international leverage and potential co-financing model. Development banks set €3 billion joint target for 2026–30 to tackle ocean plastic pollution.[5]

[2] See the page of the project: https://cordis.europa.eu/project/id/101180609/it?utm_source=chatgpt.com.
[3] See: https://cordis.europa.eu/programme/id/HORIZON_HORIZON-CL6-2025-01-ZEROPOLLUTION-04?utm_source=chatgpt.com.
[4] For a deeper description of the initiative see: https://www.eib.org/en/publications/the-clean-oceans-initiative.
[5] See: https://www.eib.org/en/press/all/2025-235-public-development-banks-launch-clean-oceans-initiative-2-0-after-original-initiative-delivered-on-its-target-ahead-of-time.

4.3 Monitoring & Reporting Obligations

Robust and harmonised monitoring is essential to understand and mitigate the health and environmental risks posed by microplastics. The EU is stepping up its data collection and reporting obligations to close critical knowledge gaps, improve regulatory enforcement, and support science-based policymaking across Member States:

- **EU-wide Harmonized Data Collection**:
    - A core commitment of the Commission's policy for 2024–2029 is to operationalise **EU-wide harmonised data collection** on microplastics across environmental and human-exposure matrices. This addresses the current fragmentation: as highlighted in the Marine Strategy Framework Directive, monitoring standards vary substantially between Member States and ecosystems, and freshwater/lake data remain especially patchy. To address this, the Commission is backing standardisation efforts under the **Zero Pollution Monitoring and Outlook Framework**, including new watchlists under the Water Framework and Bathing Water Directives that will include microplastics as a priority pollutant, alongside PFAS and micropollutants from personal care products.
    - Specific mandates include:
        - Regular **monitoring of microplastics in drinking water**, supported by provisional revisions to the Drinking Water Directive[6] that require national authorities to set detection thresholds, reporting triggers, and remediation planning when levels exceed safe limits;
        - Enhanced **wastewater treatment reporting**: by 2035, communities over 1,000 inhabitants must remove organic matter, expanding to nitrogen/phosphorus removal by 2045, and essential new steps to detect and quantify **microplastics and micropollutants** during treatment processes.These rules are tied to extended producer responsibility (EPR) schemes requiring cosmetic and pharmaceutical companies to cover ~80 % of upgraded treatment costs;[7]
        - **Performance indicators and digital tracking**, including interoperability mandates for environmental databases tied to EMODnet,[8] EU Open Data principles and the EU Data Portal,[9] enabling harmonised reporting cycles and cross-Member State comparisons.

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[6] See Directive 2020/2184: http://eur-lex.europa.eu/eli/dir/2020/2184/oj.
[7] See Directive 2024/3019: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02024L3019-20241212.
[8] See: https://emodnet.ec.europa.eu/en.
[9] See: https://data.europa.eu/en/dataeuropa-academy/what-open-data.

These enhanced obligations aim to reduce existing knowledge gaps, facilitate enforcement under evolving plastic and chemical regulations, and substantially support risk assessment capacity across European public health agencies. Data transparency is intended to empower researchers, NGOs, and policymakers alike in evaluating progress toward microplastics reduction goals.

5. Scientific State of the Art

5.1. Definition & Sources of micro-nanoplastics

Microplastics are synthetic solid particles or polymeric matrices (regular/irregular shape) sized 1 μm to 5 mm, from primary or secondary origin, insoluble in water (Frias & Nash, 2019). Common sources include synthetic textiles (microfibres), tires, plastic waste, personal care microbeads, paints, and plastic coatings.
Nanoplastics are particles 1-1000 nm in size from industrial plastic degradation, exhibiting colloidal behavior. They form through environmental degradation of larger plastics (UV light, hydrolysis, mechanical forces) or industrial processes (Ter Halle et al., 2016).

5.1.1. Primary vs. Secondary Microplastics

Primary microplastics: intentionally manufactured at microscopic scale for exfoliating cosmetics, industrial cleaners, abrasive materials, and plastic pellets (nurdles) as raw materials (Song et al., 2024).
Secondary microplastics: result from fragmentation/degradation of larger plastic debris due to UV radiation, mechanical forces, wave action, and wear in marine/terrestrial environments. Examples include fragments from bottles, bags, fishing nets (Song et al., 2024).

5.1.2. Food Chain Accumulation

Plant uptake: micro- and nanoplastics (MNPs) are absorbed by terrestrial plants, affecting growth and biomass. High concentrations found in apples and carrots, leading to accumulation in human tissues (Oliveri et al., 2020; Leslie et al., 2022).
Aquatic biomagnification: trophic transfer occurs through food webs - zooplankton ingest MNPs, passing them to fish and mollusks consumed by humans. This biomagnification increases exposure risks for top predators, including humans (Cole et al., 2013).

5.2. Health Impacts

Plastics pose a growing and under-recognised threat to human and planetary health, causing impacts at every stage of their lifecycle, from raw material extraction to disposal. Microplastics, nanoplastics, and associated chemicals have been detected in multiple human tissues, including blood, placenta, and lungs, and are linked to cardiovascular, metabolic, and reproductive disorders. These exposures carry substantial global health and economic costs, exacerbated by rising plastic production, which is projected to nearly triple by 2060 without urgent action (Landrigan et al., 2025).

5.2.1. Major Pathways of micro-nanoplastics into human bodies

- **Ingestion**:
    - Food sources: seafood, condiments (salt, sugar), honey, chicken, vegetables (Sangkham et al., 2022).
    - Beverages: drinking water (millions to tens of millions particles/liter), beer, milk, soft drinks, wine (United States Geological Survey).
    - Plastic containers: water bottles, baby bottles, food storage - heat increases particle release dramatically (Chen et al., 2023; Hu et al., 2023; Shruti et al., 2024).
- **Inhalation**:
    - Particle size influences deposition: those >10 μm are trapped in the upper airways, <10 μm can reach the bronchioles, and particles <2.5 μm may penetrate deep into the alveolar region (Kelly & Fussell, 2012).
    - Urban environments show high airborne MNP concentrations due to sources like traffic and industry (Falakdin et al., 2024).
    - Surprisingly, even remote regions (e.g., alpine and polar areas) contain airborne MNPs, underscoring their widespread environmental dispersion (Kau et al., 2024).
- **Dermal Exposure**:
    - Although the skin acts as a primary protective barrier, it is frequently exposed to MNPs through cosmetics, personal care products, topical medications, and face masks (Gamage & Mahagamage, 2024).
    - MNPs may penetrate the skin via nonspecific mechanisms, potentially accumulating in epidermal and dermal cells, such as keratinocytes or immune cells (Martin et al., 2024).

5.2.2. Known effects of micro - nanoplastics on human health

Micro- and nanoplastics (MNPs) may cause various health effects including intestinal disturbance, cardiovascular and reproductive toxicity, neurotoxicity, and metabolic disruption in mammal studies (Li et al., 2021; Jin et al., 2022; Wang et al., 2023; Zhou et al., 2023). In vitro human cell studies show MNPs induce cellular toxicity, apoptosis, inflammation, mitochondrial dysfunction, and DNA damage (Schirinzi et al., 2017; Poma et al., 2019; Wu et al., 2020; Wen et al., 2022; Lin et al., 2022; Li et al., 2022). The mechanisms appear to involve oxidative stress, inflammation, and physical damage, though direct evidence in humans remains limited and requires further research.

5.2.3. Scientists Speak Out: micro-nanoplastics and cancer

Micro- and nanoplastics (MNPs) may contribute to cancer development through multiple mechanisms identified in preclinical studies. MNPs induce tumor-promoting inflammation by increasing inflammatory cytokine production in human cancer cell lines exposed to polystyrene particles (Forte et al., 2016; Xu et al., 2022; Shi et al., 2024; Cheng et al., 2022), while in vivo studies confirm their capacity to cause mucosal inflammatory responses (Lu et al., 2021; Choi et al., 2021; Li et al., 2020; Li et al., 2022; Deng et al., 2017). They can initiate carcinogenesis by enabling anchorage-independent cell growth (Barguilla et al., 2022), suppressing immune surveillance through decreased NK cells and macrophage polarization (Hu et al., 2021), and demonstrating genotoxic potential in human blood cells (Gopinath et al., 2019; Ballesteros et al., 2020; Poma et al., 2019; Rubio et al., 2020). During cancer promotion, MNPs dysregulate cell proliferation (Forte et al., 2016, Barguilla et al., 2022; Xu et al., 2019) and induce epithelial-mesenchymal transition that enhances cancer cell invasiveness (Halimu et al., 2022; Kim et al., 2022; Traversa et al., 2024; Shao et al., 2024). Notably, MNPs are found in higher concentrations in human cancer tissues compared to normal tissues, including lung (Pauly et al., 1998), colorectal (Cetin et al., 2023), and prostate cancers (Deng et al., 2024), though whether this represents bioaccumulation or a causal relationship requires further investigation.

5.2.4. Scientists Speak Out: micro-nanoplastics and teratogenicity

Polystyrene nanoplastics (PS-NPs) demonstrate significant teratogenic effects when parents are exposed during reproductive periods. Co-parental exposure caused developmental abnormalities in offspring including skeletal and visceral malformations, reduced fetal growth, impaired neonatal reflexes, and learning deficits in adults (Kaur et al., 2025). Neurodevelopmental alterations included changed neurotransmitter levels, reduced antioxidant enzyme activity, and structural brain damage with increased vacuolization and decreased pyramidal neurons in the hippocampus (Kaur et al., 2025).

5.2.5. Scientists Speak Out: micro-nanoplastics and brain health

Micro- and nanoplastics (MNPs) are capable of crossing the blood–brain barrier and accumulating in the brain, where they may induce neuroinflammation, apoptosis, and neuronal damage, potentially contributing to the development of neurodegenerative diseases such as Alzheimer's and Parkinson's (Kopatz et al., 2023; Yin et al., 2022). MNPs can interfere with mitochondrial function, synaptic transmission, and cellular metabolism, affecting neurons, astrocytes, and microglia (Yin et al., 2022). Moreover, MNP-induced intestinal inflammation may adversely impact brain function through the gut–brain axis (Yang et al., 2023). Recent studies indicate that the smallest and chemically modified particles exhibit the highest neurotoxicity (Liu et al., 2022).

5.2.6. Scientists Speak Out: micro-nanoplastics in children

Children are particularly vulnerable to the toxic effects of microplastics (MPs) and nanoplastics (NPs) due to their ongoing physiological development and higher intake relative to body weight (Chia et al., 2025). MPs have been detected in blood, breast milk, placenta, and brain tissue (National Institute of Environmental Health Sciences, 2024), and have been associated with preterm birth (Chia et al., 2025), endocrine disruption (Ullah et al., 2023), neurological and cardiovascular effects (Prüst et al., 2020), and immune system alterations (Morrison et al., 2022). In children and adolescents, MPs may cause mitochondrial damage (Yin et al., 2023), liver injury (Zheng et al., 2021), renal oxidative stress (d'Apolito et al., 2018), and respiratory inflammation, potentially contributing to conditions such as asthma and bronchitis (Chia et al., 2025).

A study involving 1,000 children aged 6–9 years (Dong et al., 2025) identified a significant association between the presence of microplastics in urine—particularly polyamide (PA), polypropylene (PP), and polyvinyl chloride (PVC)—and behavioral problems. Higher concentrations were correlated with emotional symptoms, conduct problems, hyperactivity, and peer relationship difficulties, along with reduced prosocial behaviors (Dong et al., 2025). These findings suggest a potential neurobehavioral risk associated with early-life exposure to microplastics.

5.2.7. Gaps in research

Significant knowledge gaps persist in microplastic and nanoplastic (MNP) research that limit toxicological risk assessment. Current studies predominantly utilize commercially manufactured primary polystyrene MNPs with pristine morphologies, inadequately representing environmentally relevant secondary MNPs characterized by irregular shapes, photooxidized surfaces, and chemical contamination (Alimi et al., 2022). Most investigations employ high-dose, short-term exposures rather than chronic, low-level scenarios reflective of real-world conditions. Critical deficiencies exist in understanding physicochemical heterogeneity effects (Rozman et al., 2021), environmental pollutant dynamics (Wu et al., 2017), and molecular mechanisms beyond oxidative stress pathways (Reinholz et al., 2018). Notably absent are comprehensive genotoxicity, mutagenicity, and carcinogenicity assessments (Rubio et al., 2020). These gaps necessitate systematic investigation using environmentally relevant MNP formulations to establish science-based risk assessment frameworks.

5.3. Synergistic interactions with other pollutants, viruses and bacteria

5.3.1 Micro-nanoplastics and addtitives

Microplastics and nanoplastics (MNPs) serve as vectors for multiple toxic chemical additives, creating complex synergistic exposure scenarios with significant health implications. Brominated flame retardants (BFRs) are extensively used in plastic products including electronic casings and children's toys, disrupting reproductive and thyroid development and affecting neurodevelopment in children (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). UV stabilizers incorporated into plastic materials leach from food packaging and exhibit endocrine-disrupting properties with estrogenic (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). Dioxins, considered among the world's most toxic substances, are generated during plastic incineration and recycling processes, accumulating in fatty tissues and affecting brain development while increasing cancer risk (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). Phthalates, widely used as plasticizers, are present in 90-100% of biological samples including amniotic fluid and breast milk, causing reproductive toxicity and metabolic disruption (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). Alkylphenols function as UV stabilizers and estrogen mimics, linked to male infertility and breast cancer risk (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). Bisphenol A (BPA) from polycarbonate plastics affects brain development, reproductive outcomes, and is associated with multiple cancers (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). Perfluorinated chemicals (PFAS) used in fluoropolymer manufacturing contaminate water sources and exhibit metabolism-disrupting properties affecting immune, liver, and thyroid function (Weis & Alava, 2023; Wiesinger at al., 2021; Frias & Nash, 2018; Kumar & Singh, 2022). The adsorption and desorption mechanisms of these chemicals onto MNPs involve hydrophobic interactions, pH variations, and particle aging, creating dynamic exposure scenarios where the origin of pollutants may be both intrinsic to the plastic and extrinsic from environmental contamination (Everaert et al., 2020; Kumar & Singh, 2022).

5.3.2 Micro-nanoplastics and heavy metal

Microplastics and nanoplastics (MNPs) act as efficient vectors for heavy metals through electrostatic interactions and high surface area, with aged MNPs exhibiting increased adsorption capacities for metals including Hg, Pb, Cd, and Ti (Kumar et al., 2021; Patterson et al., 2020). Heavy metals are also intrinsically incorporated as plastic additives, with cadmium in PVC linked to oxidative stress and titanium dioxide demonstrating cytotoxic effects (Hahladakis et al., 2018; Gandamalla et al., 2019). Co-exposure studies in aquatic and terrestrial organisms show synergistic effects, where MNPs combined with cadmium significantly enhance oxidative stress, neurotoxicity, and metal bioaccumulation compared to single exposures (Tuncelli et al., 2024; Tourinho et al., 2023).

5.3.3. Micro-nanoplastics and POPs

Microplastics (MPs) adsorb persistent organic pollutants (POPs) such as DDT and PCBs at concentrations up to six times higher than those found in surrounding water (Tumwesigye et al., 2023; Liu et al., 2021). Although the production of many POPs has been banned or restricted under the Stockholm Convention, the global production and accumulation of these chemicals remain at ecologically hazardous levels, with millions of tons of DDT and PCBs produced worldwide (White et al., 2021). Studies have shown that the interaction between MPs and POPs in aquatic environments increases toxic risks; for example, MPs carrying PCBs have been linked to a higher incidence of cancer and developmental abnormalities in zebrafish larvae (Hu et al., 2024).

5.3.4. Micro-nanoplastics and pesticides

Microplastics (MPs) significantly affect pesticides behavior. While MPs can reduce pesticides bioavailability through adsorption, they also increase pesticide persistence and alter toxicity (Tang, 2025). The balance between bioavailability, persistence, and toxicity complicates assessing MPs' overall impact. High pesticides adsorption by MPs prolongs persistence, with desorption allowing gradual pesticides release that may extend action on target pests but also heighten effects on non-target organisms (Tang, 2025). It remains unclear if desorbed pesticides from MPs provide sufficient pest control without additional applications. Most studies indicate MPs mainly influence pesticides bioavailability, potentially requiring increased pesticide use, which has negative environmental and economic consequences (Tang, 2025).

5.3.5. Micro-nanoplastics and antibiotics

Microplastics (MPs) co-occur with antibiotics and antibiotic resistance genes (ARGs) in subsurface environments, acting as carriers that facilitate the transport and persistence of these contaminants (Yashir et al., 2025). This co-occurrence promotes the enrichment of bacterial genera tolerant to these pollutants, such as Acinetobacter and Pseudomonas, indicating a complex interaction between MPs and antibiotics in shaping microbial community composition (Yashir et al., 2025). The presence of MPs alongside antibiotics and ARGs suggests a synergistic potential that may enhance the spread and persistence of antibiotic resistance in the environment, underscoring the urgency for further research on their combined fate, transport, and ecological impacts

(Yashir et al., 2025). Furthermore, nanoplastics can influence ARG transformation and dissemination through mechanisms involving electron transport chain enhancement and H_2O_2 accumulation (Li et al., 2025).

5.3.6. Micro-nanoplastics and bacteria

Nanoplastics (NPs), especially polystyrene particles, have been shown to significantly promote the spread of antibiotic resistance genes (ARGs) in bacteria by enhancing transformation frequencies. A recent study using a chemically competent *Escherichia coli* strain demonstrated that NPs—particularly those with carboxyl functionalization—induce oxidative stress, mainly through the overproduction of hydrogen peroxide (H_2O_2), a key reactive oxygen species (ROS) (Li et al., 2025). H_2O_2 acts as a signaling molecule that increases bacterial membrane permeability, activates the SOS response, alters secretion systems, and facilitates the uptake of exogenous DNA. Mechanistic insights revealed that NPs disrupt bacterial membranes and DNA integrity while overloading the electron transport chain (ETC), further enhancing H_2O_2 generation. These processes collectively contribute to ARG dissemination in microbial communities, raising important concerns for environmental and public health risk assessments (Li et al., 2025).

5.3.7. Micro-nanoplastics and viruses

Polystyrene nanoplastics (PS-NPs), increasingly present in aquatic environments, have been shown to exacerbate viral infections in fish by impairing host cell function and immune responses. In a recent study on *Micropterus salmoides* fin (MsF) cells infected with Largemouth bass ranavirus (LMBV), PS-NPs were internalized in a time- and dose-dependent manner and significantly promoted viral replication (Zhi et al., 2024). This was associated with lysosomal and mitochondrial dysfunction, elevated oxidative stress, and suppression of antioxidant-related gene expression. Furthermore, PS-NPs intensified virus-induced inflammatory responses and interfered with the host's antiviral defenses by downregulating the cGAS-STING signaling pathway, resulting in reduced interferon production. These findings suggest that nanoplastics may increase host susceptibility to viral infections and contribute to the spread of diseases in freshwater fish populations (Zhi et al., 2024).

5.4. Detection & Measurement Challenges

5.4.1. Analytical methods and limitations

The characterization of micro- and nanoplastics (MNPs) involves complex analytical workflows with significant limitations. Pretreatment processes can cause loss or alteration of target materials (Nabi et al., 2022; Löder et al., 2017), while physical identification through microscopy suffers from observer subjectivity and limited resolution for nanoplastics (Girão, 2022; Caputo et al., 2021). Chemical identification using vibrational spectroscopy (FTIR, Raman) is limited by particle size and water interference (Böke et al., 2022), whereas mass spectrometry provides sensitive analysis but requires sample destruction (Käppler et al., 2018; Dehaut et al., 2020). Nanoplastics present unique challenges due to increased Brownian motion, subwavelength size, and enhanced surface reactivity (Gigault et al., 2021), with theoretical accumulation times ranging from days to centuries at environmentally relevant concentrations (De Angelis et a., 2021). While conventional methods achieve ng/L–μg/L detection limits (Zhou et al., 2021), recent innovations including self-propelled micro/nanorobots (Wang et al., 2019; Heckel & Simmchen, 2019), optical tweezers with Raman detection (Gillibert et al., 2019), and machine learning-enhanced hyperspectral imaging (Fang et al., 2023) offer promising pathways for real-time, in situ detection.

6. Annexes

6.1 MEPs Written Questions & EU Commission Responses

- Question for written answer E-002878/2025 - Contamination from microplastics (15/07/2025) - Daniel Buda (PPE) - Pending answer by the Commission.
- Question for written answer E-002644/2025 - Implementation and enforcement of the ban on rubber granules on sports fields (30/06/2025) - Biljana Borzan (S&D) - Pending answer by the Commission.
- Question for written answer E-002262/2025 - Plastic cigarette filters – Inadequate implementation of Directive (EU) 2019/904 and lack of progress regarding prevention, alternatives and education (04/06/2025) - Manuela Ripa (PPE) - Pending answer by the Commission.
- Question for written answer E-001669/2025 - Implementation of the Marine Strategy Framework Directive in Greece and tackling marine pollution in the Thermaic and Corinthian Gulf (24/04/2025) - Sakis Arnaoutoglou (S&D) - Answer by the Commission.
- Question for written answer E-001389/2025 - Regulation of airborne microplastics under EU environmental and health legislation (04/04/2025) - Biljana Borzan (S&D) - Answer by the Commission.
- Question for written answer E-000744/2025 - The risks of microplastics produced by plastic orthodontic aligners (18/02/2025) - Costas Mavrides (S&D) - Answer by the Commission.
- Question for written answer E-000648/2025 - Improving drinking water quality and checking the safety of plastic packaging (12/02/2025) - Loucas Fourlas (PPE) - Answer by the Commission.
- Question for written answer E-000377/2025 - Labelling rules for textiles (28/01/2025) - Liesbet Sommen (PPE) - Answer by the Commission.
- Question for written answer E-000225/2025 - Imported fish contaminated with microplastics (20/01/2025) - Emmanouil Fragkos (ECR), Galato Alexandraki (ECR) - Answer by the Commission.

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