

JEJU PLUS INTERNATIONAL  
ENVIRONMENT FORUM 2022  
Aug 4-5, 2022



# Biological effects of Nano/Microplastics

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Korea Research Institute of Bioscience and Biotechnology

# The Plastic Age



STONE  
AGE



IRON  
AGE



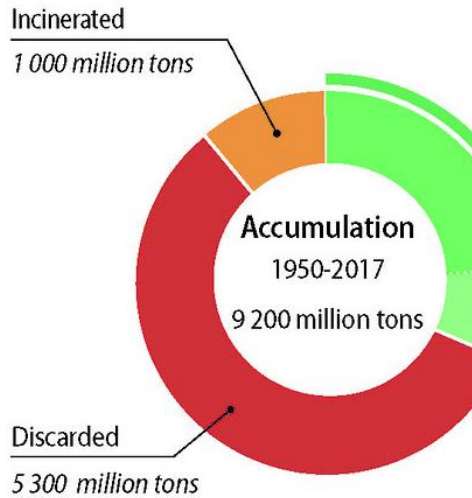
PLASTIC  
AGE

© Lukman2019  
Gatis  
Sluka

# Production of Plastics



## Global plastic production and accumulation



## ... and future trends

Million tons  
1 200

### The rapid rise of plastics

A world without plastics seems unimaginable today, yet their large-scale production and use only dates back to around 1950.

#### Global plastic production estimates



### Yearly production Resin and fibres



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<https://www.news.ucsb.edu/2017/018137/plastic-planet>

Illustrated by GRID-Arendal

## Prediction of plastic waste

### Calculating plastic waste

Plastic waste can be recycled, incinerated or discarded where it accumulates in landfills.

TOTAL PLASTIC WASTE

2015

**6.3B**  
METRIC TONS

**12B**  
METRIC TONS  
2050

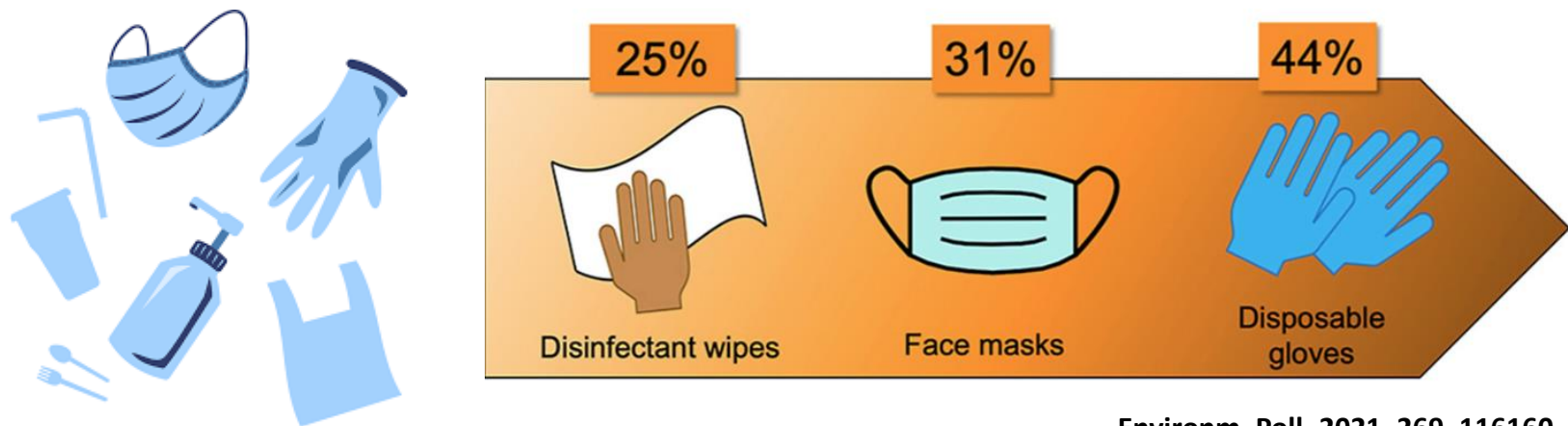


UC **SANTA BARBARA** in partnership with the **UNIVERSITY OF GEORGIA**

# Plastics waste and COVID-19



## Plastic Personal protective equipment (PPE) debris related to COVID-19



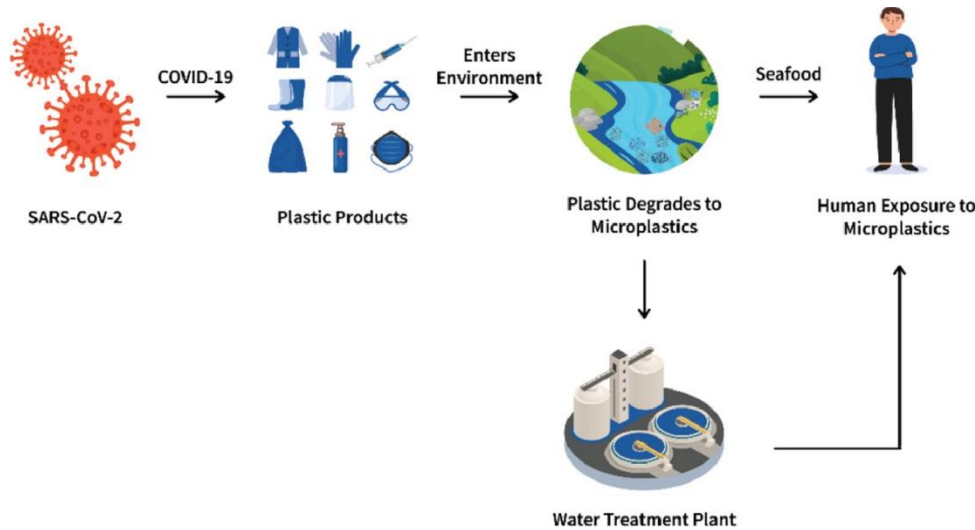
# Plastics waste and COVID-19



Environmental Advances  
Volume 5, October 2021, 100119



## Plastic pollution during COVID-19: Plastic waste directives and its long-term impact on the environment

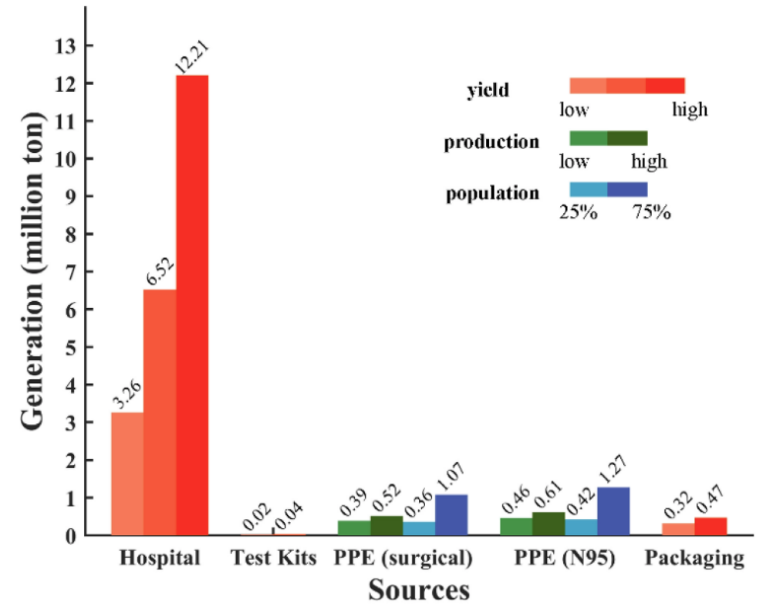


## Plastic waste release caused by COVID-19 and its fate in the global ocean

Yiming Peng, Peipei Wu, Amina T. Schartup, and Yanxu Zhang [Authors Info & Affiliations](#)

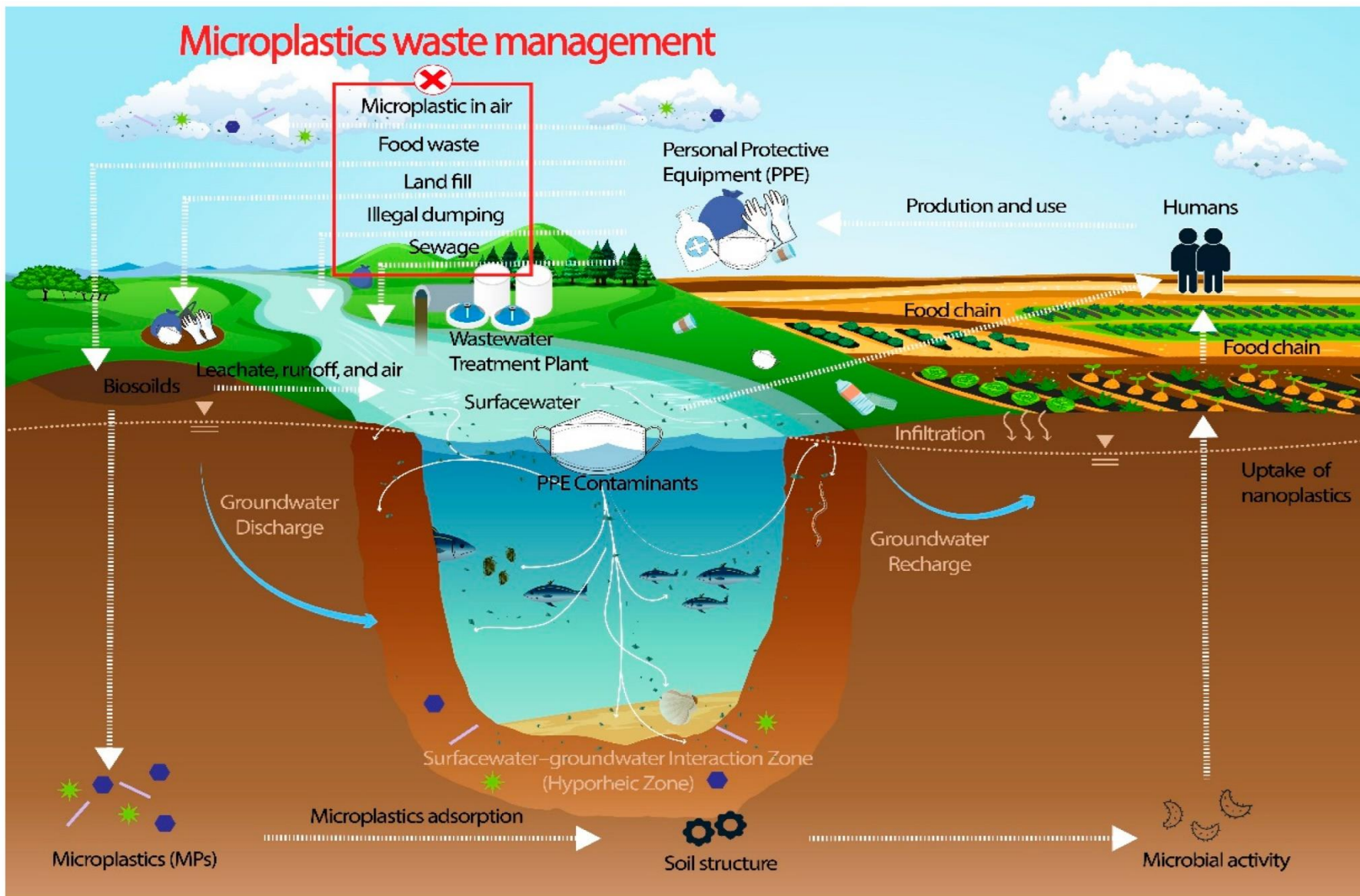
Edited by B. L. Turner, Arizona State University, Tempe, AZ, and approved October 6, 2021 (received for review June 22, 2021)

November 8, 2021 | 118 (47) e2111530118 | <https://doi.org/10.1073/pnas.2111530118>



Global generation of mismanaged plastics from different sources (hospital medical waste, test kits, PPE, and online packaging) attributable to the COVID-19 pandemic. High- and low-yield scenarios are considered for each source (Methods).

# Microplastics and COVID-19





# Microplastics Nanoplastics





# What is Nano/Microplastics (NMPs)



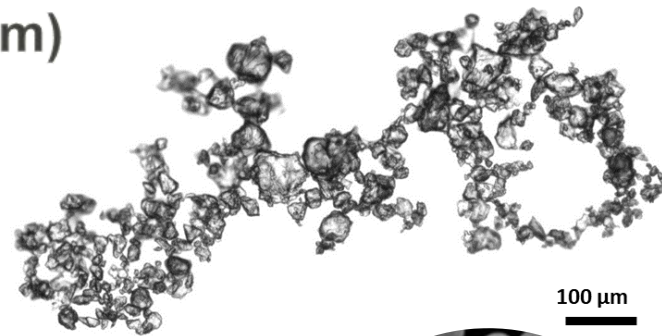
## Definition

Plastics fragments of any type of plastic less than 5 mm in length, according to the US National Oceanic and Atmospheric Administration (NOAA) and the European Chemical Agency.

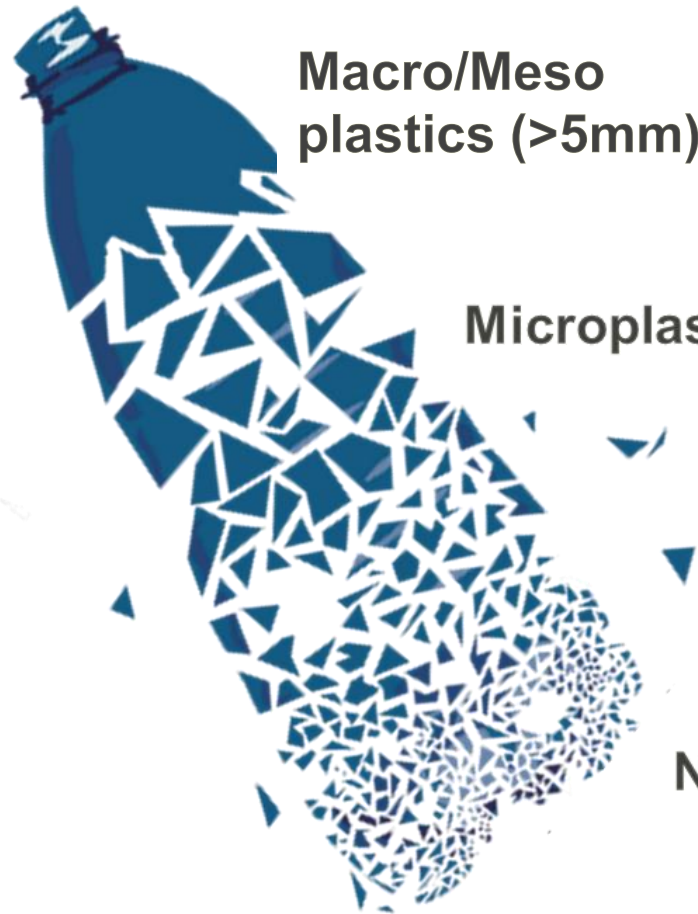
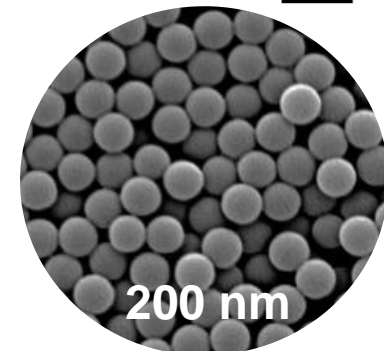
**Macro/Meso  
plastics (>5mm)**



**Microplastic (< 5mm)**



**Nanoplastic (< 1 μm)**

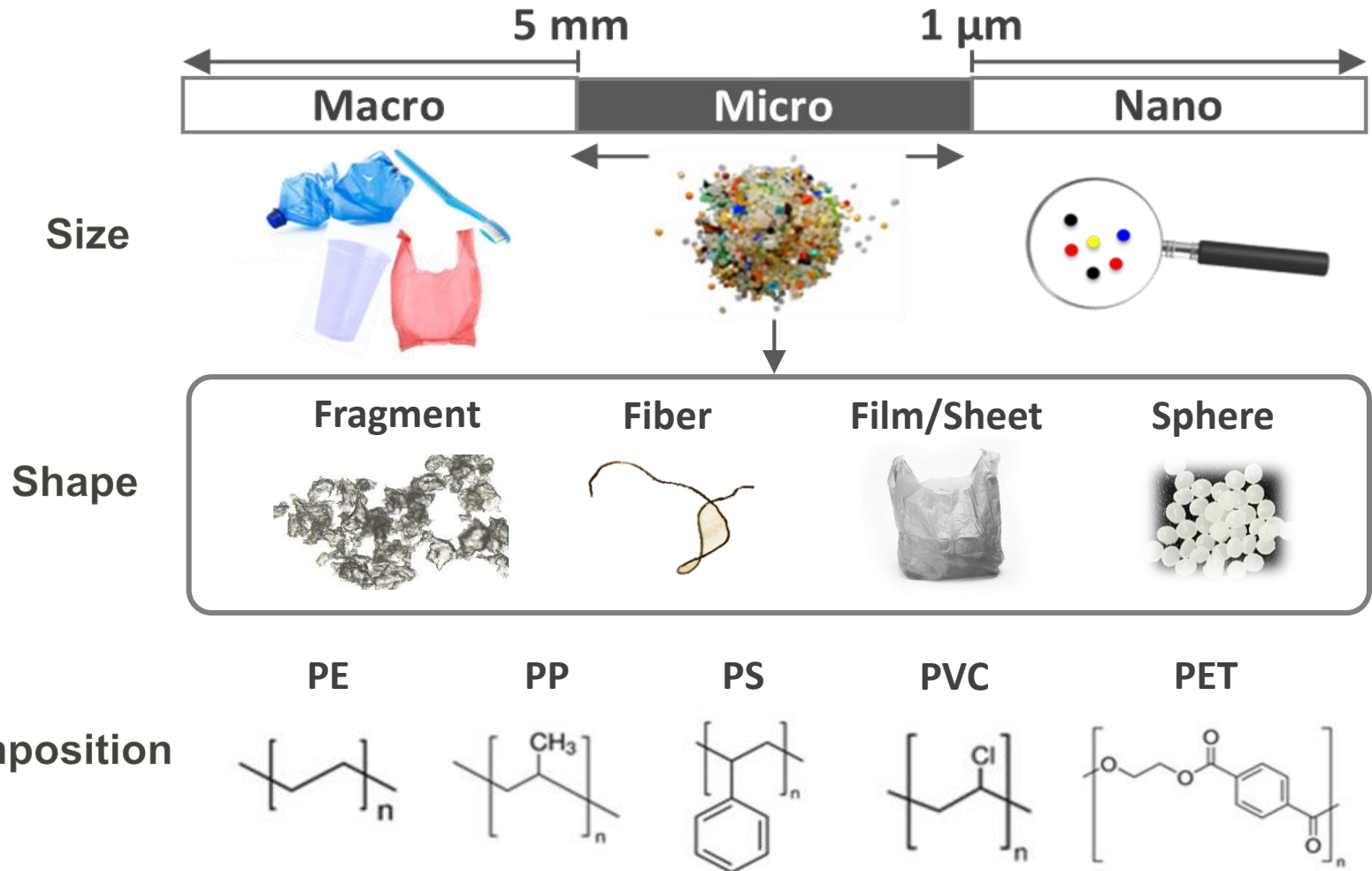


# What is Nano/Microplastics (NMPs)

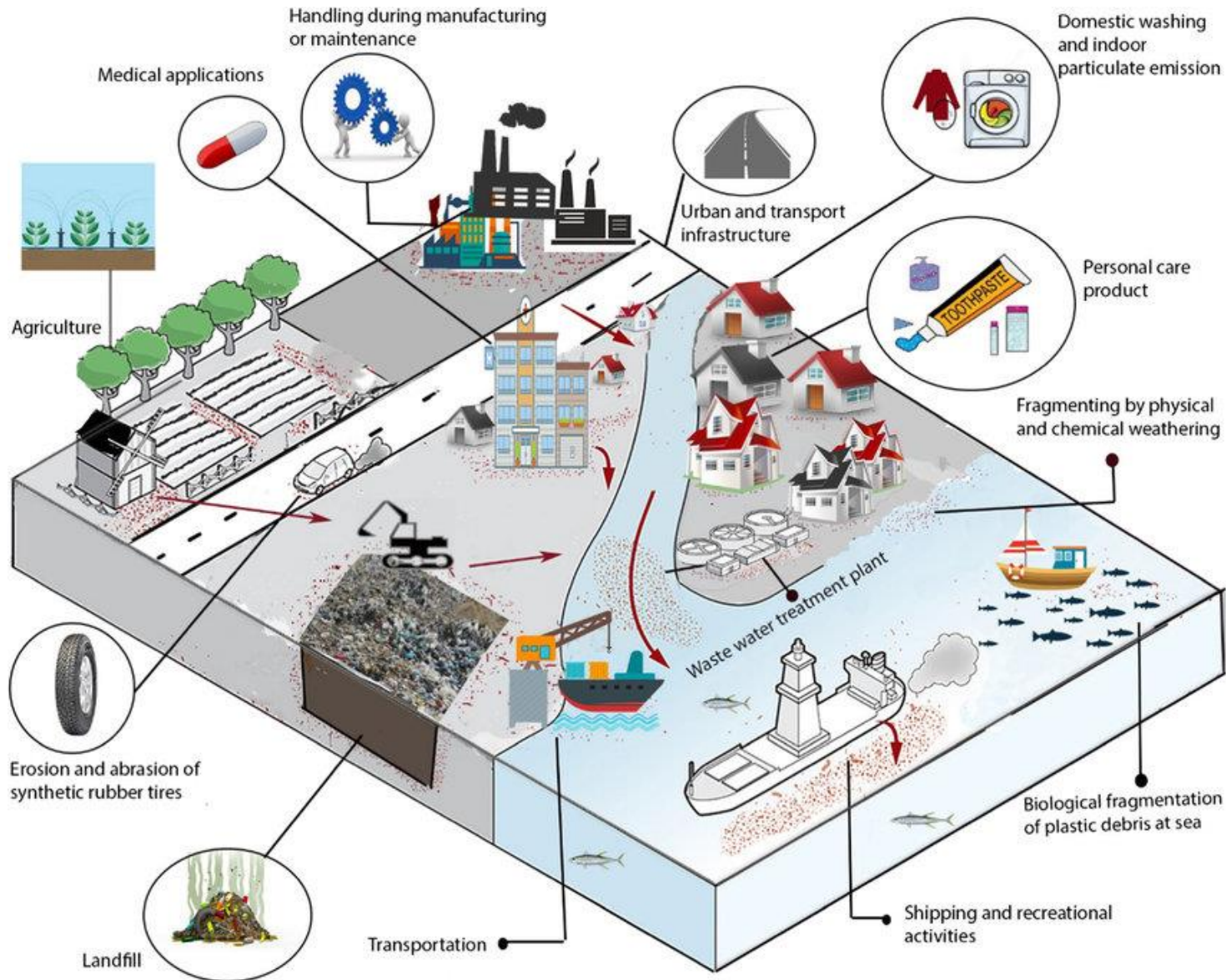


## Definition

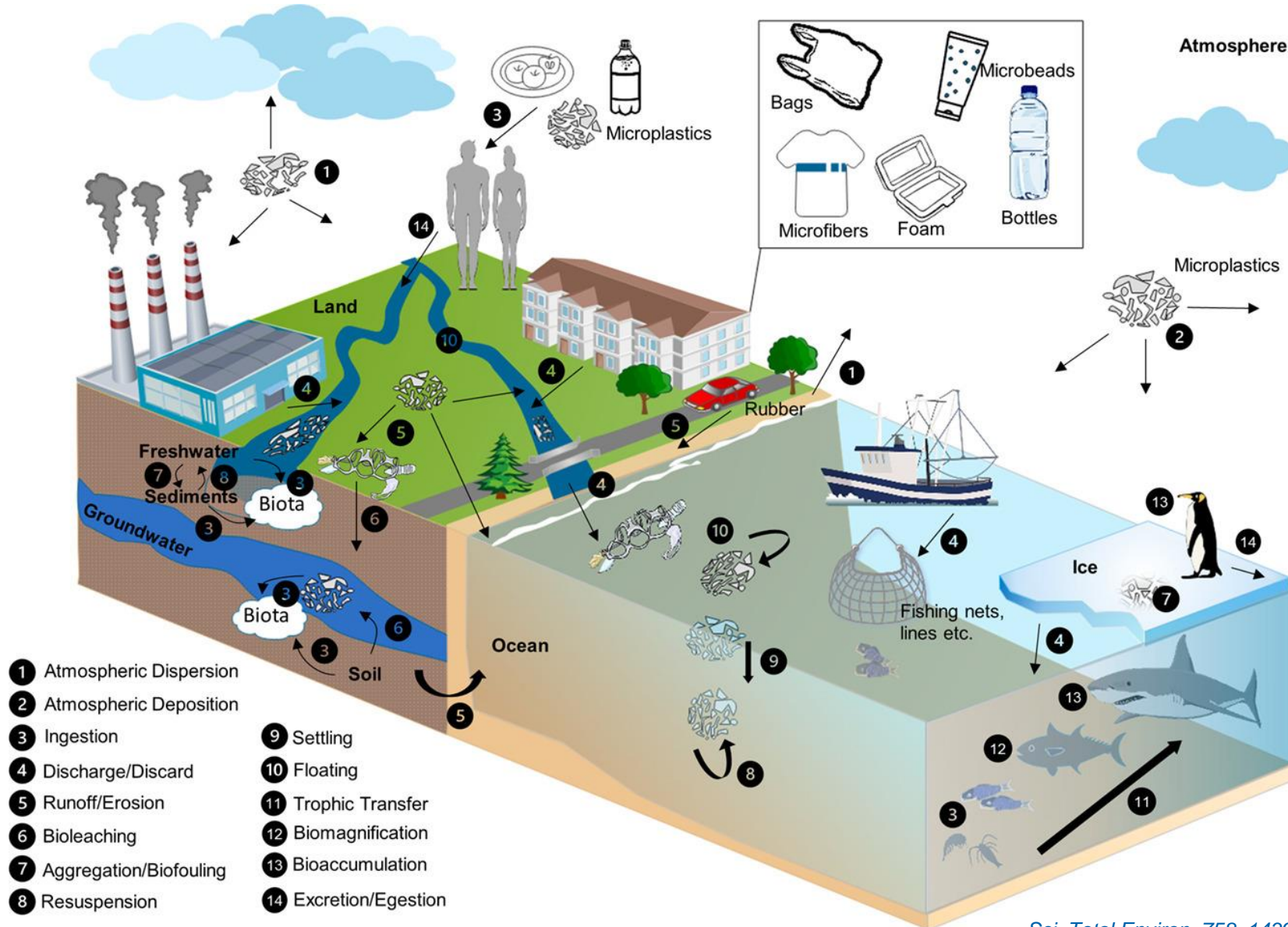
Plastics fragments of any type of plastic less than 5 mm in length, according to the US National Oceanic and Atmospheric Administration (NOAA) and the European Chemical Agency.



# Occurrence of Nano/Microplastics

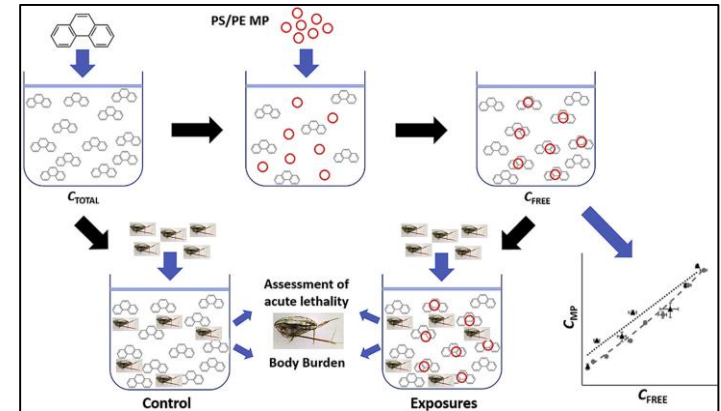
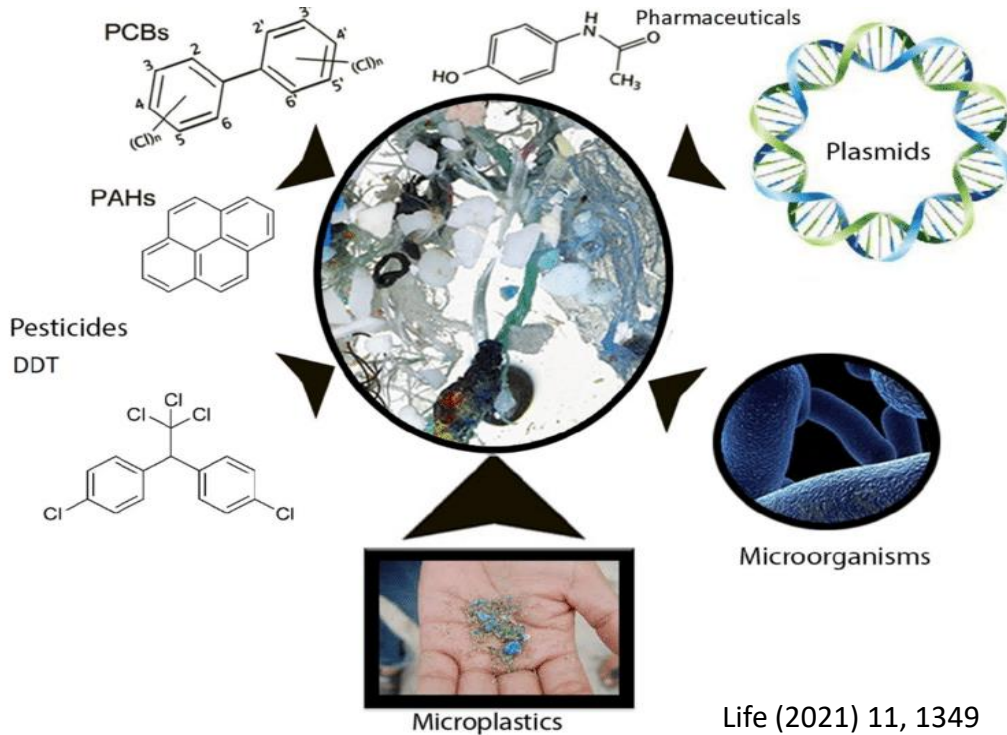


# Transport of Microplastics

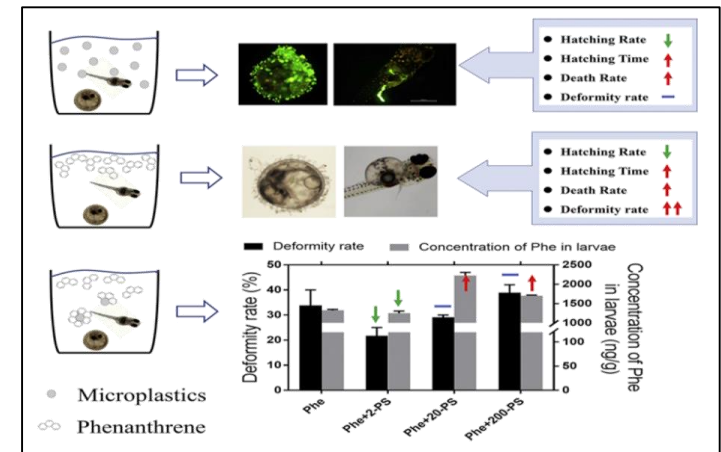


- 1 Atmospheric Dispersion
- 2 Atmospheric Deposition
- 3 Ingestion
- 4 Discharge/Discard
- 5 Runoff/Erosion
- 6 Biodegradation
- 7 Aggregation/Biofouling
- 8 Resuspension
- 9 Settling
- 10 Floating
- 11 Trophic Transfer
- 12 Biomagnification
- 13 Bioaccumulation
- 14 Excretion/Egestion

# Microplastics as carriers



Environ. Poll. 258, 113844 (2020)

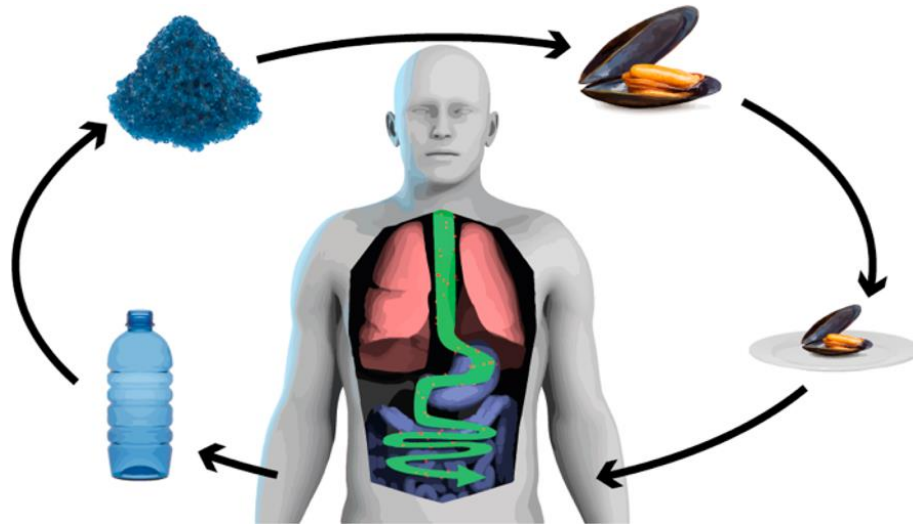


J. Hazard. Mater. 385, 121586 (2020)

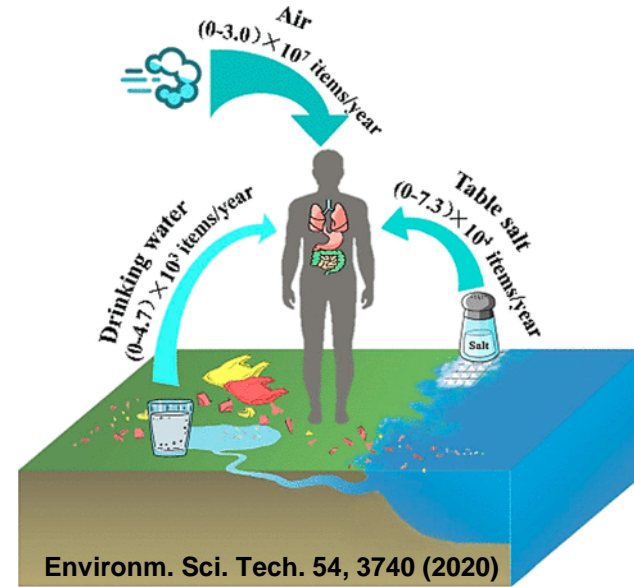
**Polystyrene nanoplastics and microplastics can act as Trojan horse carriers of benzo(a)pyrene to mussel hemocytes in vitro**

Sci. Rep 11, 22396 (2021)

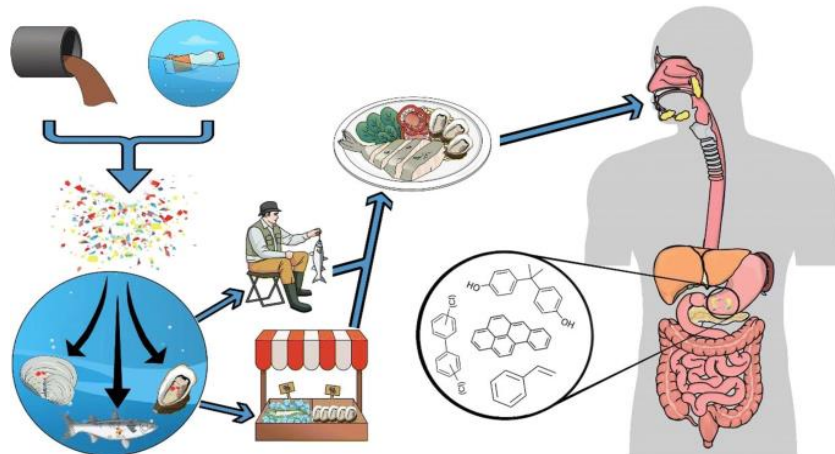
# Human exposure of Microplastics



Environ. Sci. Technol. 53, 1748 (2019)



Environm. Sci. Tech. 54, 3740 (2020)



J Food Sci. Tech. 57, 1601, (2020)

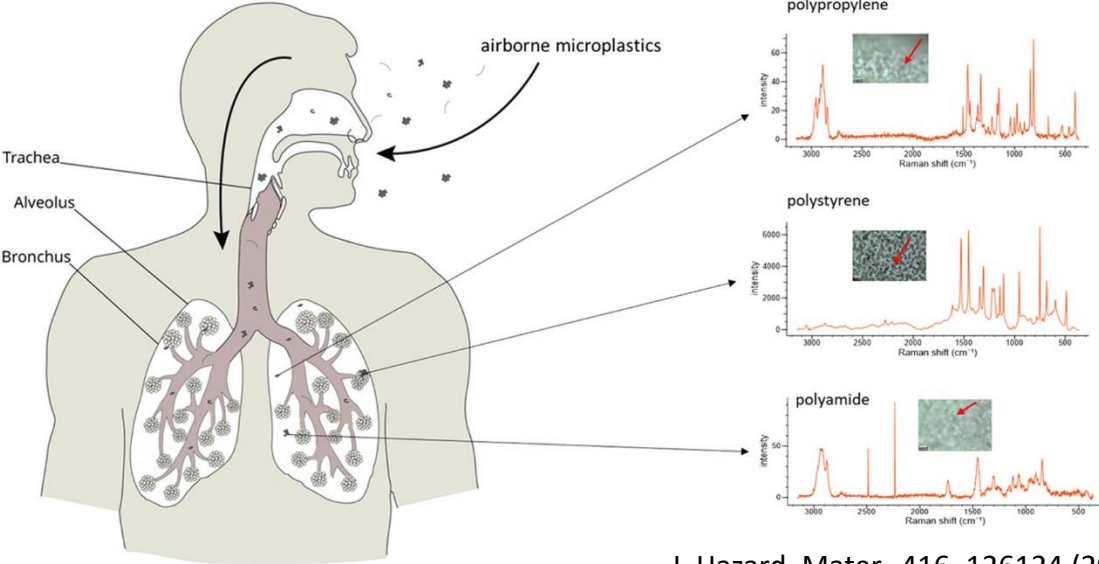


Life 11, 1349 (2021)

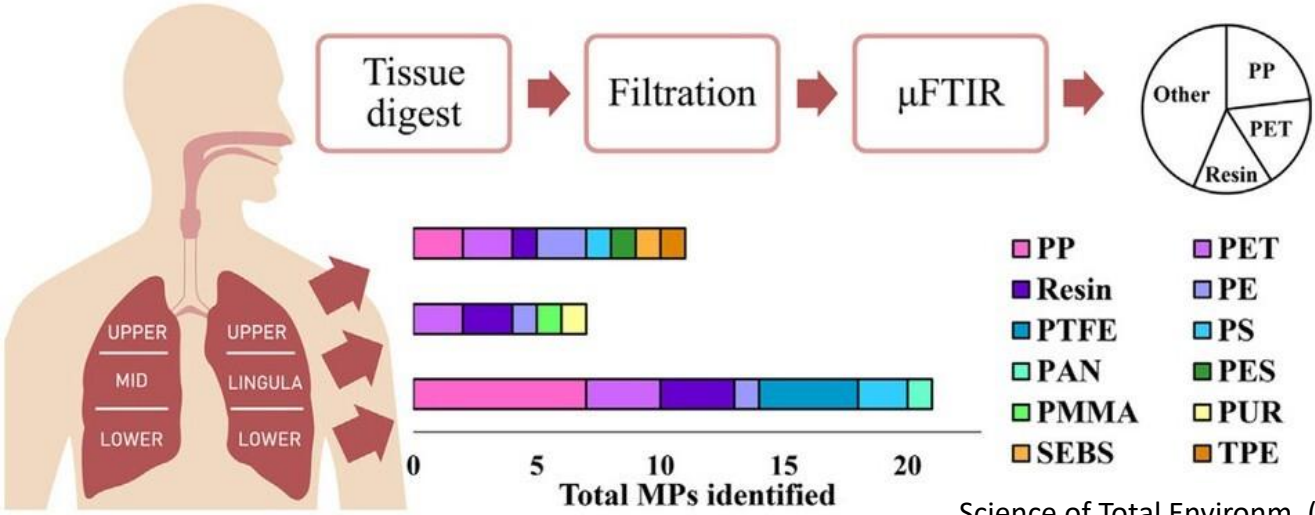
# Airborne microplastics in human



## Airborne microplastics in human lung tissue



J. Hazard. Mater., 416, 126124 (2021)



Science of Total Environm, (2022)

# Nano/Microplastic in pregnancy



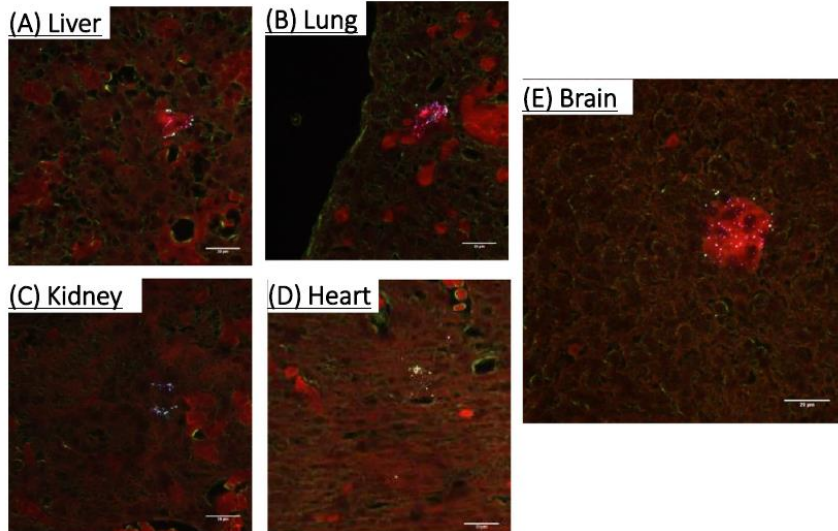
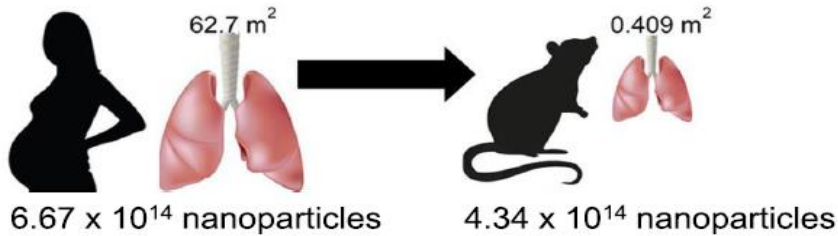
Fournier et al. *Particle and Fibre Toxicology* (2020) 17:55  
<https://doi.org/10.1186/s12989-020-00385-9>

Particle and Fibre Toxicology

RESEARCH

Open Access

Nanopolystyrene translocation and fetal deposition after acute lung exposure during late-stage pregnancy



NanoPS (21nm) founded in Fetal tissues



Environment International

Volume 146, January 2021, 106274




## Plasticenta: First evidence of microplastics in human placenta

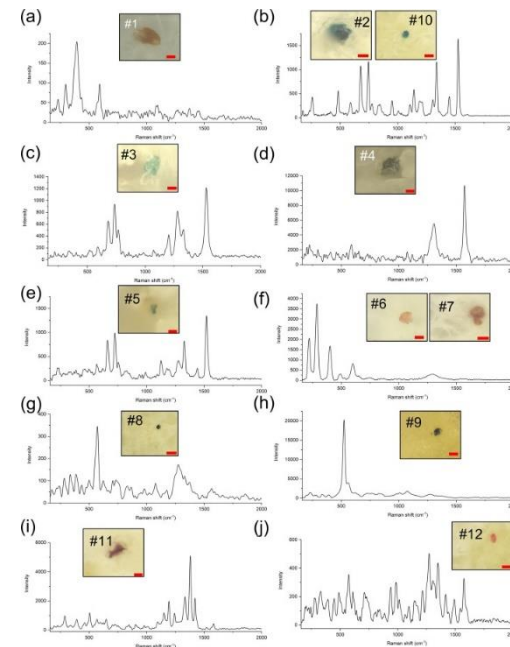
**Plastic Fragments Detected in Human Placenta**

Microplastic particles revealed in the placentas of unborn babies

The microplastic fragments lead to adverse pregnancy outcomes including preeclampsia and fetal growth restriction

www.medindia.net



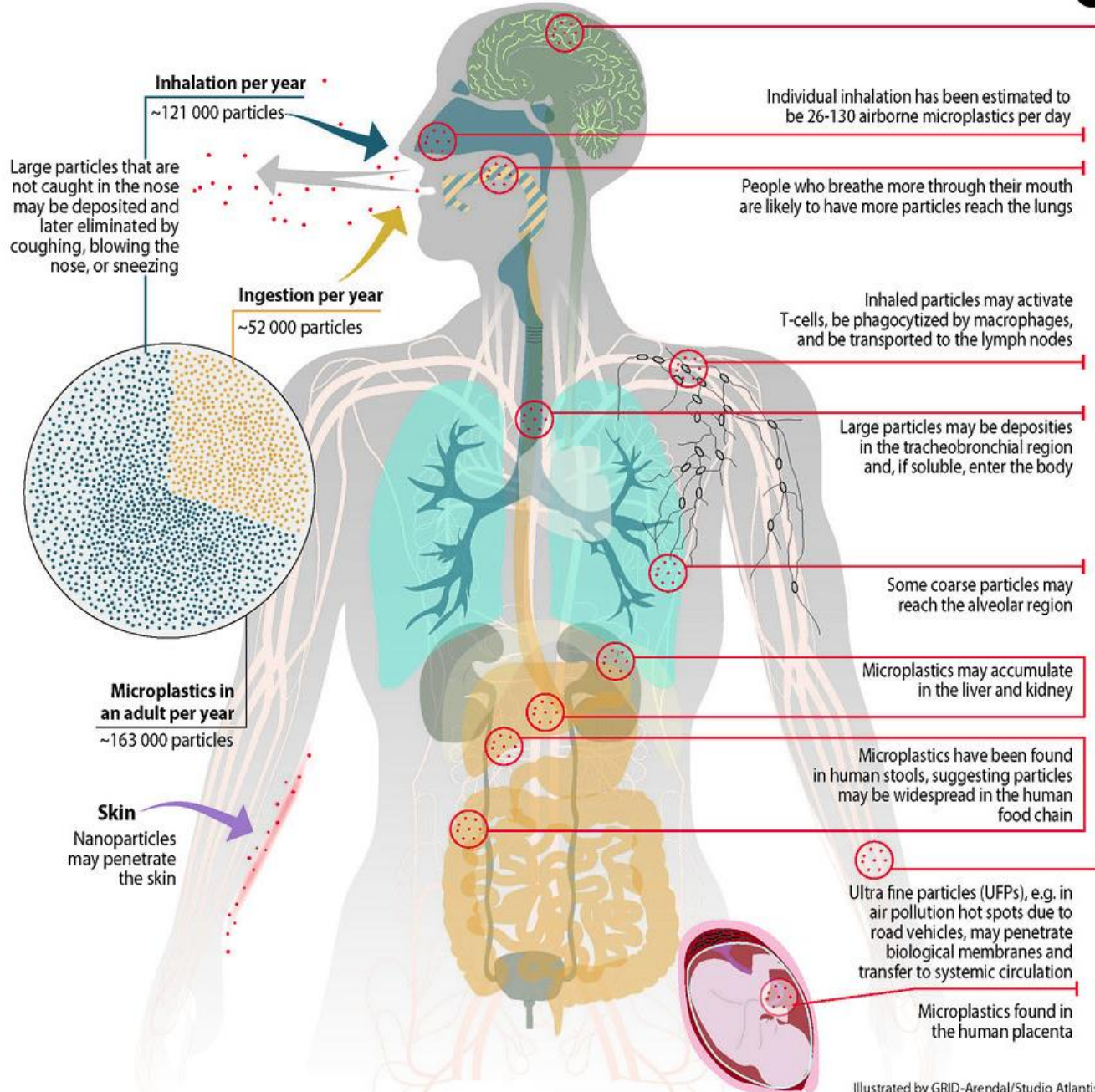


Polypropylene with colors (dark blue, violet, pink, red, orange as pigments)



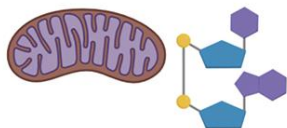
# Human exposure to microplastic and nanoplastic particles

A



Illustrated by GRID-Arendal/Studio Atlantis

# Biological effects of NMPs



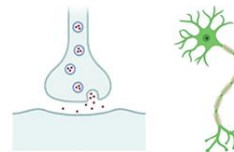
**Oxidative Stress**

38



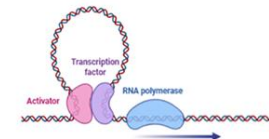
**Growth & Survival**

34



**Neurotoxicity & Locomotor Toxicity**

20



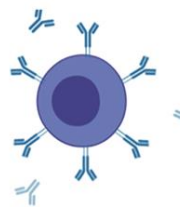
**Gene Expression**

11



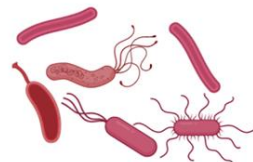
**Metabolic Toxicity**

11



**Immunotoxicity**

8



**Microbiome Modulation**

6



**Genotoxicity**

5

# Nano/Microplastics study in zebrafish



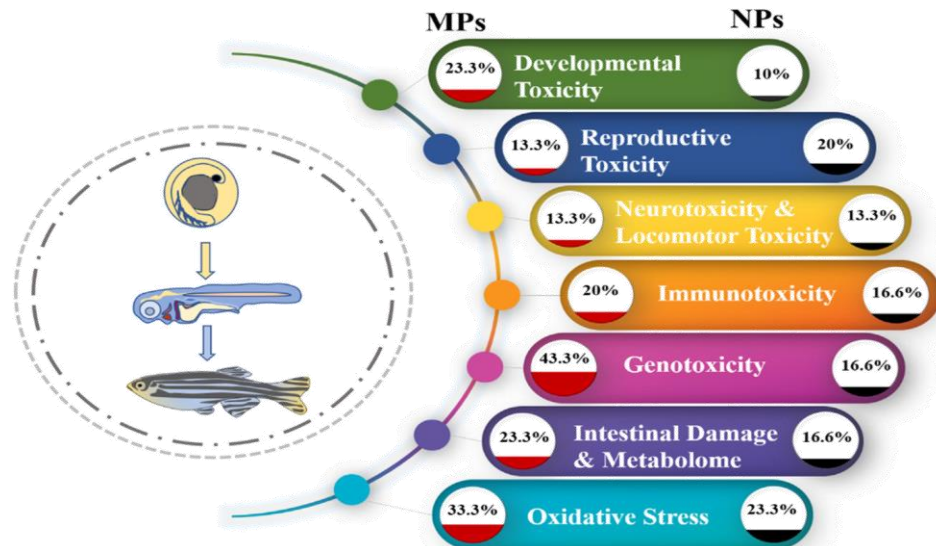
## Zebrafish as an animal model

- Transparent
- Fast growth
- High fecundity
- Tissue similarity (brain, liver, intestine)
- Genetic similarity (~ 70%)

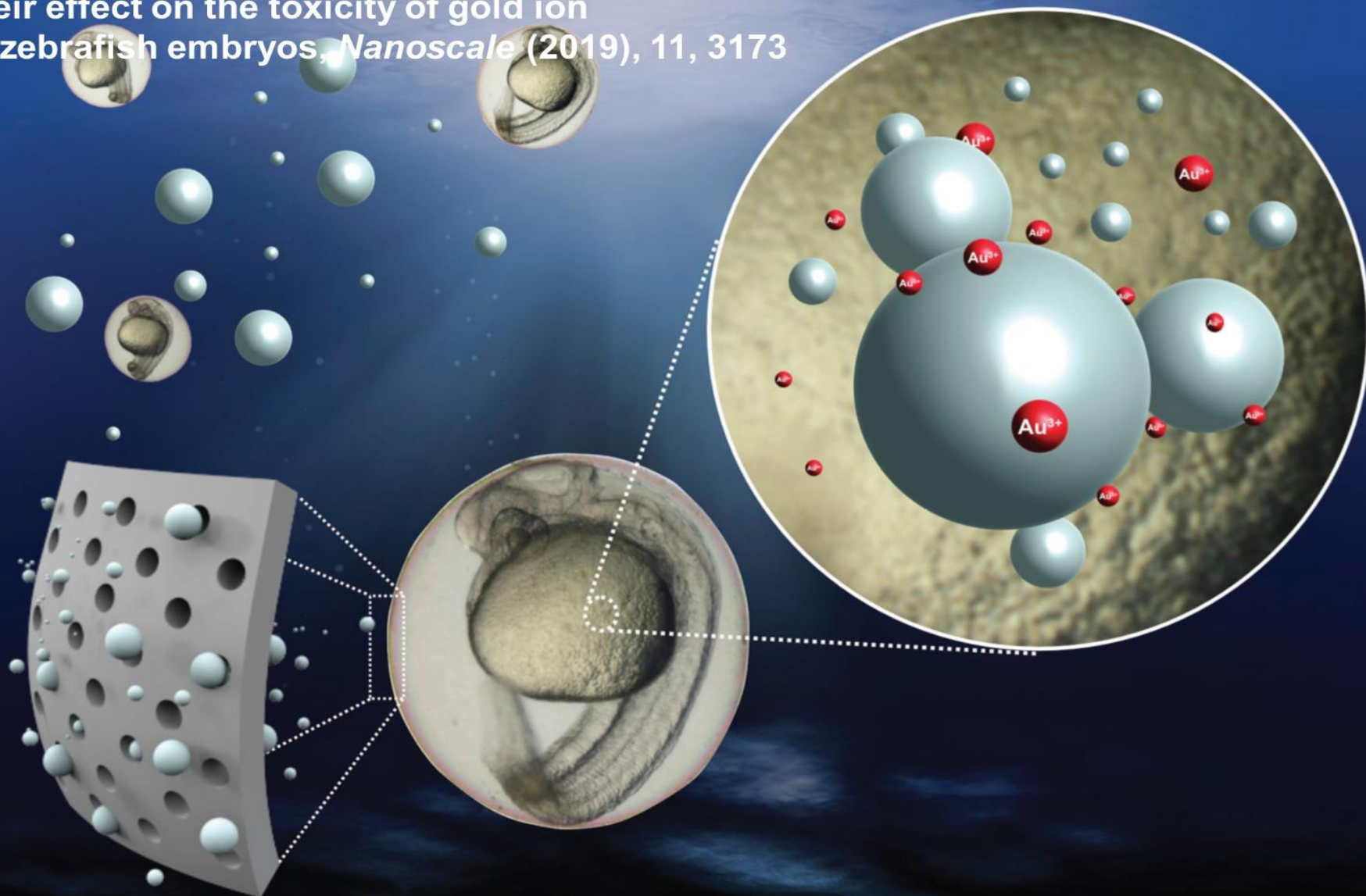


## Nano/Microplastics studies using Zebrafish

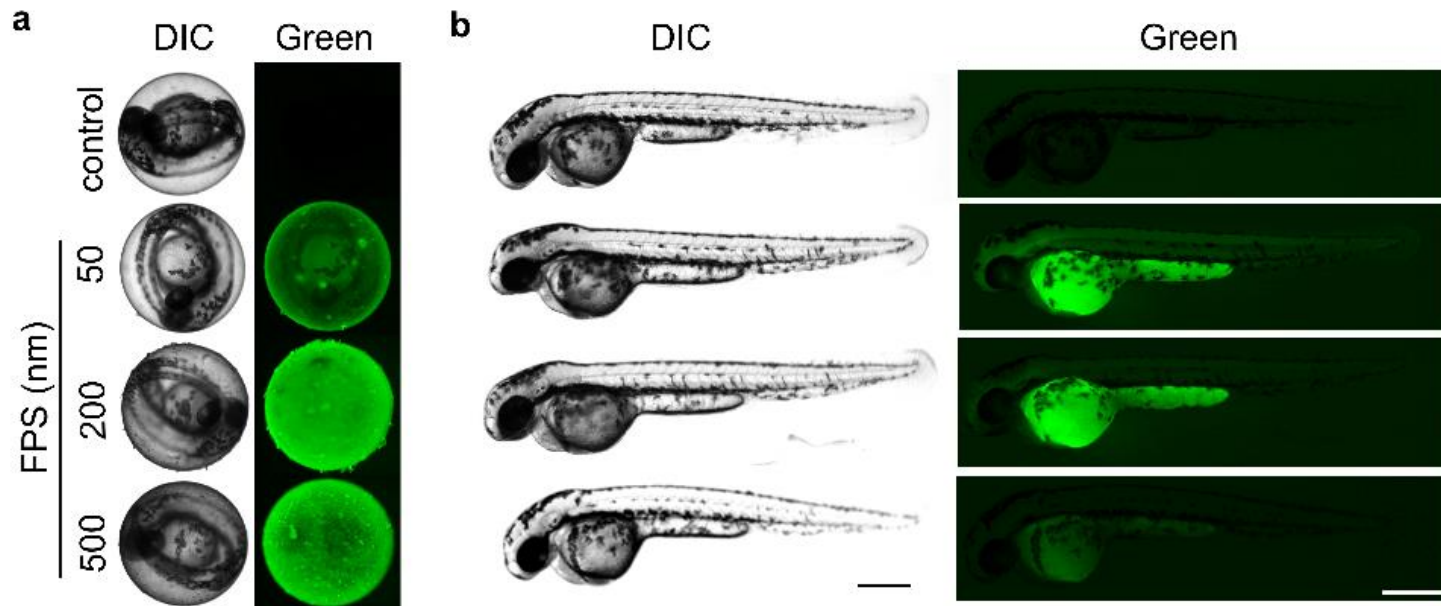
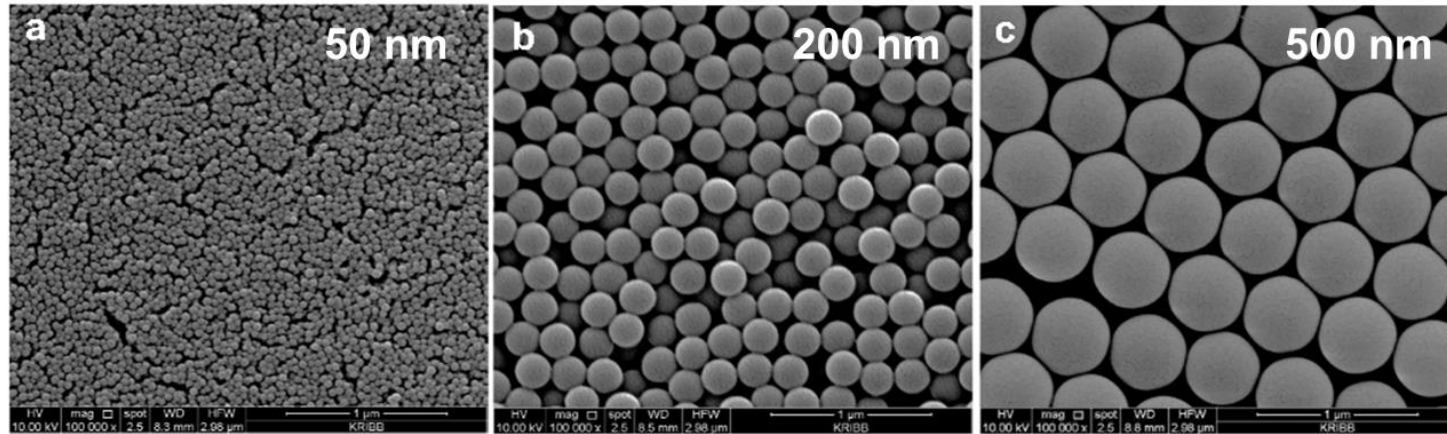
- Developmental toxicity
- Reproductive toxicity
- Neurotoxicity toxicity
- Immunotoxicity
- Genotoxicity
- Intestinal Damage
- Oxidative stress



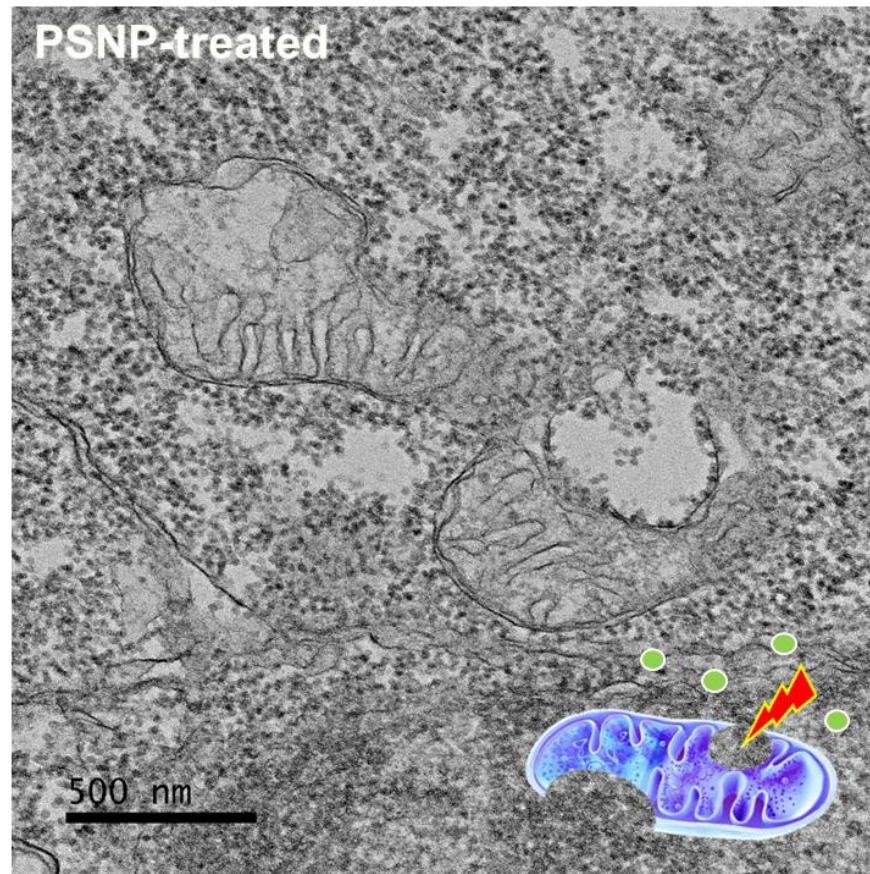
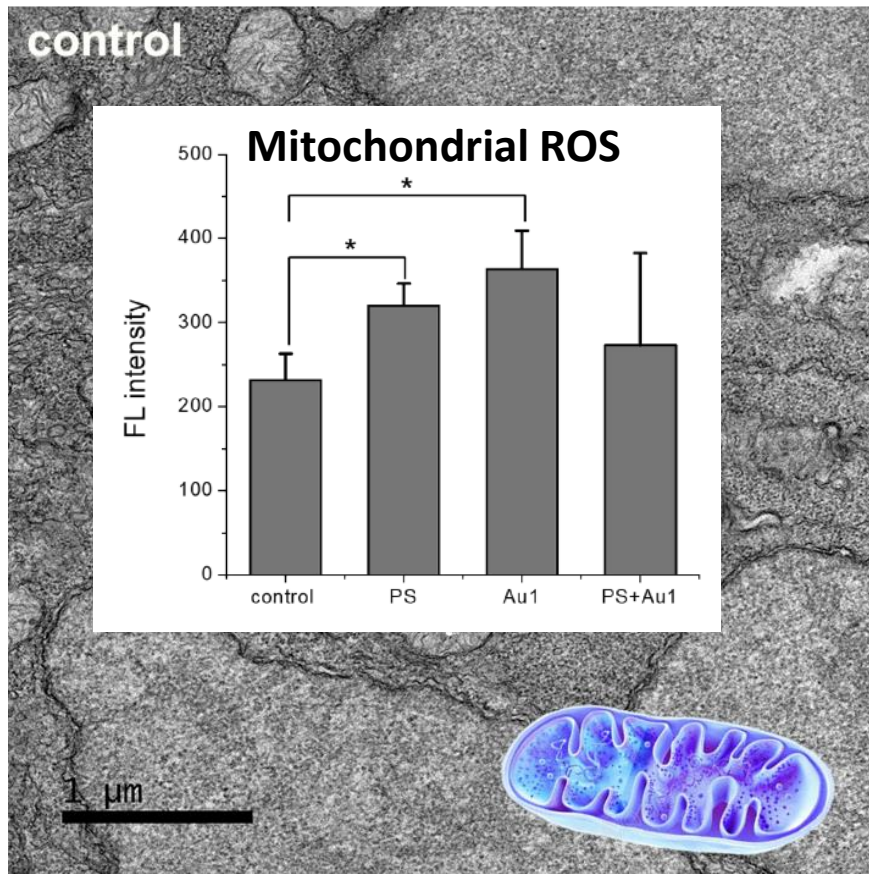
Bioaccumulation of polystyrene nanoplastics and their effect on the toxicity of gold ion in zebrafish embryos, *Nanoscale* (2019), 11, 3173



# Accumulation of Nanoplastastics



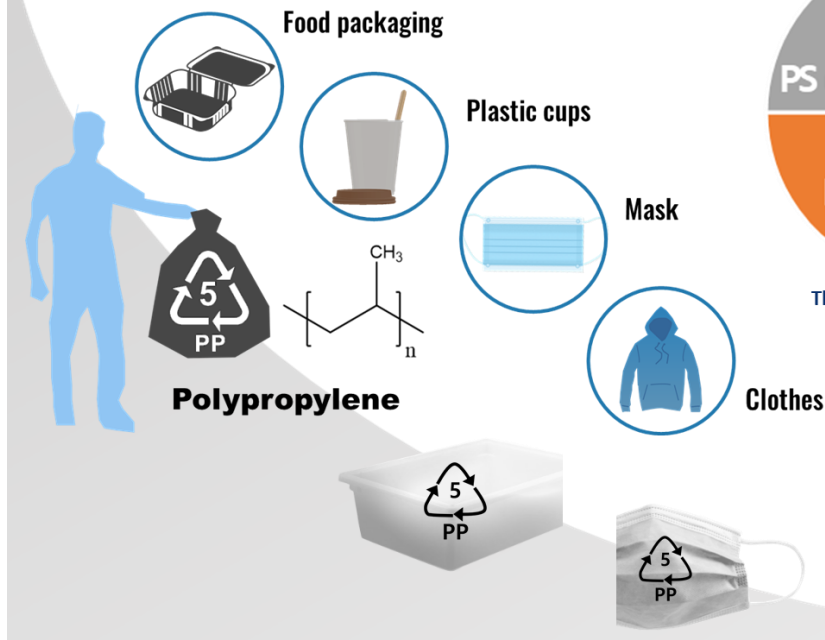
# ROS and Mitochondrial damage



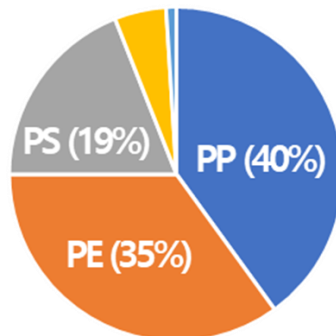
# PP microplastics



## PP production and use



## Plastic waste composition



Thermal Sci. Eng. Prog. 2017



Marine Pollution Bulletin, 159, 111517 (2020)

## PP waste & Micro/Nanoplastics



Microplastic release from the degradation of polypropylene feeding bottles during infant formula preparation

Jemec Kokalj et al. *Microplastics and Nanoplastics* (2022) 2:1  
<https://doi.org/10.1186/s43591-021-00020-0>

Microplastics and Nanoplastics



[pubs.acs.org/journal/estlcv](https://pubs.acs.org/journal/estlcv)



Letter

RESEARCH ARTICLE

Open Access



Environmental hazard of polypropylene microplastics from disposable medical masks: acute toxicity towards *Daphnia magna* and current knowledge on other polypropylene microplastics

Release of Microplastics from Discarded Surgical Masks and Their Adverse Impacts on the Marine Copepod *Tigriopus japonicus*

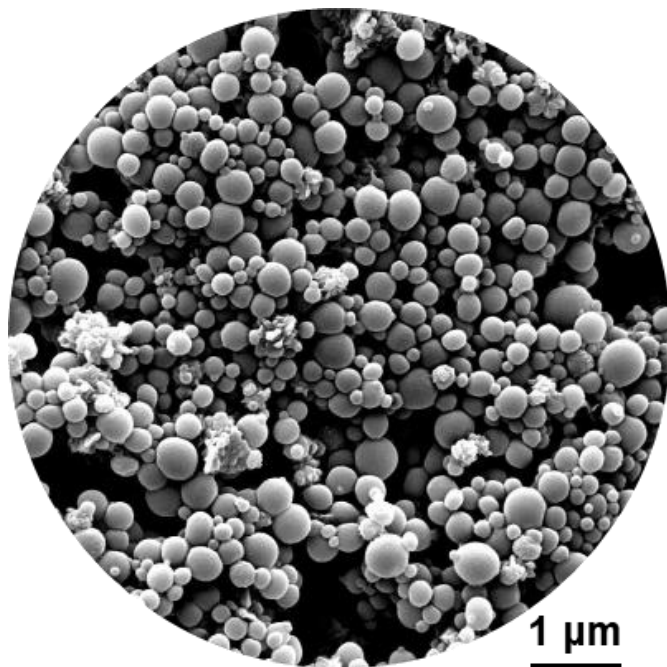
## Fluorescent Polypropylene Nanoplastics for Studying Uptake, Biodistribution, and Excretion in Zebrafish Embryos

Wang Sik Lee, Hyunjung Kim, Yugyeong Sim, Taejoon Kang, and Jinyoung Jeong\*

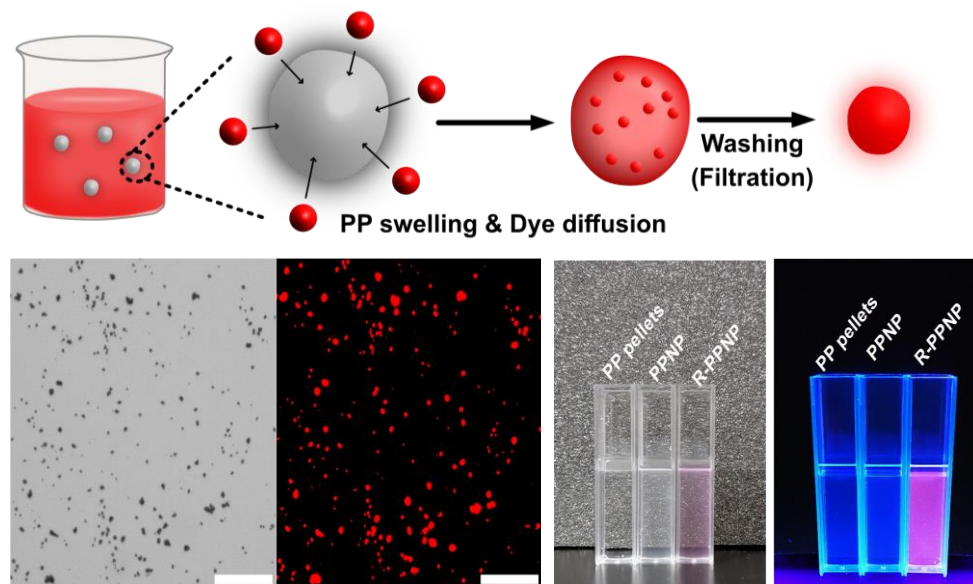
Cite This: <https://doi.org/10.1021/acsomega.1c06779>

 Read Online

### PP nanoplastics (PPNP)



### Red fluorescent PPNP (R-PPNP)



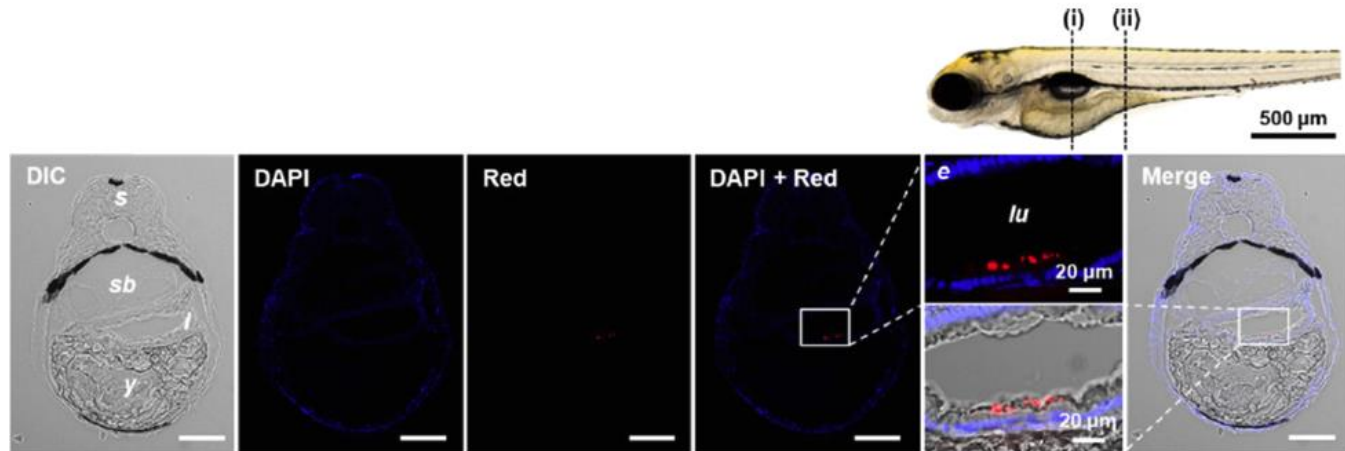


# PP nanoplastics in Zebrafish

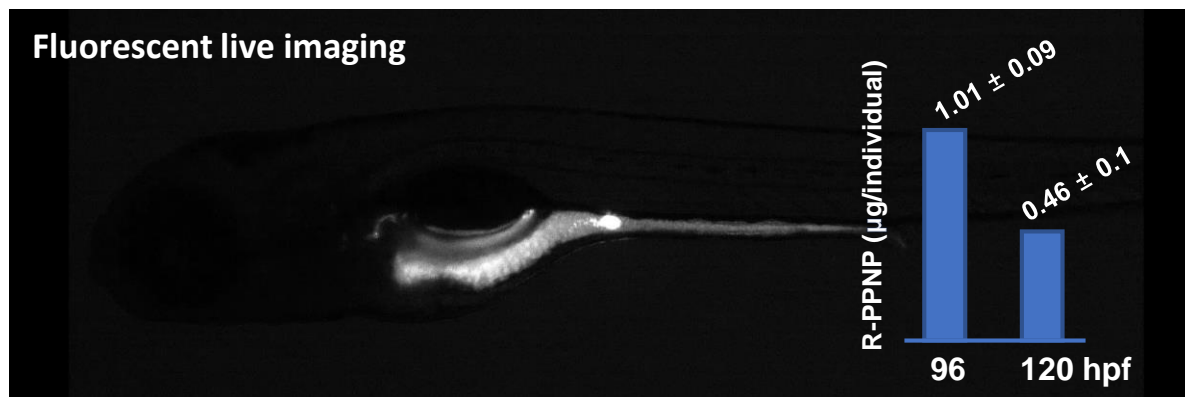
Uptake



Biodistribution



Excretion



# Nanoplastics and pregnancy/birth



Journal of Hazardous Materials 426 (2022) 127815



Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: [www.elsevier.com/locate/jhazmat](http://www.elsevier.com/locate/jhazmat)



Research Paper

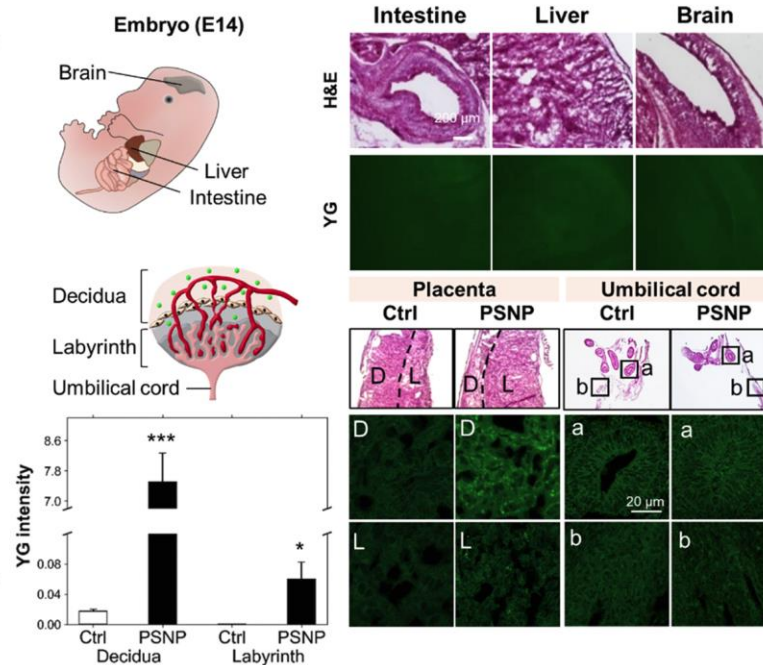
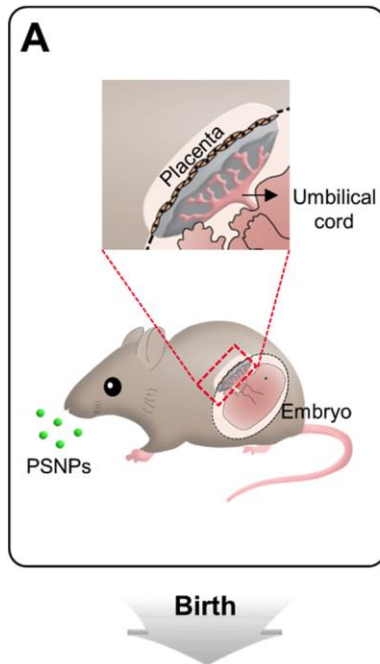
Maternal exposure to polystyrene nanoparticles causes brain abnormalities in progeny



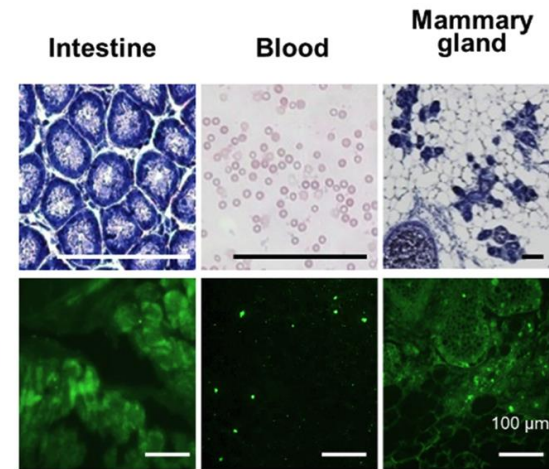
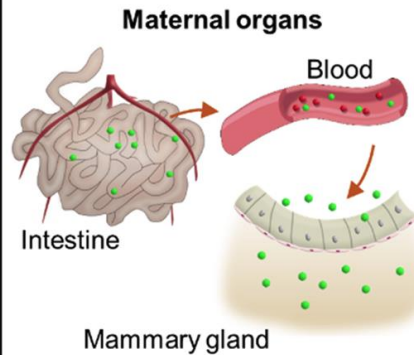
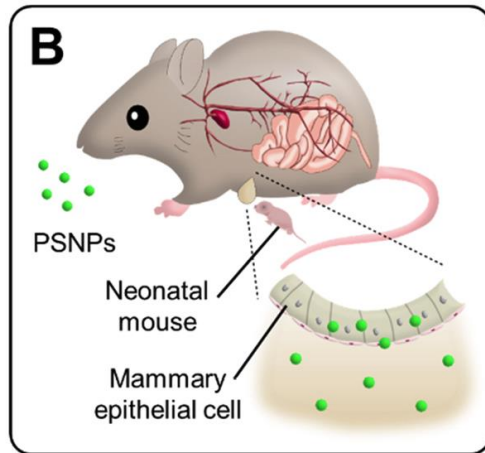
“엄마가 섭취한 초미세플라스틱, 모유 통해 자녀에게 전달”

생명연, 세대 간 전이와 자손 뇌 발달 이상 유발 검증

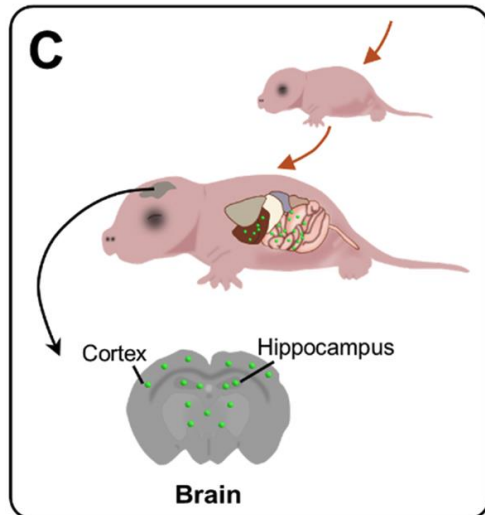
2021.12.15 07:00 | 연합뉴스



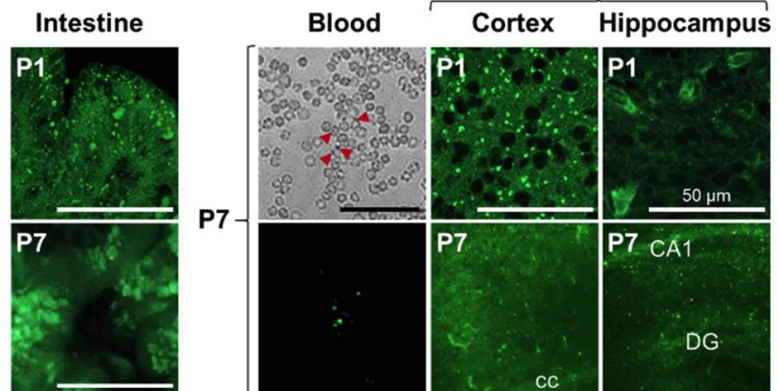
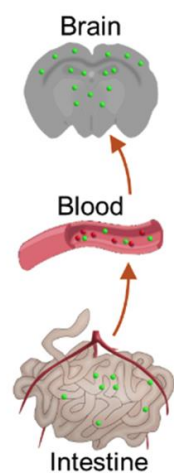
# Nanoplastics and pregnancy/birth



**Breast feeding**



Offspring organs

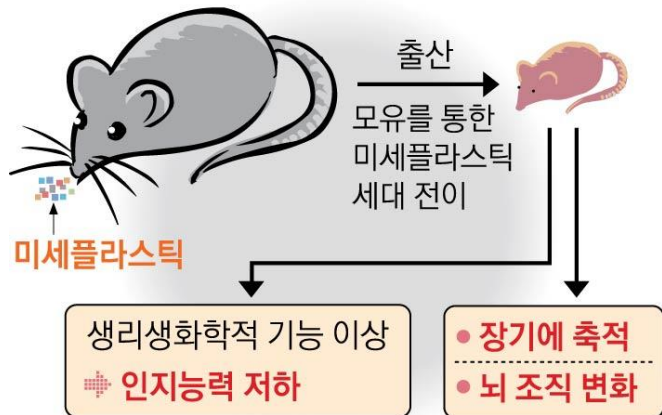


**P1: postnatal day 1, P7: postnatal day 7**

# Nanoplastics and neurotoxicity

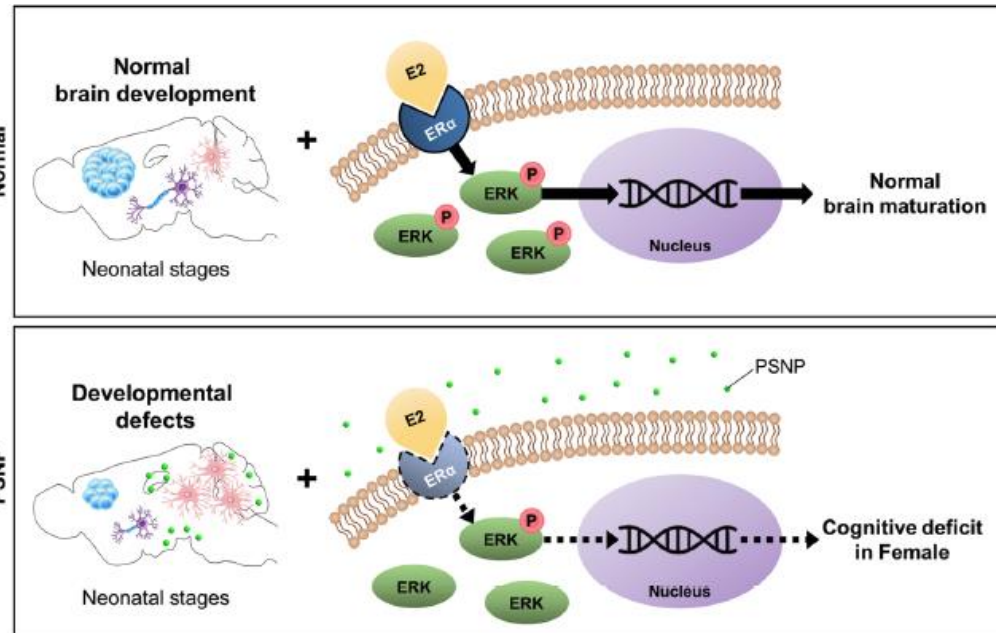
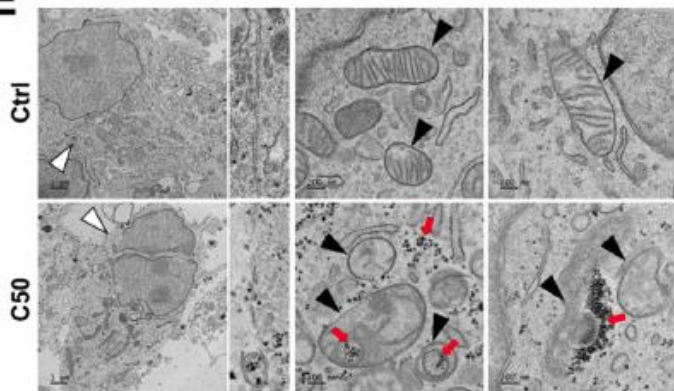


## 미세플라스틱의 유전과 영향

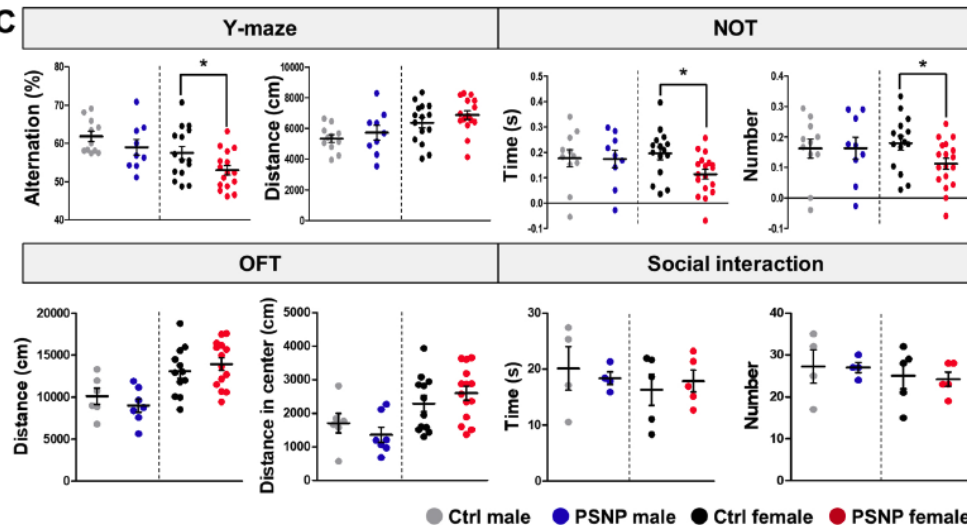


〈자료: 한국생명공학연구원〉

**E**



**C**





- ✓ **Toxic effect of various size, shape and composition of NMPs**
- ✓ **NMPs uptake, accumulation, translocation, and excretion in diverse tissues and organisms**
- ✓ **Monitoring and quantitative analysis of NMPs in animals and human samples**
- ✓ **Combinative effects of plastic additives or environmental pollutants such as plastic additives, PAHs and heavy metals**

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***Thank you***

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