

CIAMC – Centro di Ricerca Dipartimentale (DELIBERA n. 3 del 5 febbraio 2025)

Environmental Pollution and Cardiovascular Diseases

CIAMC is the Departmental Research Center of DAMSS – University of Campania “Luigi Vanvitelli”, dedicated to the translational investigation of the impact of environmental pollutants, with a specific focus on micro- and nanoplastics (MNPs), on cardiovascular and systemic health. The Center integrates clinical research, advanced tissue analysis, immunology and molecular biology, cardiovascular imaging, and next-generation spectroscopic technologies to elucidate the mechanisms linking environmental exposure, inflammation, and atherosclerosis, and to generate evidence applicable to prevention strategies and clinical practice.

Directed by Prof. G. Paolisso and Prof. Raffaele Marfella as Scientific Coordinator, CIAMC has established a structured network of national and international collaborations with leading academic and clinical institutions.

Prevention Strategy within a One Health Framework – CIAMC

Within the One Health paradigm, the strategy to reduce the impact of MNPs on human health is structured along two complementary and interdependent axes: primary prevention and secondary prevention.

Primary prevention aims to reduce environmental contamination by MNPs at its source. This includes limiting plastic production and dispersion, improving waste management systems, promoting sustainable materials, and implementing regulatory policies at national and international levels. While this strategy is essential and ethically imperative, it inherently involves complex political, economic, and social dimensions. Moreover, even if large-scale primary prevention policies were initiated today, measurable reductions in human tissue contamination would likely require decades, if not one to two centuries, given the persistence of plastics in ecosystems and food chains.

Therefore, primary prevention alone cannot address the current burden of human exposure.

In parallel, and with immediate urgency, a secondary prevention strategy must be implemented. Secondary prevention does not aim to eliminate environmental MNPs, but rather to mitigate their biological and clinical impact once human contamination has occurred. This includes identifying contaminated individuals, characterizing tissue deposition, understanding inflammatory and molecular activation pathways, stratifying cardiovascular risk, and developing targeted diagnostic and therapeutic interventions capable of reducing MNP-induced damage.

CIAMC’s integrated translational model is specifically designed to operationalize this secondary prevention framework through a four-step approach:

STEP 1 – Clinical-pathogenetic studies to define tissue contamination patterns and mechanistic pathways.

STEP 2 – Development of non-invasive diagnostic tools and biomarker-based risk stratification.

STEP 3 – Interventional studies aimed at modulating inflammation, metabolic dysfunction, and vascular instability associated with MNP exposure.

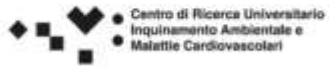
STEP 4 – Evaluation and implementation of plastic-free environments and materials in clinical and community settings to reduce ongoing exposure.

While primary prevention remains a global societal objective, secondary prevention represents an immediate and indispensable scientific and clinical priority. In this context, CIAMC plays a strategic and essential role by providing the translational infrastructure necessary to reduce the cardiovascular consequences of MNP contamination in the present generation.

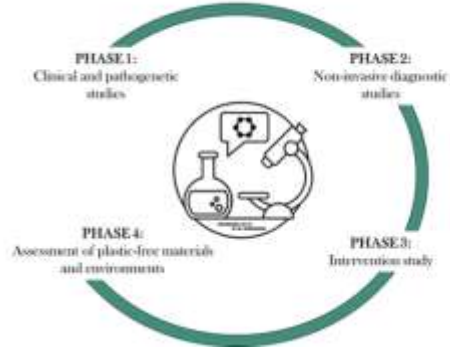
SECONDARY Prevention

What can we do
now to reduce
the MNP's effects
on health?

MNPs Vanvitelli Research
Center



V: Università
degli Studi
della Campania
Luigi Vanvitelli
*Scuola di Medicina e Chirurgia
Dipartimento di Scienze Mediche e
Chirurgiche Avanzate*



OBJECTIVES

Playlist microplastic research center

Research line 1: Clinical and pathogenetic studies

- Identification of microplastics in human tissues
- Effects of tissue microplastic contamination on pathogenetic pathways
- Effects of tissue microplastic contamination on clinical outcomes
- Effects of drugs therapy on microplastic contamination pathogenetic pathways
- Effects of drugs therapy on microplastic contamination clinical outcomes

Research line 2: Non-invasive diagnostic studies

- Identification of microplastics in human tissues by imaging technology (PET, CT, MR artificial intelligence evaluation)
- Identification of microplastic biomarker on blood samples (lymphocytes, eosinophils, neutrophils)
- Non-invasive cross-sectional studies in humans for the identification of microplastics and correlation with biopsy data

Research line 3: Intervention studies

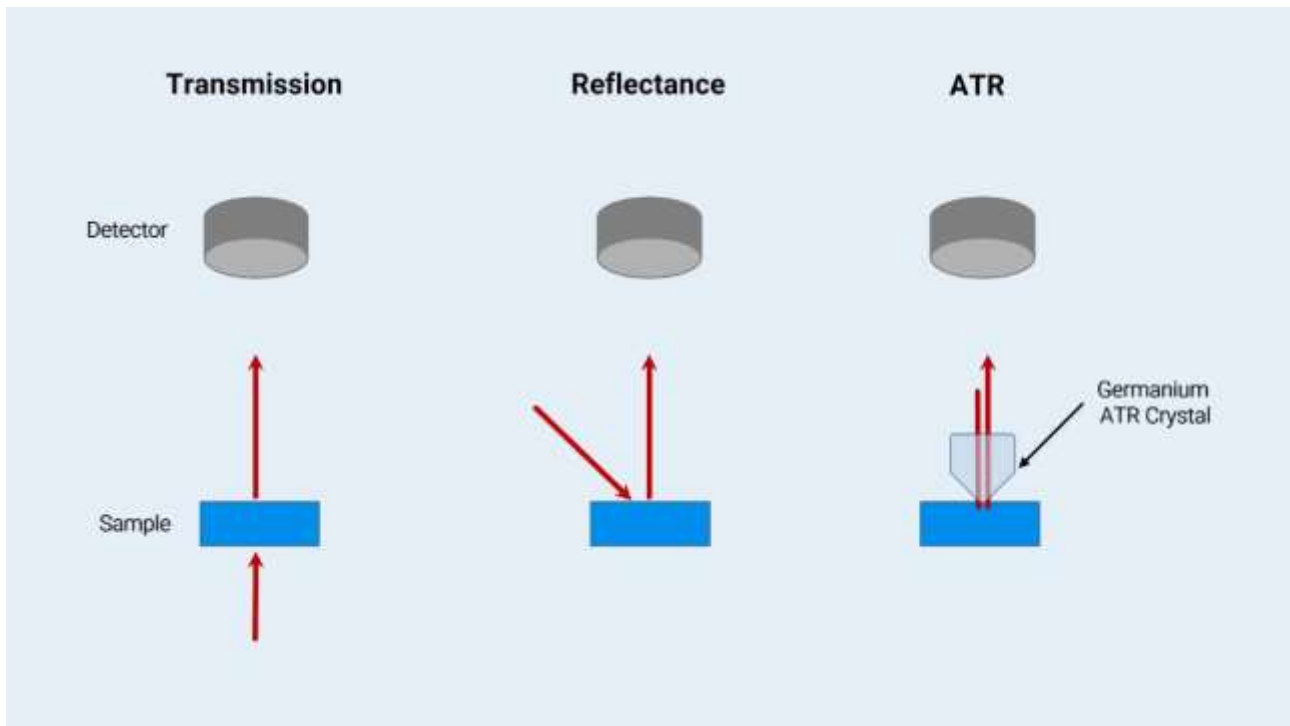
- Evaluation of PETase and MHEase enzymes from *Ideonella sakaiensis* bacteria effects in microplastic-contaminated cultured cells
- Evaluation of degradation product effects from PETase and MHEase enzyme activities in microplastic-contaminated cultured cells
- Effects of PETase and MHEase enzymes enriched devise on microplastic-contaminated tissue animal study
- Effects of PETase and MHEase enzymes enriched devise on microplastic-contaminated coronary atherosclerotic plaques human study

Research line 4: Assessment of plastic-free materials and environments

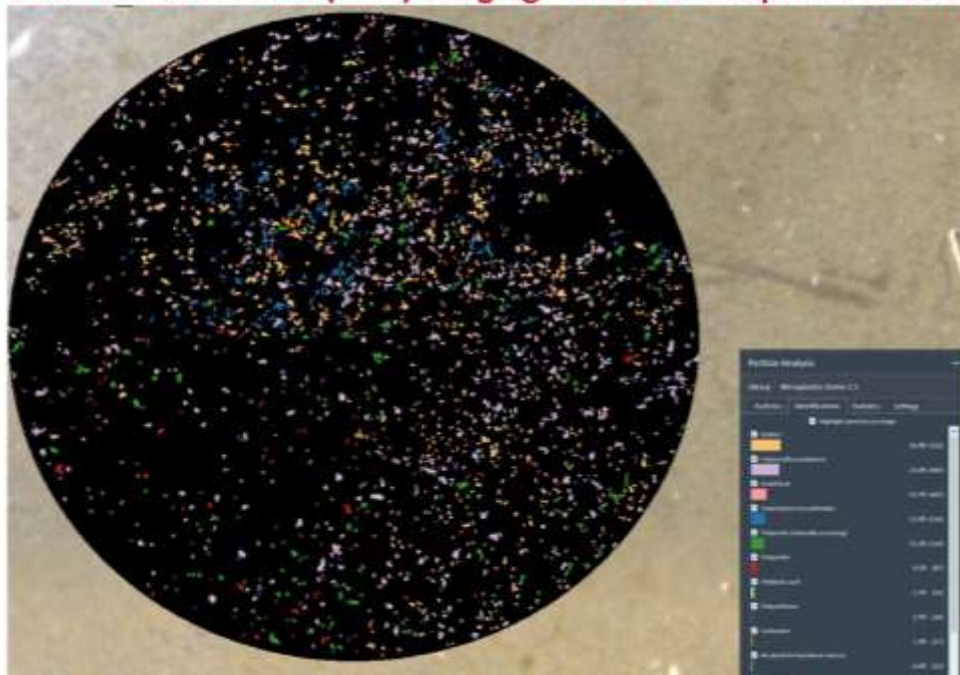
- Environmental Assessment of Alternative Packaging Materials
- The Issue of Bio-Based and Biodegradable Plastics
- Food Waste and Conservation of Food in a Non-Plastic Packages

Micro- and Nanoplastic (MNP) Detection and Characterization Platforms





Laser Direct Infrared (LDIR) Imaging – MNPs in Plaque Atheroma



The Center is equipped with advanced spectroscopic and analytical platforms for the identification, localization, and chemical characterization of micro- and nanoplastics in human tissues. Optical Photothermal Infrared Spectroscopy (O-PTIR) enables submicron-resolution polymer identification directly in biological matrices without labeling. Micro-Raman spectroscopy and confocal Raman imaging allow precise chemical fingerprinting and three-dimensional localization of particles in FFPE and fresh tissue sections. Micro-FTIR and ATR-FTIR provide complementary polymer identification and spectral validation. Pyrolysis-GC/MS allows definitive polymer confirmation and semi-quantitative assessment through thermal degradation profiling. Scanning Electron Microscopy coupled with Energy Dispersive Spectroscopy (SEM-EDS) supports morphological and elemental characterization, while Transmission Electron Microscopy (TEM) enables visualization of intracellular nanoplastics. Standardized tissue

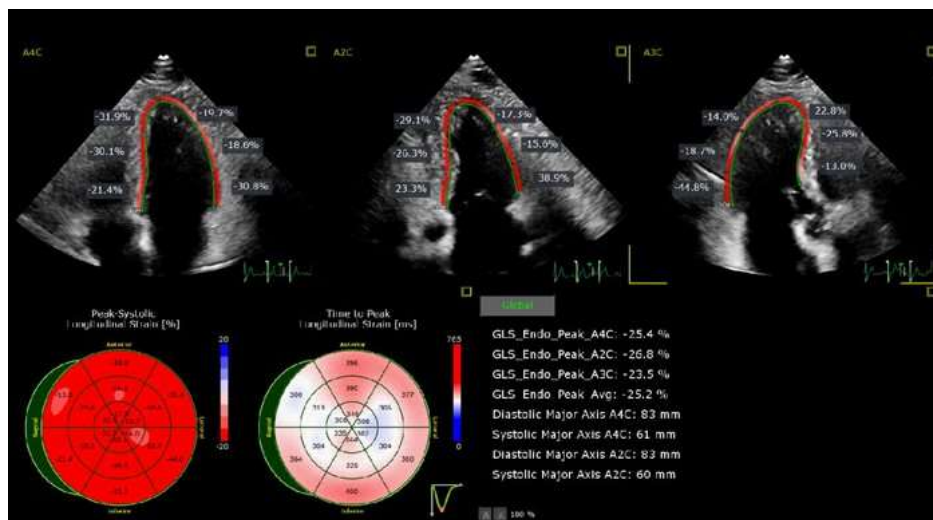
digestion protocols, density gradient separation, contamination-controlled filtration systems, and cryo-sectioning platforms ensure high analytical reliability.

Molecular and Cellular Biology Platforms



The molecular research infrastructure includes quantitative Real-Time PCR (qPCR) and digital PCR for gene expression profiling of inflammatory, oxidative stress, and inflammasome-related pathways (including IL-6, TNF- α , NLRP3, NF- κ B). Western blotting platforms enable protein-level validation of signaling pathways relevant to cardiovascular inflammation and metabolic dysfunction. Next-Generation Sequencing (RNA-seq) allows transcriptomic profiling in vascular and myocardial tissues. Multiplex ELISA systems quantify circulating cytokines and biomarkers. Flow cytometry supports immune cell phenotyping and activation studies. Integrated metabolomics, lipidomics, and proteomics platforms allow multi-omics characterization of exposed versus non-exposed subjects.

Clinical and Cardiovascular Assessment Platforms

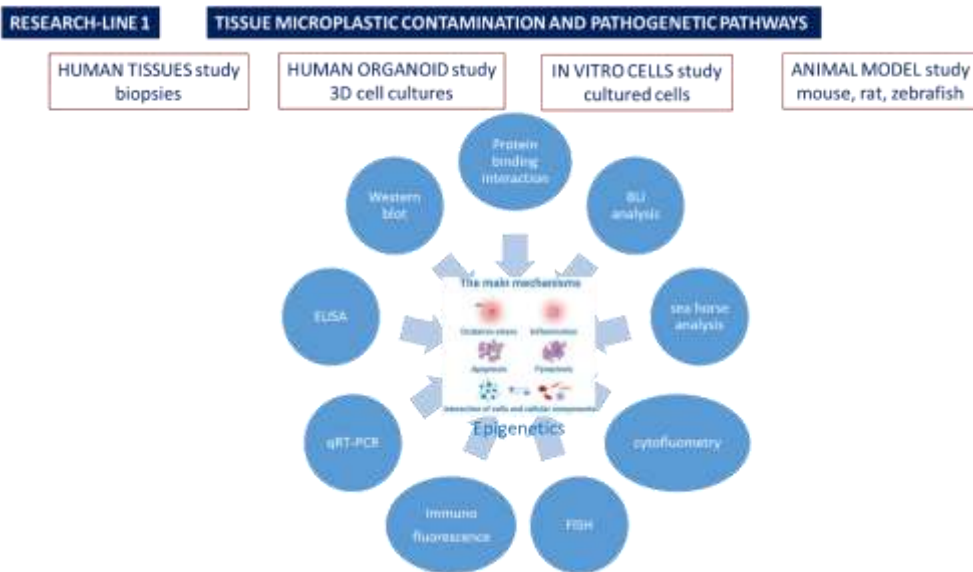
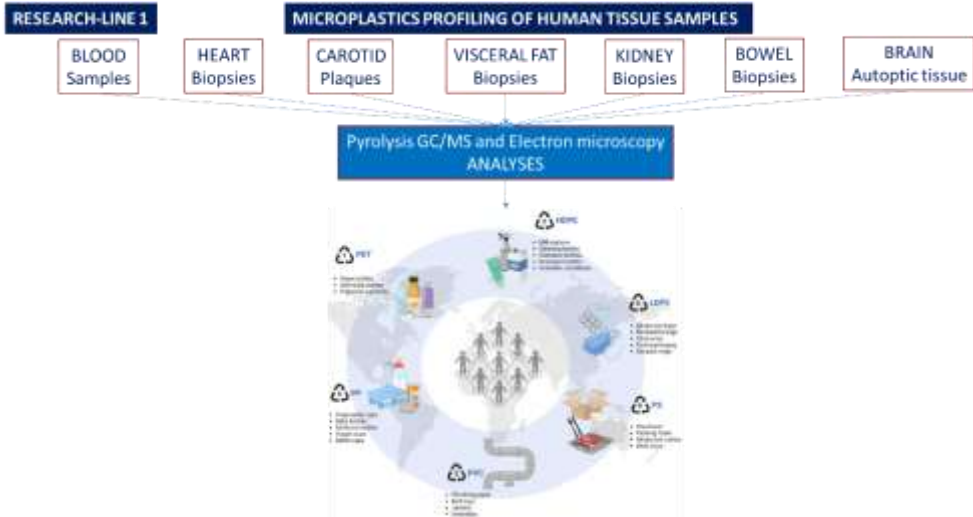


The clinical translational platform integrates advanced cardiovascular imaging and biomarker assessment. High-resolution carotid ultrasound enables intima-media thickness measurement, plaque characterization, and intraplaque neovascularization assessment. Advanced echocardiography with strain imaging provides detailed ventricular function analysis. Coronary CT angiography and cardiac magnetic resonance imaging allow structural and functional evaluation. PET-CT imaging supports assessment of vascular inflammation. Circulating biomarkers include high-sensitivity C-reactive protein, IL-6, NT-proBNP, high-sensitivity troponin, lipoprotein(a), PCSK9, and oxidative stress markers. Dedicated prospective clinical databases allow short-term and long-term outcome tracking, including acute cardiovascular

events. Artificial intelligence tools, radiomics, and multivariate modeling support advanced risk stratification and mechanistic interpretation.

Translational Integration Model

The Center operates within a fully translational framework that integrates human tissue analysis, molecular profiling, advanced imaging, and prospective clinical outcomes. This integrated model has already demonstrated high-impact translational relevance, including the landmark publication in the *New England Journal of Medicine* (2024) on microplastics and atherosclerosis. The infrastructure positions the Center among the few international institutions capable of directly linking environmental contaminants detected in human tissues with molecular activation pathways and clinically relevant cardiovascular outcomes.



RESEARCH-LINE 1 **TISSUE MICROPLASTIC CONTAMINATION AND CLINICAL OUTCOMES**



- Microplastic evaluation
- Clinical evaluation
- Routine analysis
- Instrumental analysis
- Clinical evaluation
- Routine analysis
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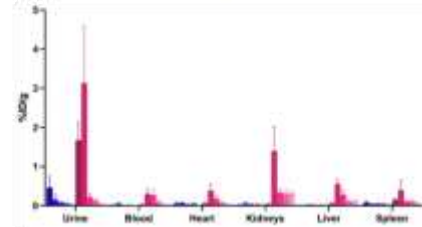
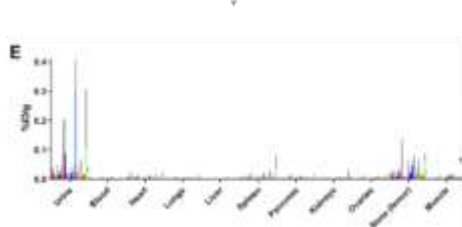
RESEARCH-LINE 2

BACKGROUND

Identification of microplastics in human tissues by imaging technology

Positron emission tomography (PET) with positron-emitting radiometal zirconium-89 IN MICE
doi.org/10.3039/41208-015-00029-6

Neutron and X-ray tomography IN SEDIMENTS
doi.org/10.1002/1522-0109-021-02000-4



RESEARCH-LINE 2

ARTIFICIAL INTELLIGENCE IN IMAGING

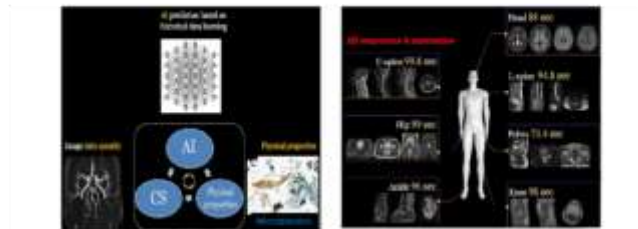


FIGURE 1 (A) The principle of AI. It integrates the advantages of different acquisition techniques such as deep learning-based denoising, parallel imaging, and compressed sensing. (B) AI normally can achieve great speed (i.e., >10 s) for different body parts and sequences.

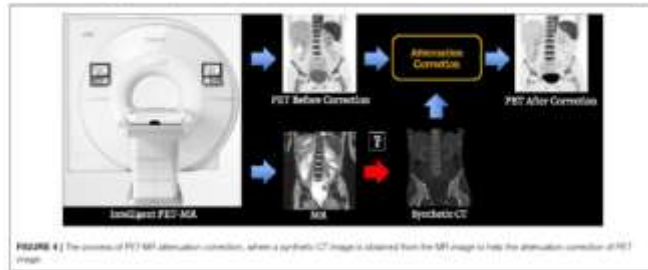
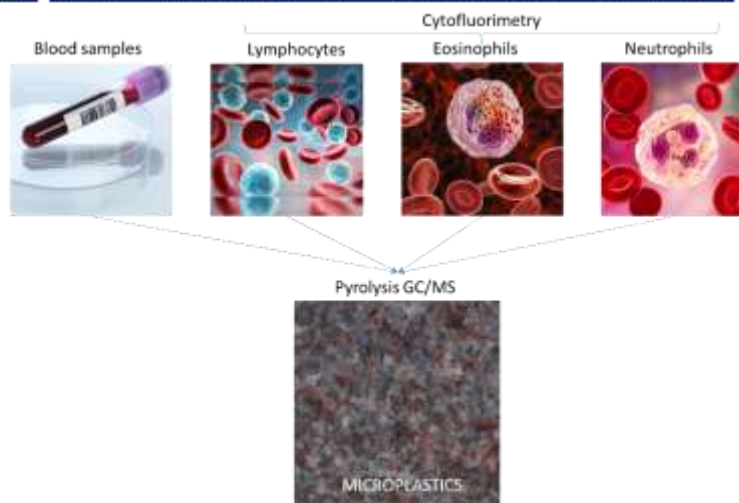
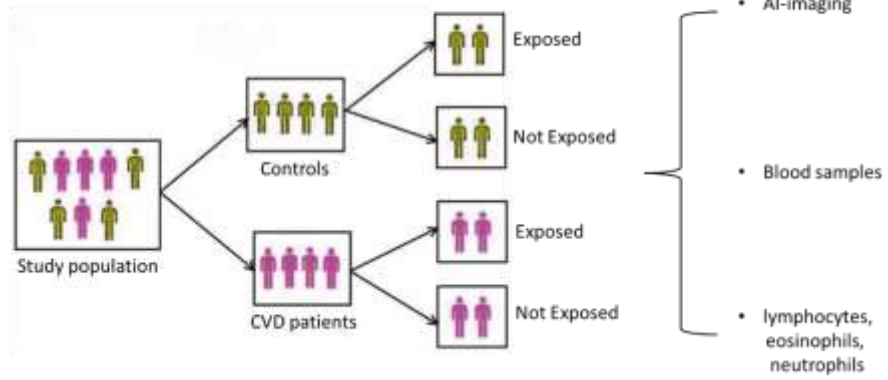


FIGURE 4 | The process of PET-MR attenuation correction, where a synthetic CT image is obtained from the MR image to help the attenuation correction of PET image.

RESEARCH-LINE 2 Identification of microplastics on blood samples, lymphocytes, eosinophils and neutrophils

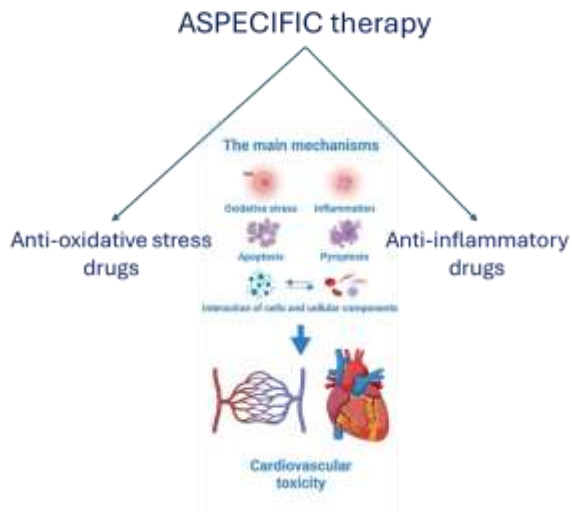


NON-INVASIVE DIAGNOSTIC STUDY FOR MICROPLASTIC
CONTAMINATION EVALUATION IN HUMANS AND CORRELATION
WITH BIOPSY DATA



RESEARCH-LINE 3

THERAPY



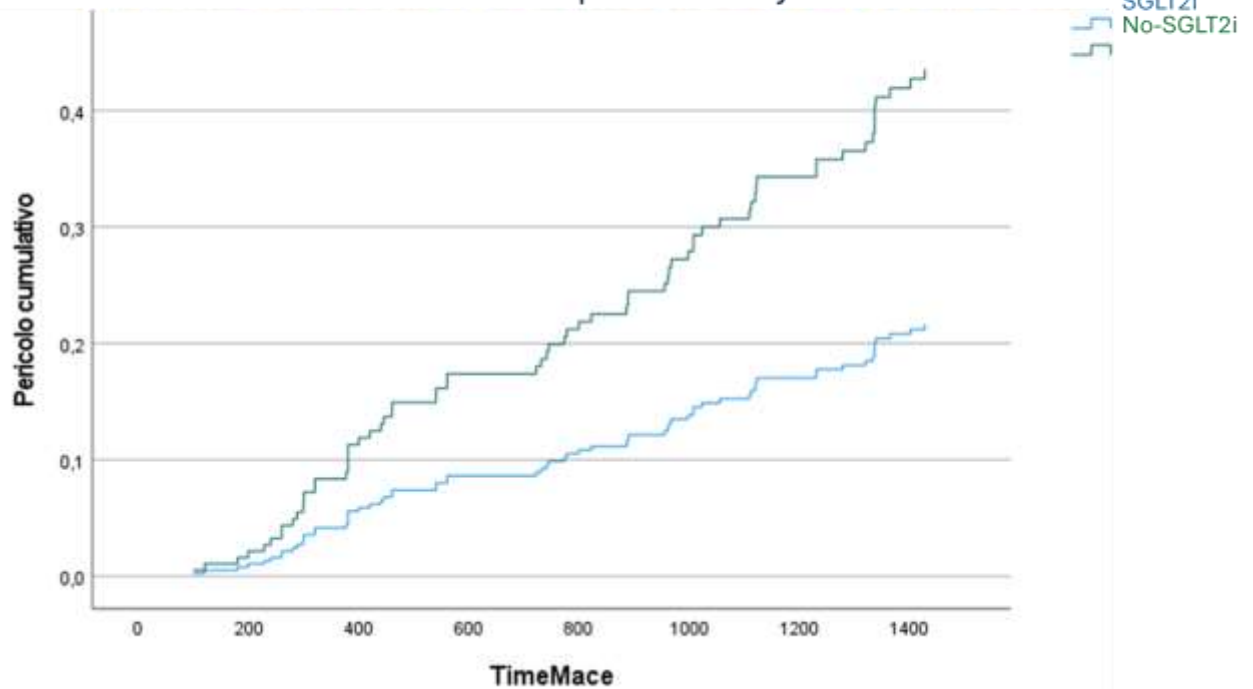
PRECISION therapy

Plastic BIODEGRADATION

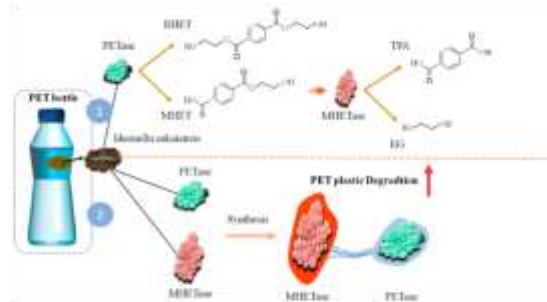



ASPECIFIC therapy

Cardiovascular events can be prevented by SGLT2-inhibitors



PRECISION therapy



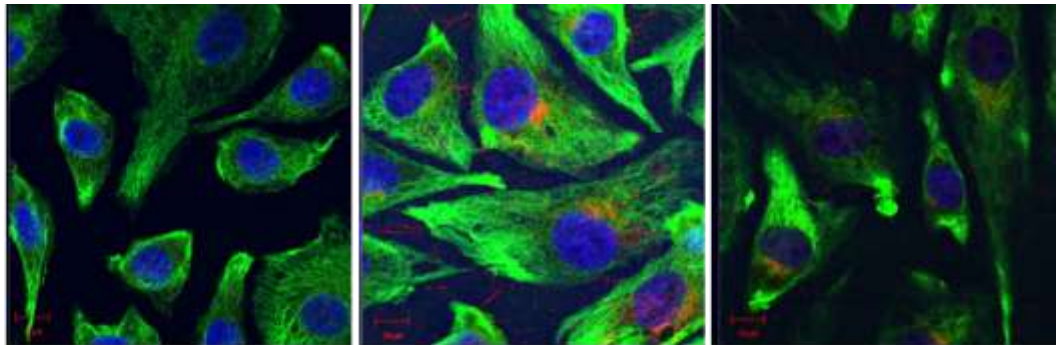
		
<i>Fusarium solani</i>	<i>Trametes versicolor</i>	<i>Curvularia senegalensis</i>
PET, PU, PLA	PE, PVC, PLA	PS, PE, PVC
Esterase Cutinase	Laccase, Manganese Peroxidase	Monoxygenase, Possibly Laccase
Potential for Enzyme isolation only indicable on PU & PET	Moderate— lignolytic system inducible by lignin analogs	Low—Moderate— limited studies; may require co- culture setup
Maestri et al. (2023)	Maestri et al. (2023)	Maestri et al. (2023)

Fusarium solani: Maestri, C., Tonelli, M., Ferrarini, A., & Papinutti, V. L. (2023). Fungal biodegradation of polyurethanes: Current knowledge and future perspectives. *Journal of Fungi*, 9(7), 760.

Versicolor: Srikanth, M., Balaji, M., Suresh, M., Soni, P., & Ghosh, S. (2022). Biodegradation of plastic polymers by fungi: A brief review. *Bioresources and Bioprocessing*, 9, 59.

Curvularia senegalensis: Bhavsar, P. S., Shaikh, Z. R., & Thorat, B. N. (2023). Solving the plastic dilemma: Fungal and bacterial perspectives on polyurethane biodegradation. *World Journal of Microbiology and Biotechnology*, 39, 197.

TNF-alpha



MNPs
(PET, PE,
PVC, PS)



IN PRESS

Cultured
Endothelial Cells

Cultured
Endothelial Cells + MNPs

Cultured
Endothelial Cells + MNPs + Enzymes

A PLASTIC REVOLUTION

Plastic plays a vital role in the construction industry. Follow the journey plastic takes to and from our sites.

Packaging

Plastic in the form of wraps, foam or bands is the most commonly used material for packaging both materials and products.

Materials

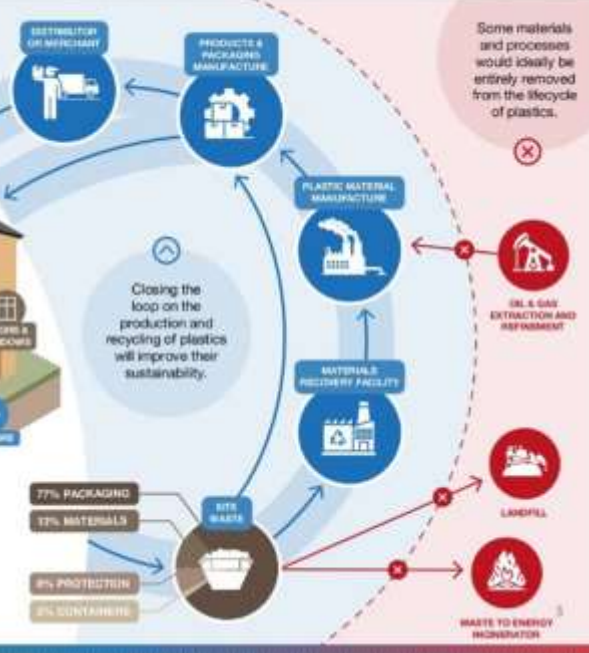
Plastics are common in a wide range of building materials from pipes and utility boxes to light fittings and window frames.

Protection

During construction solutions such as Conter, rot & drill and glass film help protect materials and products on site.

Containers

Most consumables such as paint, adhesives or cleaning solution arrive in plastic tubs or tubs.



77% PACKAGING
 77% MATERIALS
 8% PROTECTION
 2% CONTAINERS

Some materials and processes would ideally be entirely removed from the lifecycle of plastics.

- Oil & Gas Extraction and Refinement
- Landfill
- Waste to Energy Incineration

National and international collaborations of the CIAMC (Center for departmental Research on Environmental Pollution and Cardiovascular Diseases), including molecular, biochemical, and clinical patient networks.

Institution / Center	Country	Type of Collaboration	Focus Area
Massachusetts General Hospital	USA	Research collaboration, human tissue analysis, MTA agreements	Cardiovascular pathology, coronary plaques, translational imaging
Harvard Medical School	USA	Academic and scientific collaboration	Environmental cardiology, vascular biology
Loyola University Chicago	USA	Joint research collaboration	Micro- and nanoplastics, cardiovascular inflammation
California Office of Environmental Health Hazard Assessment	USA	Scientific exchange and workshops	Environmental toxicology, microplastics risk assessment
University of New Mexico	USA	International academic collaboration	Environmental exposure and population studies
IRCCS MultiMedica	Italy	Molecular and translational collaboration	Advanced molecular analyses, cardiovascular biomarkers
Università degli Studi di Napoli Federico II (Department of Biochemistry)	Italy	Biochemical collaboration	Enzymatic assays, metabolic pathway analysis
Università degli Studi di Palermo	Italy	PLASTAMINATION project collaboration	Tissue contamination analysis, microplastic detection
Sapienza Università di Roma	Italy	Academic and translational collaboration	Cardiovascular and environmental medicine
Ospedale del Mare	Italy	Clinical patient recruitment	Cardiovascular patients, prospective cohorts
AORN Antonio Cardarelli	Italy	Clinical collaboration	Acute cardiovascular care, high-risk patients
Ospedale Santa Maria delle Grazie Pozzuoli	Italy	Clinical collaboration	Cardiovascular patient recruitment and follow-up