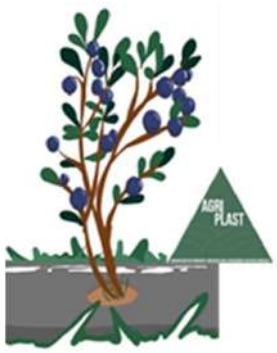


MICROPLASTICS IN THE ENVIRONMENT:

A BIG CHALLENGE

Joana Antunes

1 october 2024 ITQB NOVA, Oeiras

PRR Plano de Recuperação e Resiliência

REPÚBLICA PORTUGUESA

Financiado pela União Europeia NextGenerationEU

iniav Instituto Nacional de Investigação Agrária e Veterinária, I.P.

itqb INSTITUTO DE TECNOLOGIA QUÍMICA E BIOLÓGICA

PRESENTATION STRUCTURE

Plastic production

Microplastic pollution

Sources of microplastics in the agriculture

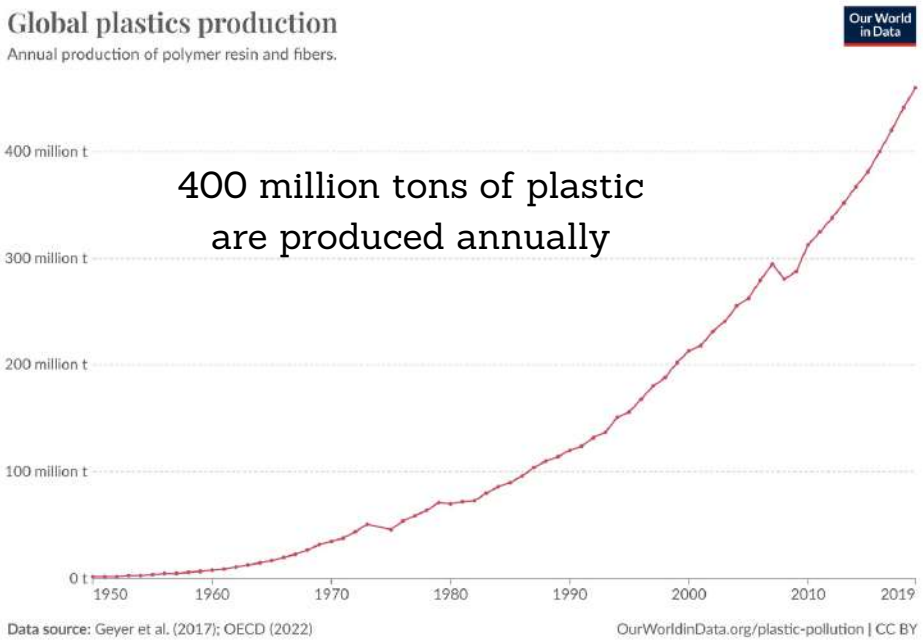
Plastic degradation

Microplastics in the environment

Adverses effects of microplastics in agriculture

How can we reduce the impact?

PLASTIC PRODUCTION



400 million tons of plastic
are produced annually

Versatile, durable, low cost

9% recycled

12% incinerated

79% ends up in landfills or the environment

11 million tons plastic per year
enter in the oceans

MICROPLASTICS

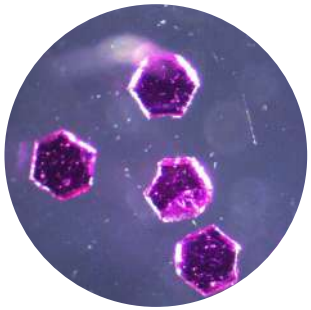
plastic particles with dimensions < 5 mm

Synthetic polymers

Primary

Intentionally produced

pellets



glitter

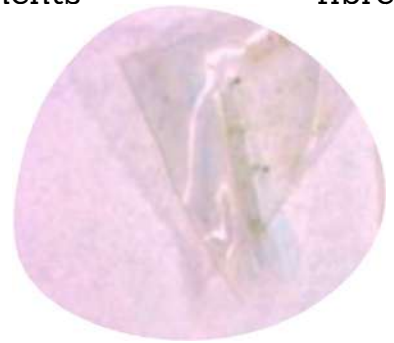
cosmetics

Secondary

Degradation of macroplastics

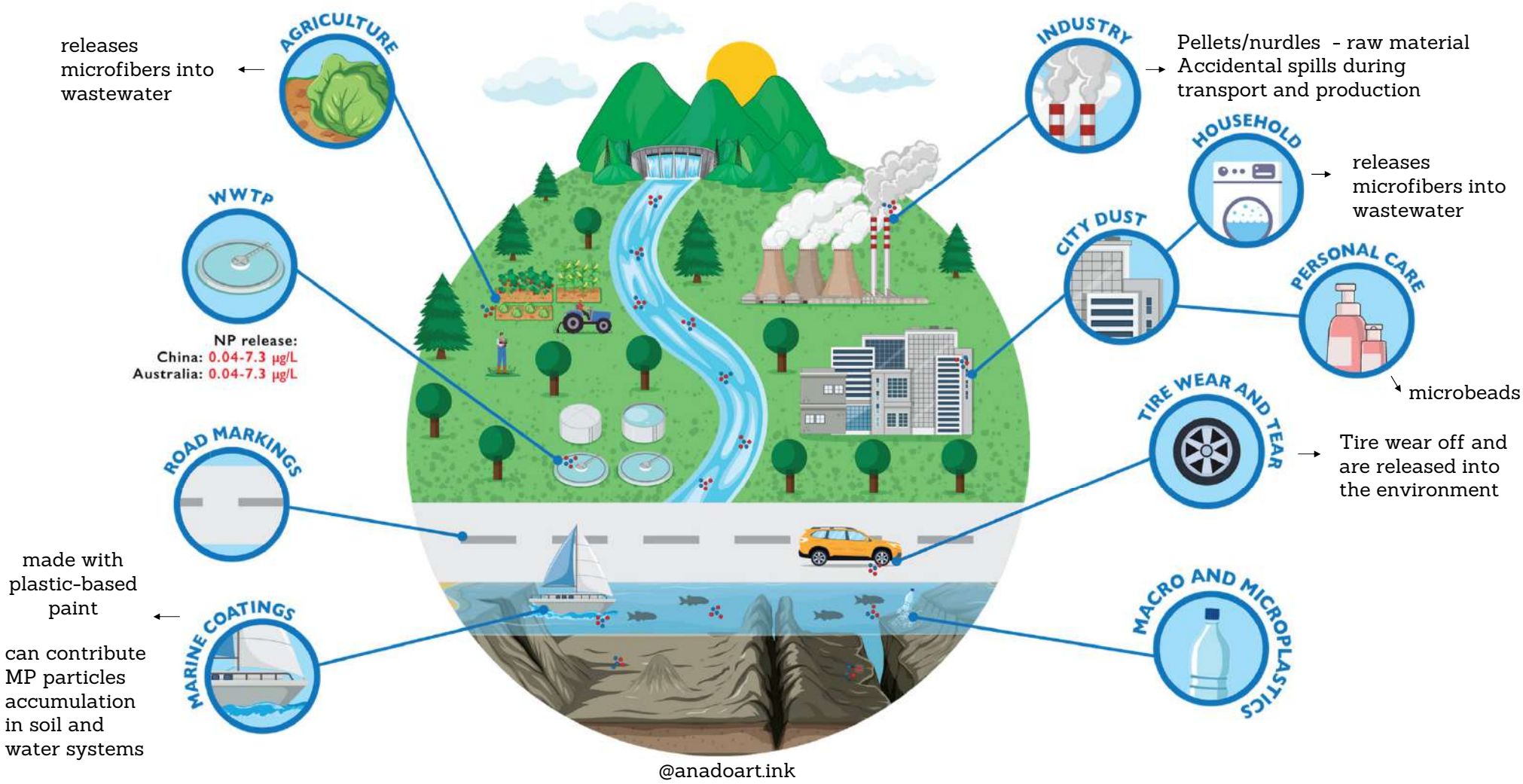
fragments

fibres



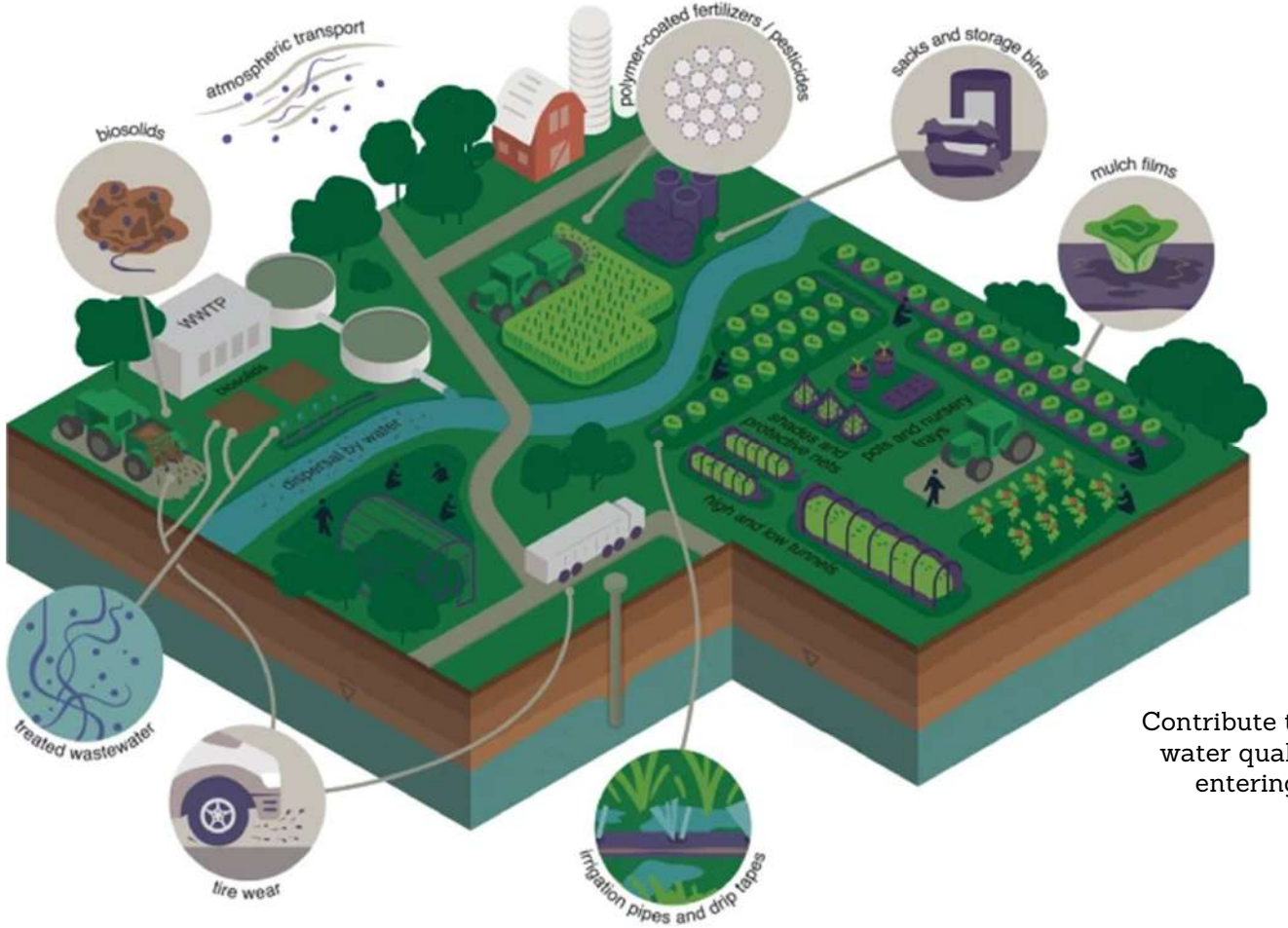
films

MICROPLASTIC POLLUTION



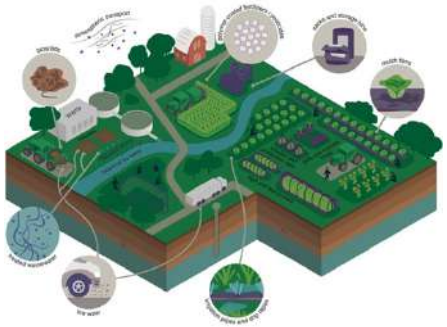
@anadoart.ink

SOURCES OF MICROPLASTICS IN AGRICULTURE



Contribute to impact soil health, water quality, and potentially entering the food chain.

SOURCES OF MICROPLASTICS IN AGRICULTURE



Source: Hofmann et al., 2023

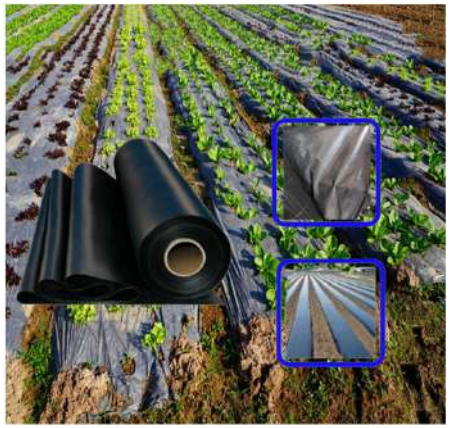
Mulch films

control weeds
regulate soil temperature

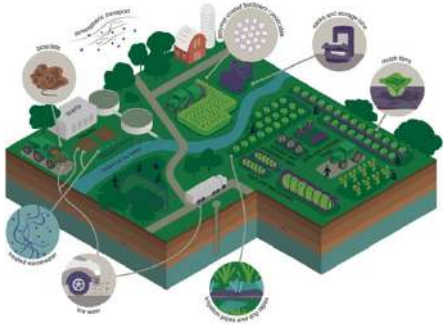
polyethylene or polypropylene

Installation and removal of mulches can **cause tears and wear**, releasing microplastics

After use, many plastic mulches are **left in the field**, where they **continue to degrade**



SOURCES OF MICROPLASTICS IN AGRICULTURE

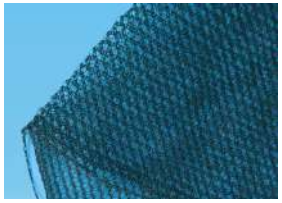


Source: Hofmann et al., 2023

Nets, tunnels, greenhouses

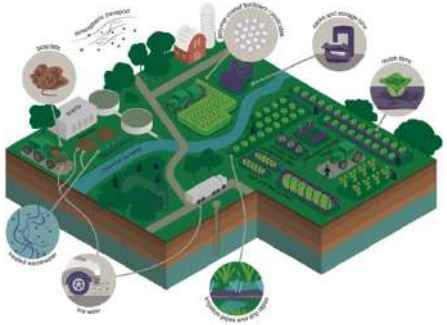
Protect crops, enhance growh extend the growing season

help in controlling environmental conditions and minimizing pest damage



Improper disposal or burning can lead to fragmentation, releasing microplastics into the soil and air.

SOURCES OF MICROPLASTICS IN AGRICULTURE

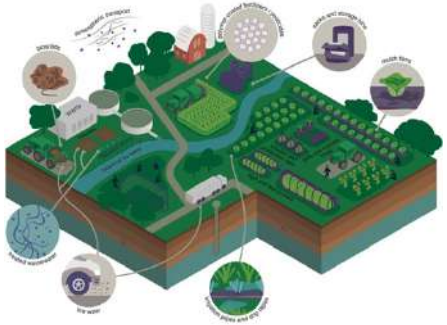


Source: Hofmann et al., 2023

Trays and tree guards

protect young trees from environmental stress, pests and physical damage

SOURCES OF MICROPLASTICS IN AGRICULTURE



Source: Hofmann et al., 2023

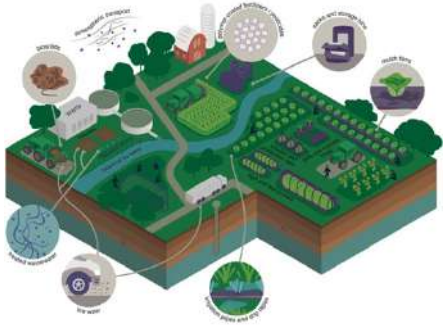
irrigation systems

Water reservoirs, tanks, cisterns, storage containers, sprinklers drip irrigation, irrigation pipes

facilitate the distribution of water in agricultural fields

polyvinyl chloride
polyethylene

SOURCES OF MICROPLASTICS IN AGRICULTURE



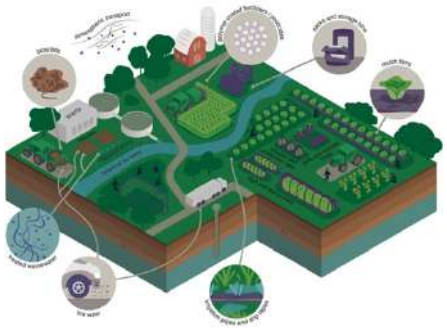
Source: Hofmann et al., 2023

silage films

avoid the need of storage buildings
protect silage from air exposure

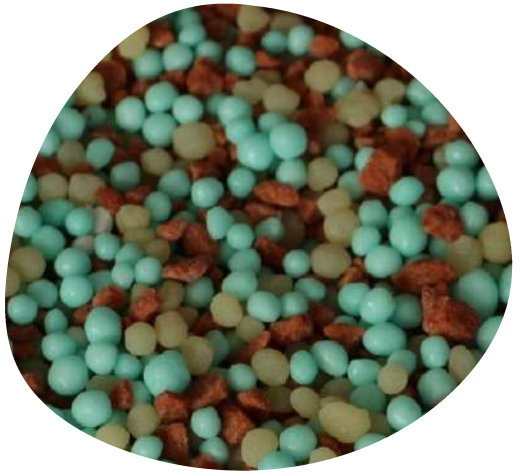
polyethylene

SOURCES OF MICROPLASTICS IN AGRICULTURE

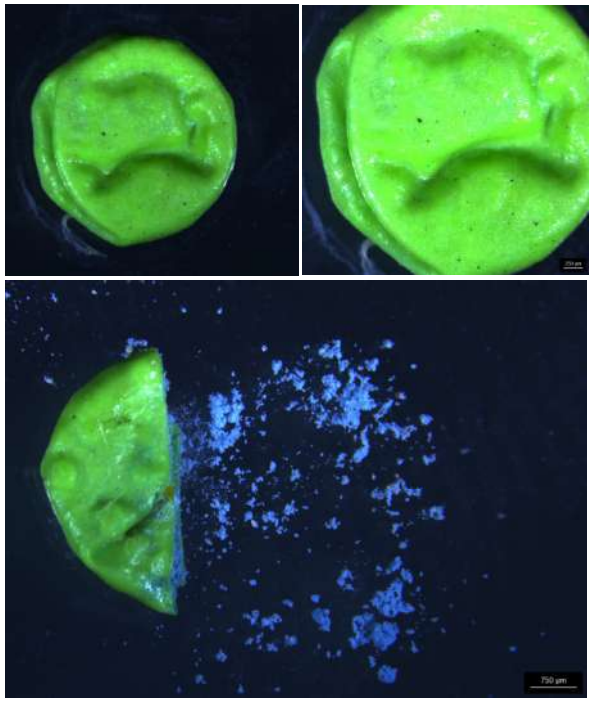


Source: Hofmann et al., 2023

Coatings on fertilizers, pesticides and seeds



intentionally added to the coating to ensure that the nutrients are released more slowly



chlorinated polyethylene

PLASTIC DEGRADATION

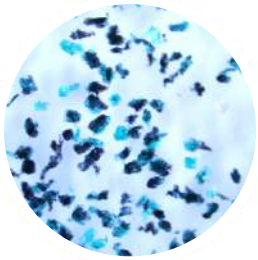
microorganisms

UV radiation
Photodegradation
thermal degradation

mechanical abrasion
physical breakdown

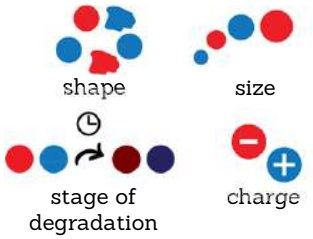
wind

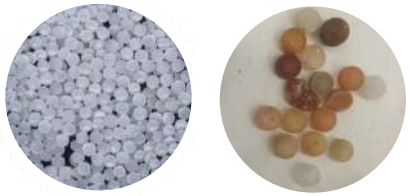
MICROPLASTICS IN THE ENVIRONMENT



microplastics

different characteristics





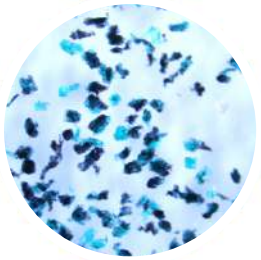
≠ shapes ≠ interactions

risks to wildlife, particularly through ingestion

develop positive or negative electrical charges

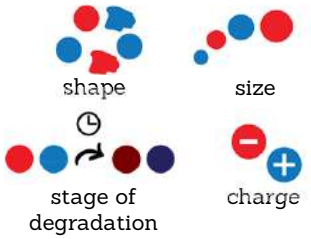
affects how they bind to other materials (other pollutants)

MICROPLASTICS IN THE ENVIRONMENT

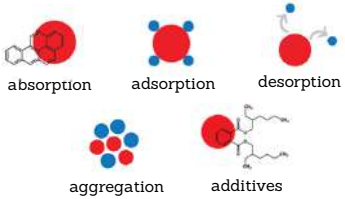


microplastics

different characteristics



interaction other environmental contaminants or additives



≠ shapes ≠ interactions

risks to wildlife, particularly through ingestion

develop positive or negative electrical charges

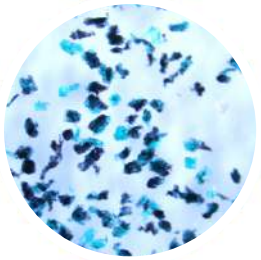
affects how they bind to other materials (other pollutants)

metals
organic matter
antibiotics
additives
organic persistent pollutants

Toxic carriers

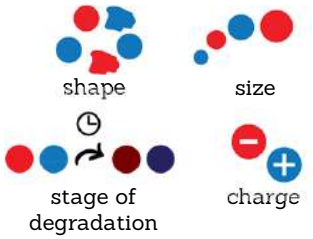
Introduce adsorbed contaminants into food webs and disperse through soils and water systems

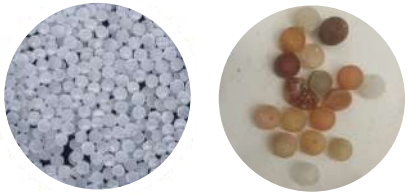
MICROPLASTICS IN THE ENVIRONMENT



microplastics

different characteristics





before

after

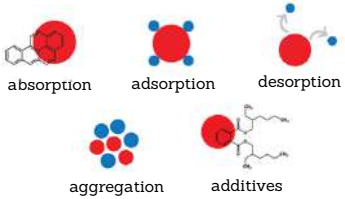
≠ shapes ≠ interactions

risks to wildlife, particularly through ingestion

develop positive or negative electrical charges

affects how they bind to other materials (other pollutants)

interaction other environmental contaminants or additives



metals
organic matter
antibiotics
additives
organic persistent pollutants

Toxic carriers

Introduce adsorbed contaminants into food webs and disperse through soils and water systems

biofilm formation

develop a coating of organic material
=
biofilm

Bacteria substract

Hydrophobicity changes
Emit olfactory signal
Enhance bioavailability

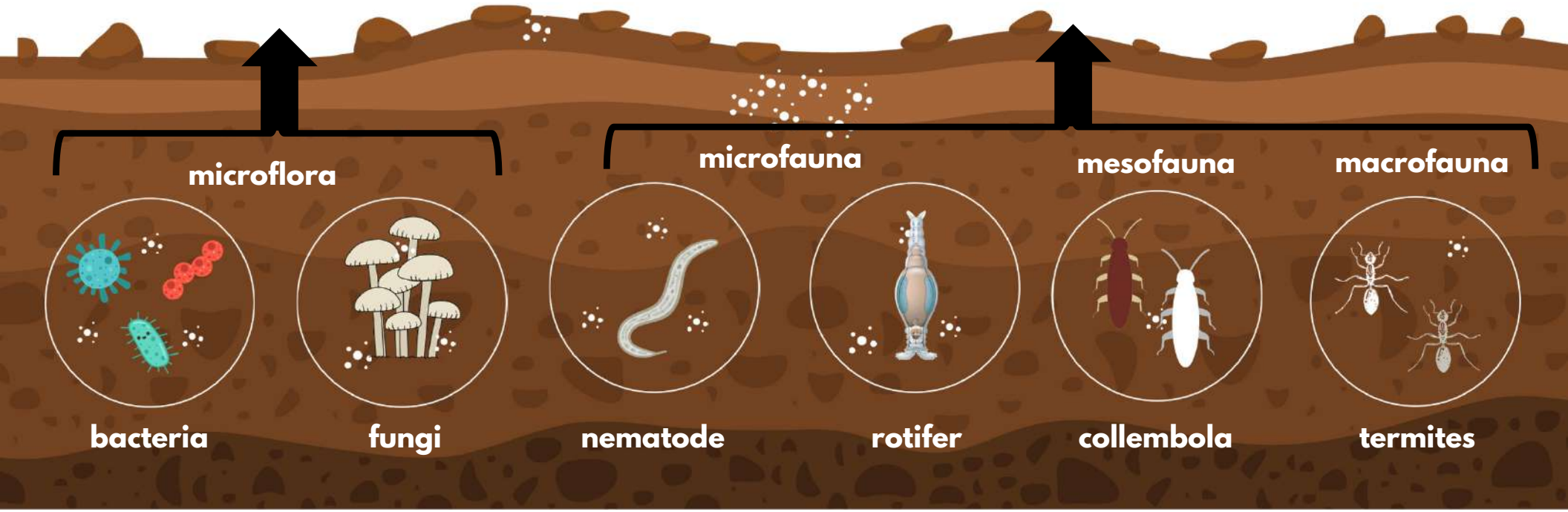
MICROPLASTICS IMPACTS IN SOILS

toxicological impacts on soil biota

plays a vital role in soil ecosystems

alter microbial community structures
metabolic processes
reduce enzyme activity

blockage in their digestive tracts
impairing nutrient absorption
reduce growth, reproduction and survival

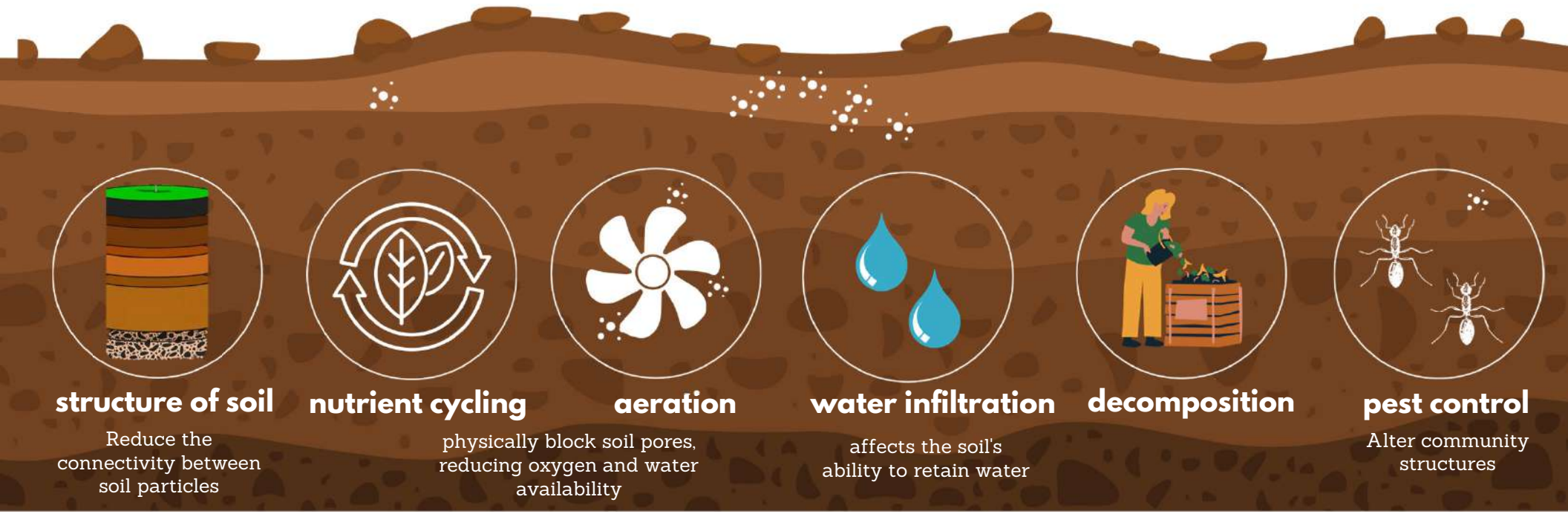


MICROPLASTICS IMPACTS IN SOILS

toxicological impacts on soil biota

impact on soil physical properties

negative consequences for soil health and agricultural productivity



structure of soil

Reduce the connectivity between soil particles

nutrient cycling

aeration

physically block soil pores, reducing oxygen and water availability

water infiltration

affects the soil's ability to retain water

decomposition

pest control

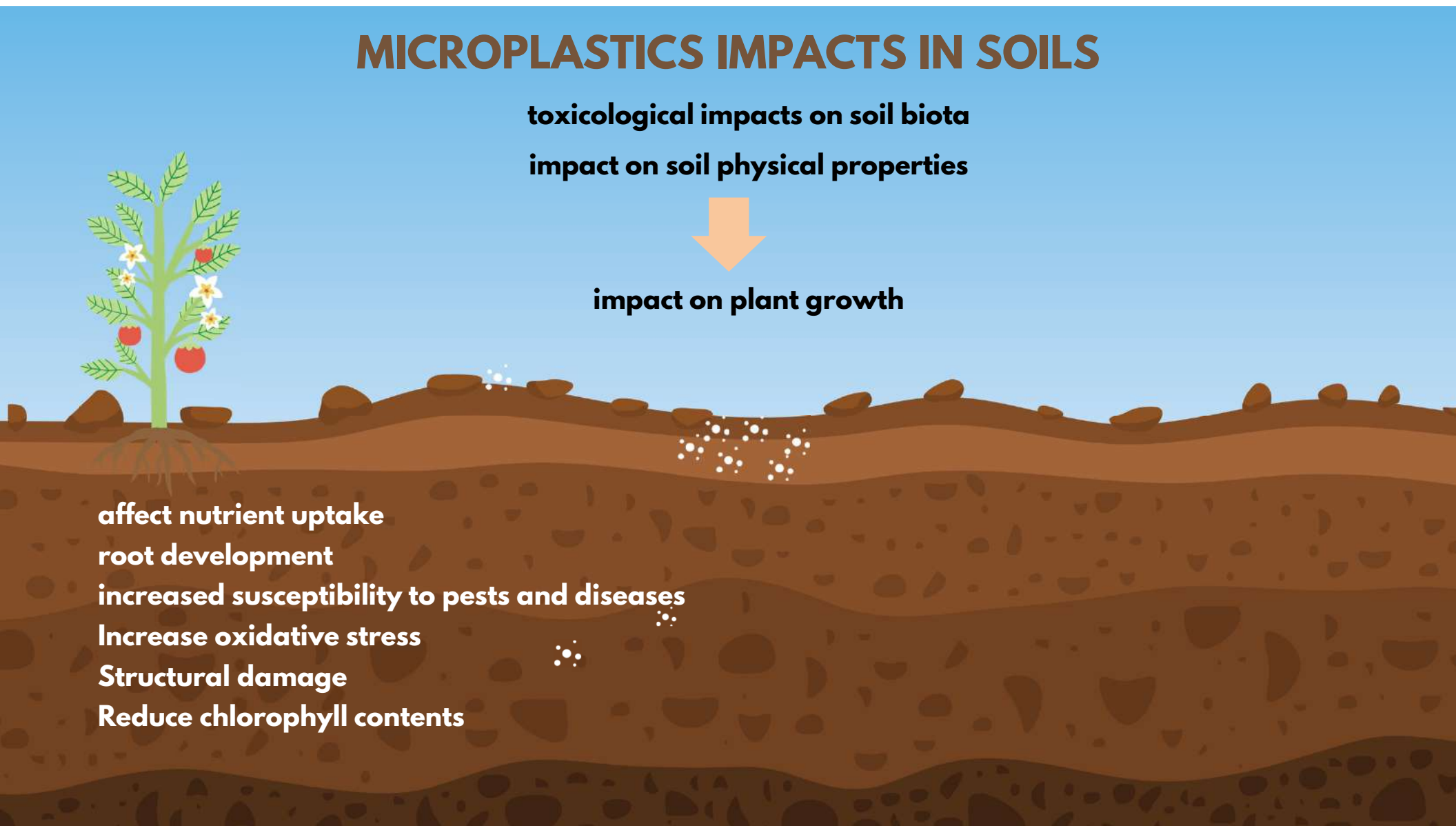
Alter community structures

MICROPLASTICS IMPACTS IN SOILS

toxicological impacts on soil biota

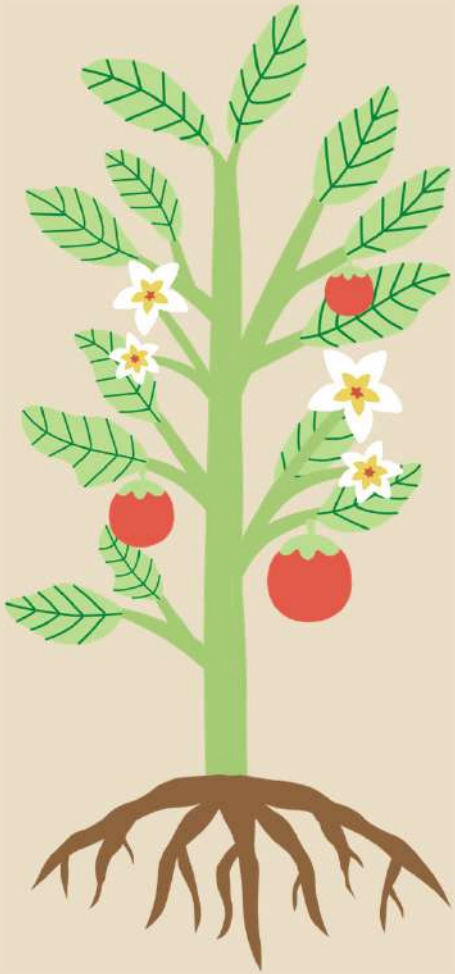
impact on soil physical properties

impact on plant growth



affect nutrient uptake
root development
increased susceptibility to pests and diseases
Increase oxidative stress
Structural damage
Reduce chlorophyll contents

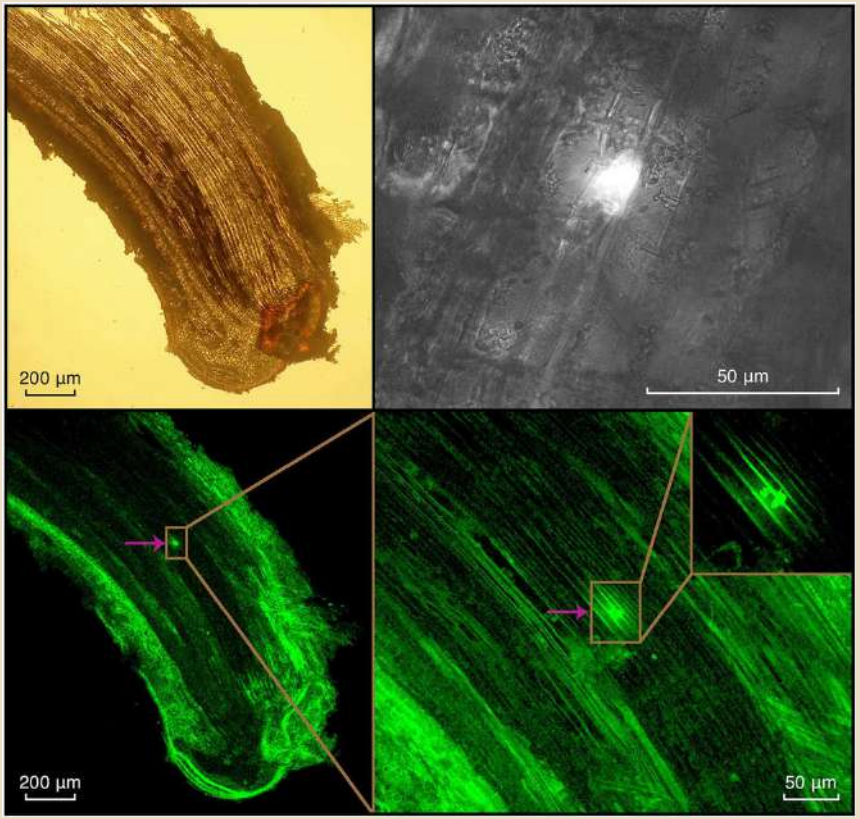
MICROPLASTICS UPTAKE BY PLANTS



uptake and storage of microplastics

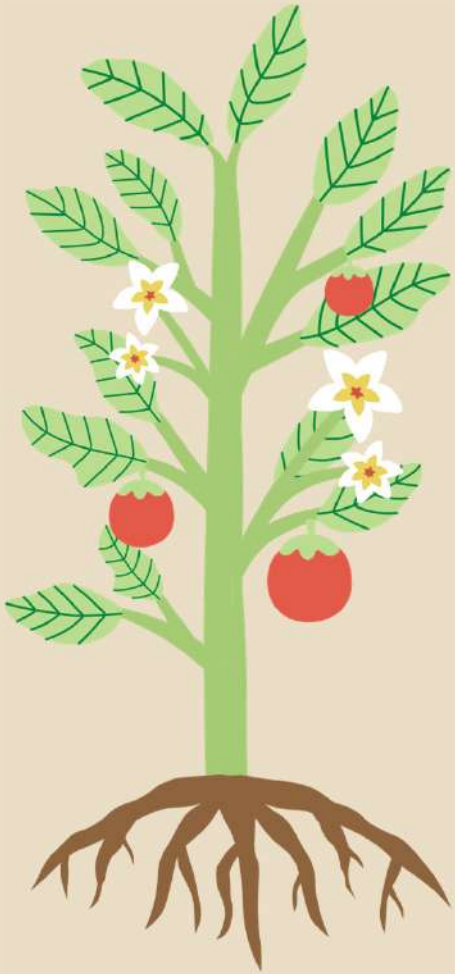
Betula pendula Roth

Austen et al., 2022

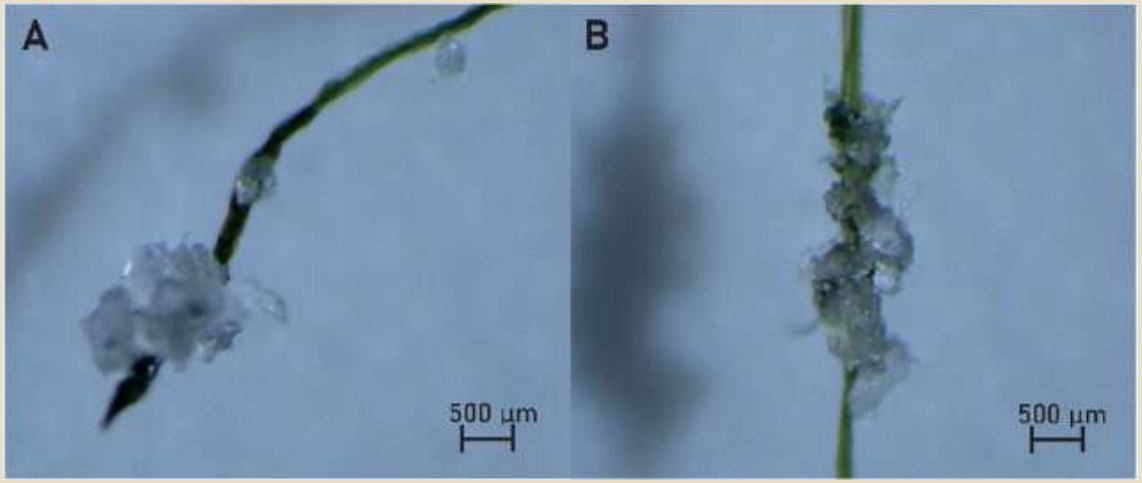


Longitudinal cross-section showing polyamide microplastics (5 to 50 µm) inside a birch lateral root in a one-year-old tree after being exposed to contaminated soil for 5 months.

MICROPLASTICS UPTAKE BY PLANTS



Putar et al., 2023



Microplastics adhered to roots of *L. minor*: formation of aggregates (A), and presence of biofilm at the plant-microplastic line (B).

MICROPLASTICS UPTAKE BY ORGANISMS

MICROPLASTICS IN THE FOOD CHAIN

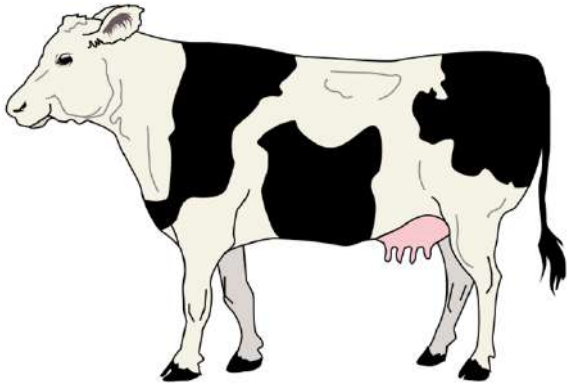
Concentration of microplastics

Lower trophic levels

Higher trophic levels

trophic transfer

bioaccumulation



risks to biodiversity and ecosystem health, as well as potential dangers to **human health**

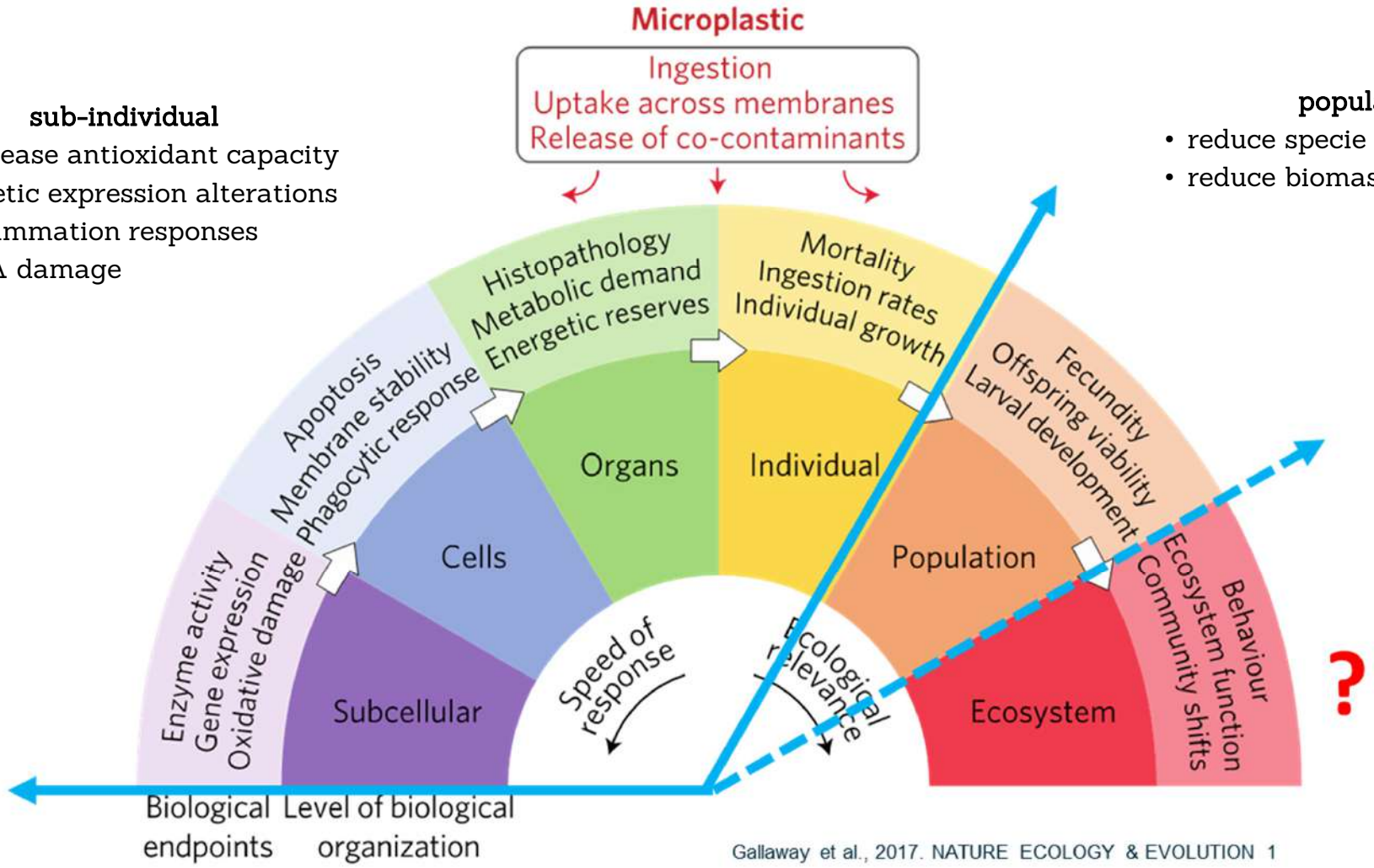
EFFECTS ACROSS LEVELS OF BIOLOGICAL ORGANIZATION

sub-individual

- decrease antioxidant capacity
- genetic expression alterations
- inflammation responses
- DNA damage

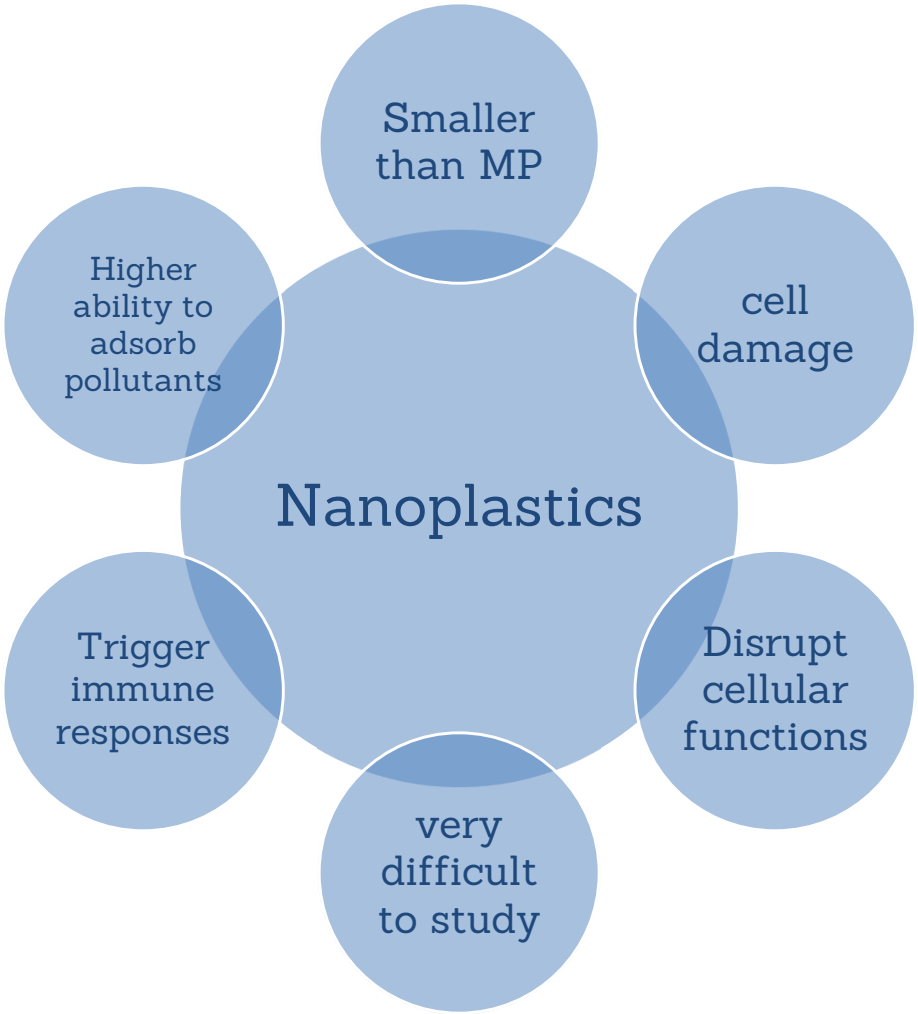
population

- reduce specie number
- reduce biomass



Gallaway et al., 2017. NATURE ECOLOGY & EVOLUTION 1

MICROPLASTICS CAN BE DEGRADED INTO NANOPLASTICS



HOW CAN WE REDUCE THE IMPACT?

Replacing plastic mulch films with bio-based biodegradable films	Use Plastic-Free fertilizers	Circular Economy
Increase recycling rates	Filter Water Sources	Public awareness and education
Improve waste management practices	Policy and Regulation on plastic use in agriculture	Support Research and Innovation

AGRI-PLAST PROJECT

Testing new alternatives to plastic mulches

T0 – Pine bark

T1 - Paper Kraft

T2- Black geotextile

T3 – Black plastic mulch

T4 – Biofilm Kritifel

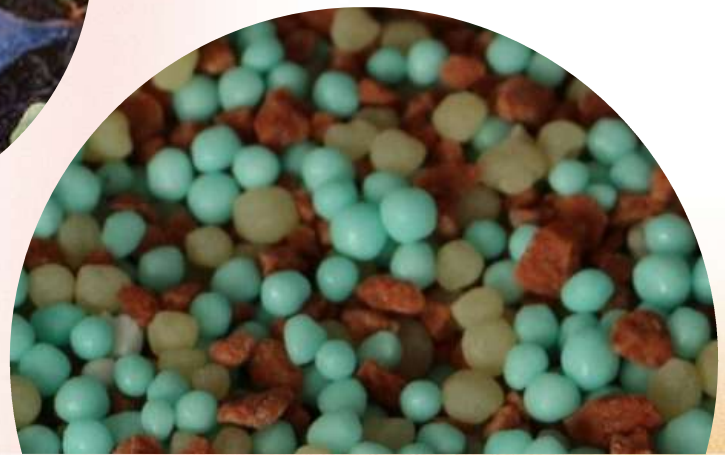
Mapping sources of microplastics in agriculture

Testing biodegradable materials such as paper, pine bark and nature-based biodegradable mulch materials (derived from starch and cellulose)

Monitorize the presence of microplastics in soils, irrigation water and fruits exposed to plastic mulches and their associated additives

Evaluating the soil health biomarkers (nematodes, enzymatic activities))

Evaluating the rootdevelopment of blueberry plants using the mini-rhizotron technique and plant development



THANK YOU!

Contact: joana.antunes@iniav.pt