Planarians as an alternative *in vivo* model to study micro- and nanoparticle-induced neurodevelopmental toxicity

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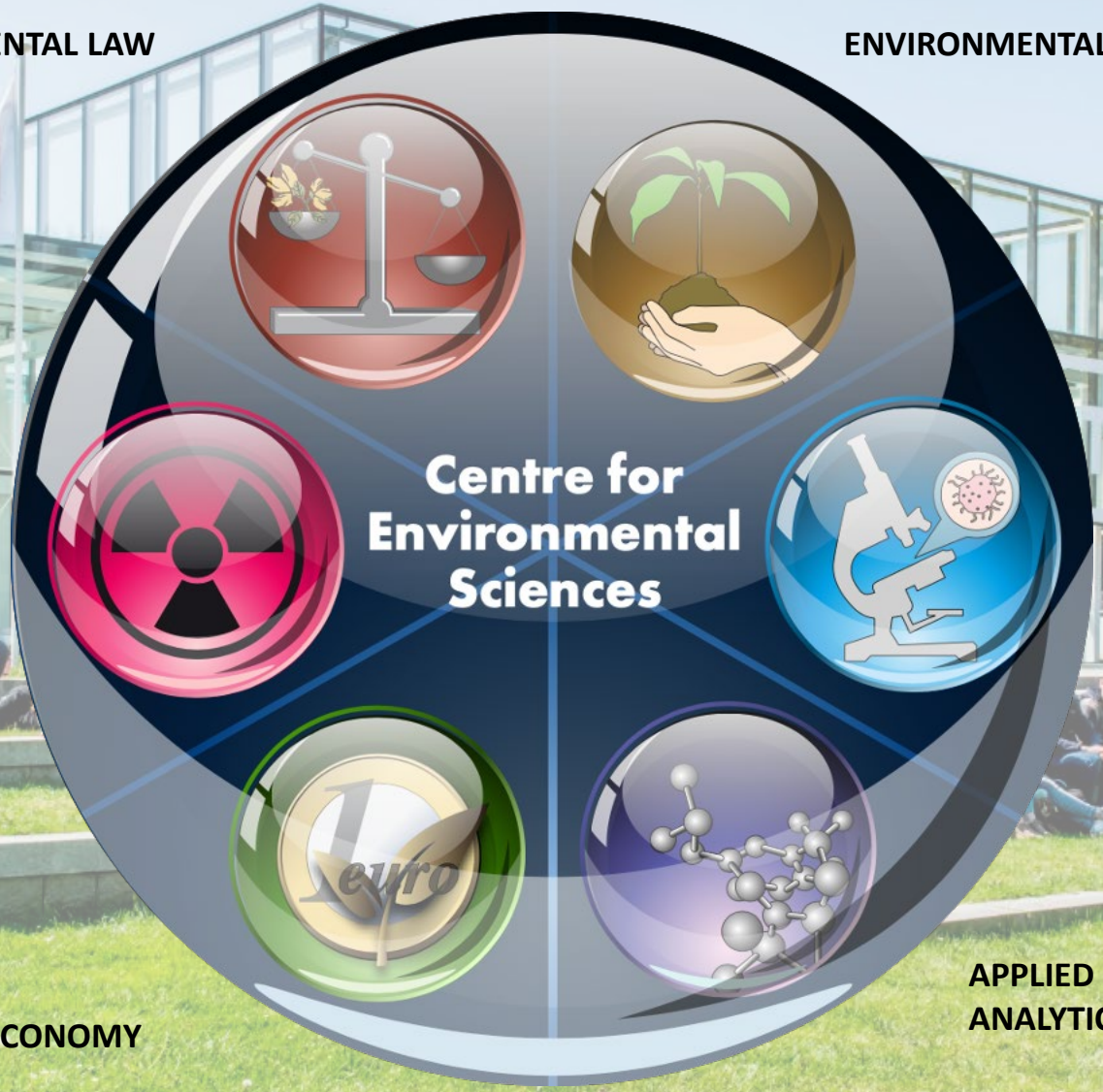


NUCLEAR
TECHNOLOGY

ZOOLOGY:
BIODIVERSITY AND TOXICOLOGY

BiTE Lab

APPLIED AND
ANALYTICAL CHEMISTRY

ENVIRONMENTAL ECONOMY

BiTE Lab | Our mission

Biodiversity **Toxicology** and Ecology

Regeneration

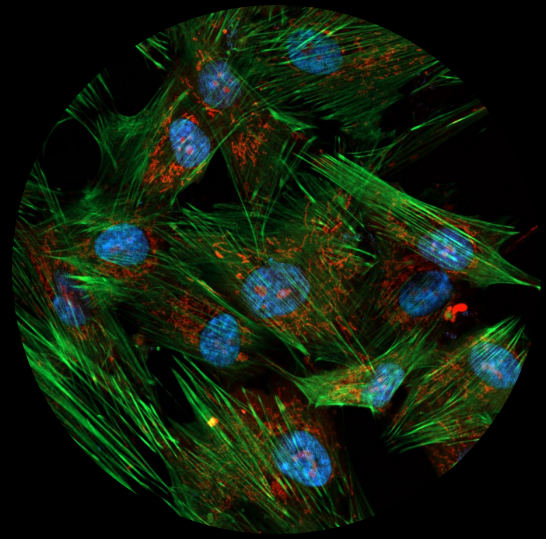
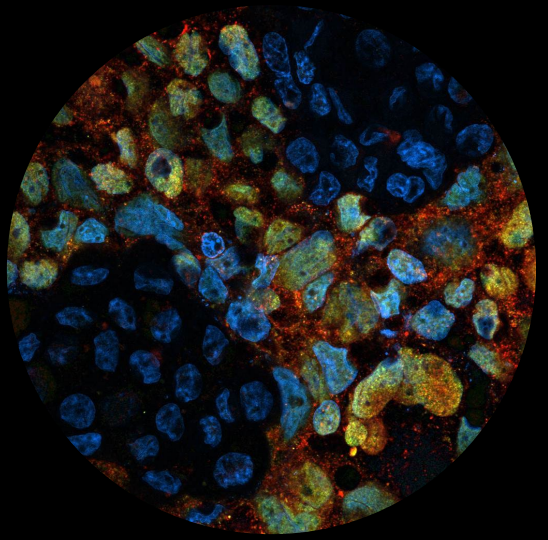
Toxicology

- Session III 15h | **Martijn Heleven**
- Poster A12 | **Charlotte Segnana**
- Poster B05 | **Martijn Heleven**

New emerging pollutants



Integrated toxicity assessment

Alternative models: *in vivo* & *in vitro*

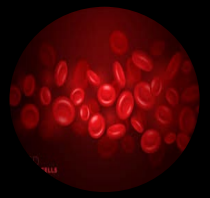
Micro- and nanoparticles | Definition

1 cm

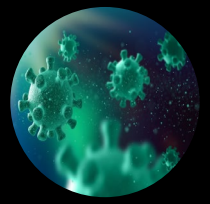
5 mm

1 mm

1 µm



10 µm



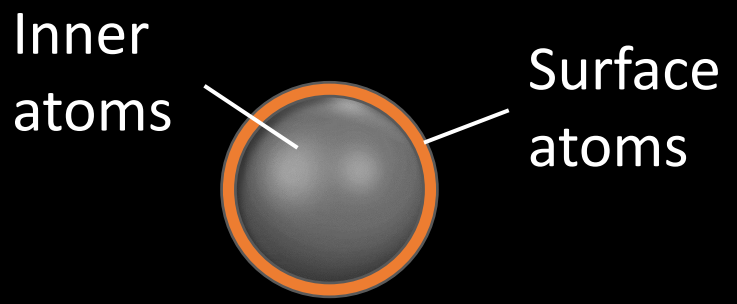
100 nm

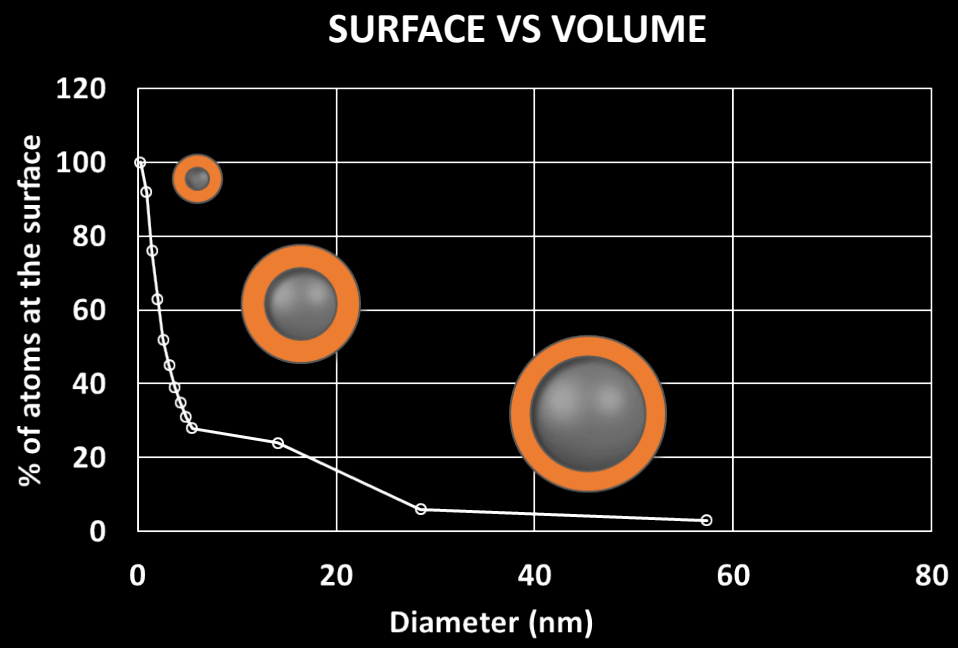
1 nm

0.1 nm

MICRO PARTICLES

NANO PARTICLES





Micro- and nanoparticles | Our focus

Ag-NPs

SiO_2-NPs

MNPs

TiO_2-NPs

FeO_2-NPs

Micro- and nanoparticles | Relevance

TiO_2-NPs
Ag-NPs

Micro- and nanoparticles | Relevance

TiO_2-NPs
SiO_2-NPs
MNPs

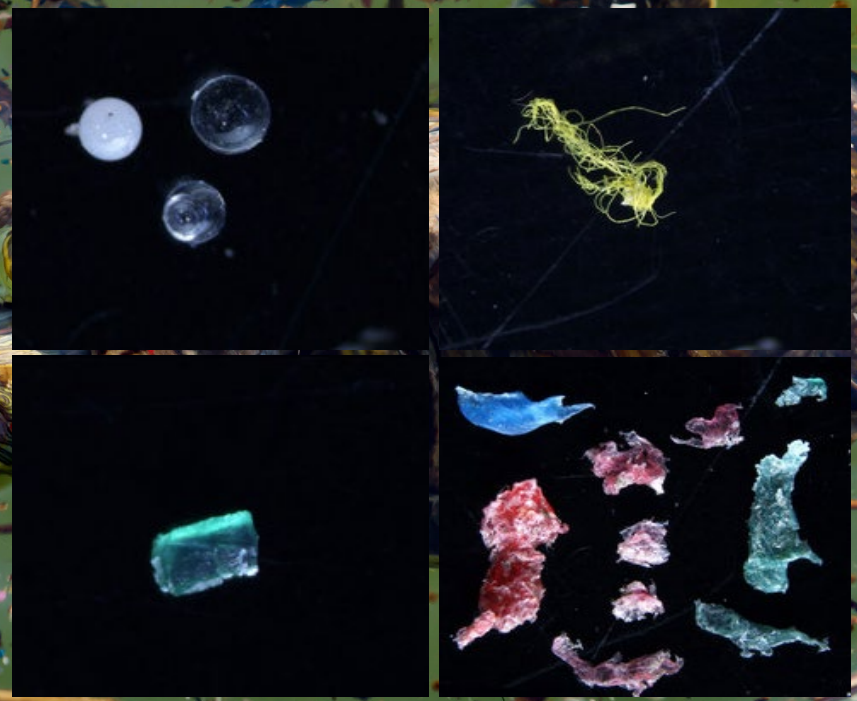
Micro- and nanoparticles | Relevance

Micro- and nanoparticles | Relevance

MATERIAL

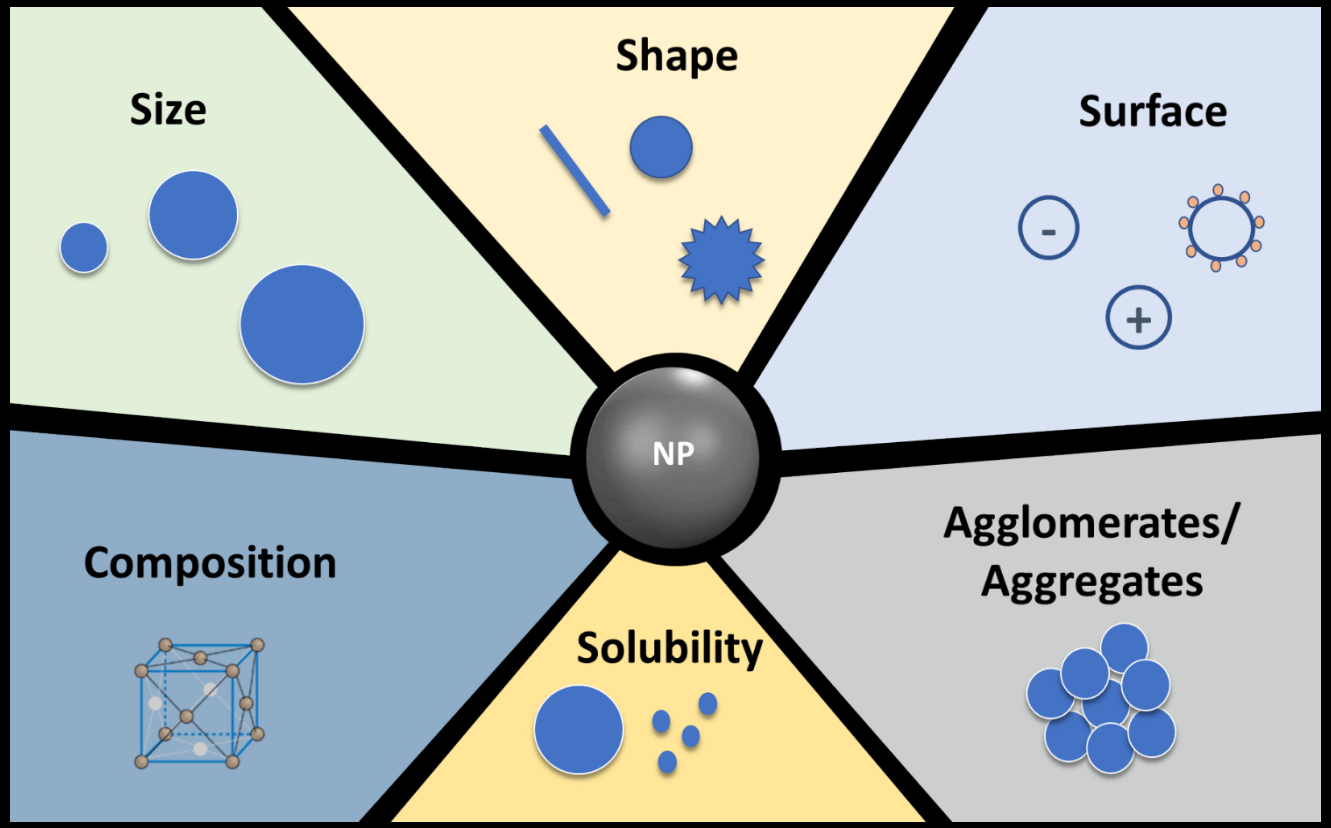
Polyethylene (PE)
Polypropylene (PP)
Polyethylene teraphthalate (PET)
Polyvinyl chlorine (PVC)
Polystyrene (PS)
...

SHAPE



MNPs

Micro- and nanoparticles | Challenges



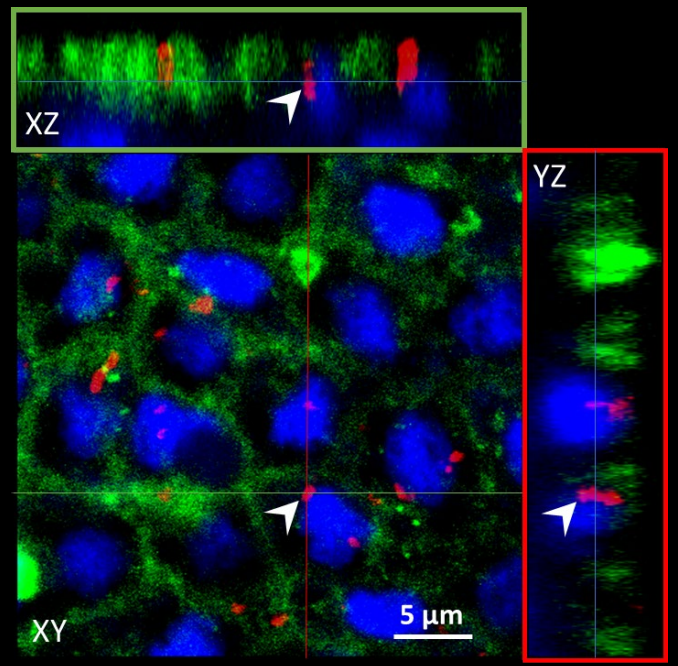
Wide variety of physicochemical characteristics
+ complex adverse outcomes (i.e. neurodevelopmental toxicity)

→ PLANARIANS

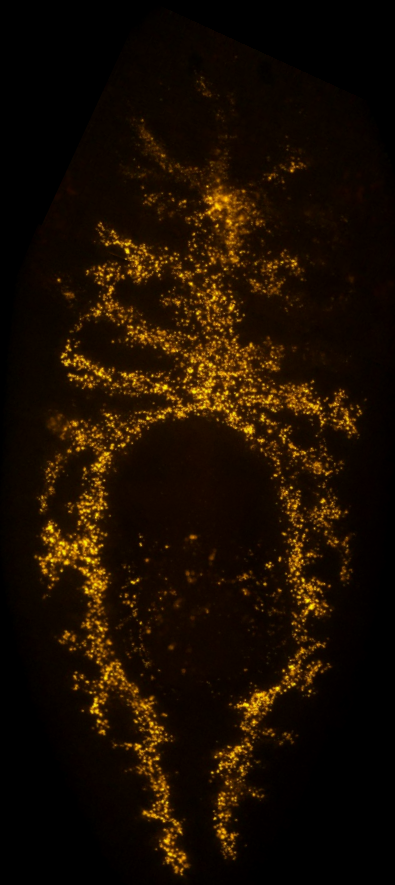
→ Complicates adequate risk assessment and policy making

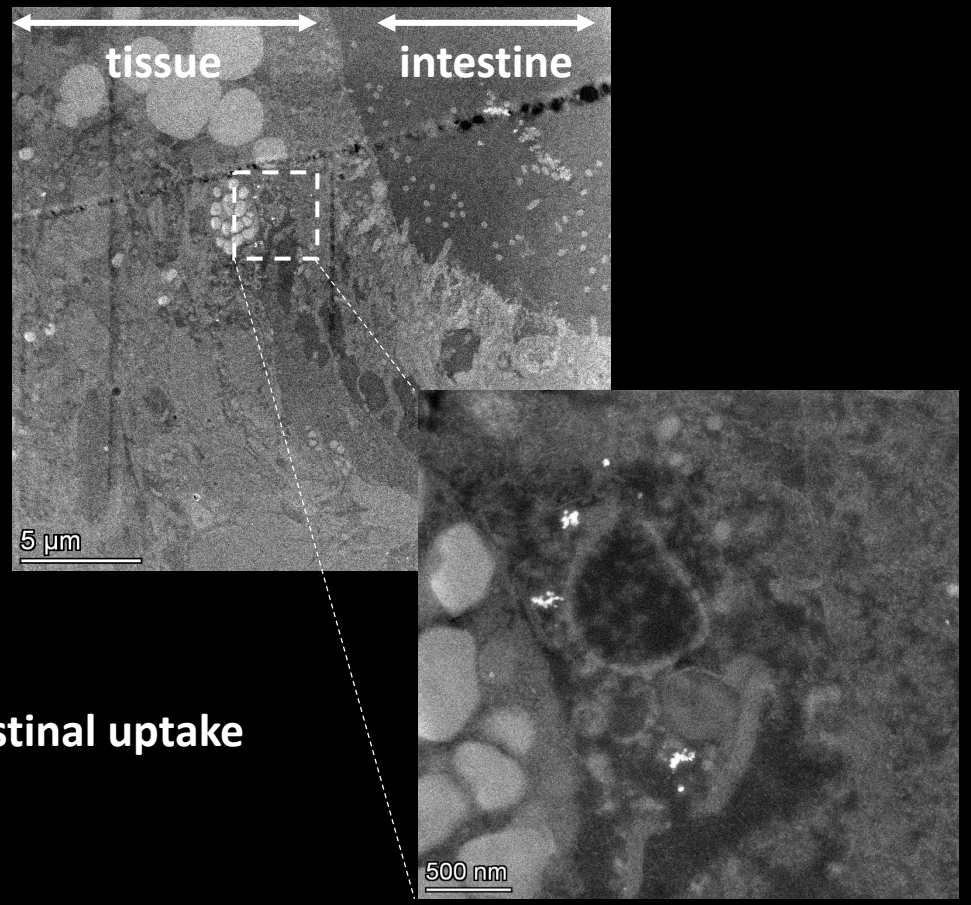
Micro- and nanoparticles | Uptake and tissue location

Epidermal and intestinal uptake: Ag-NPs, TiO_2-NPs and PS-MNPs



Epidermal uptake



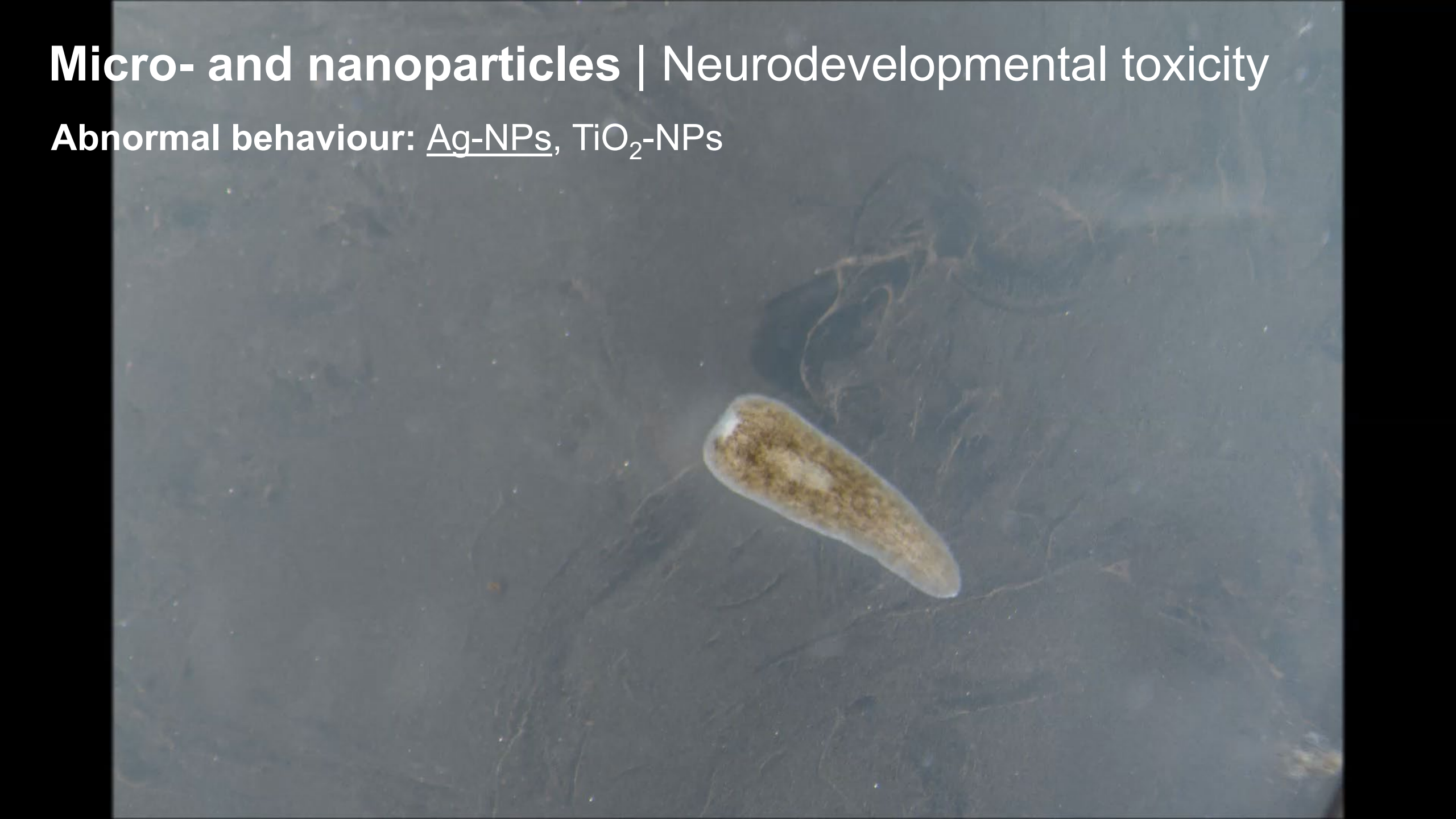


Intestinal uptake

Leynen et al. 2019 (Nanotoxicology)

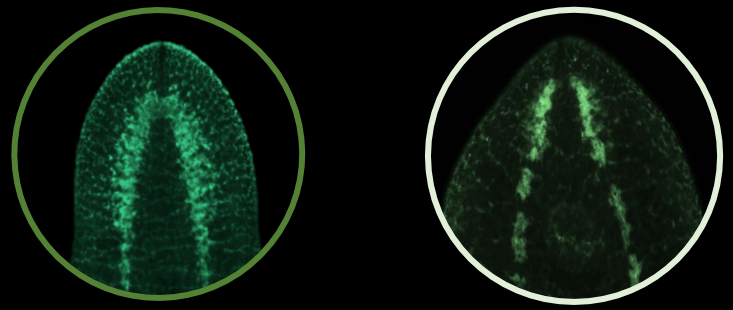
Micro- and nanoparticles | Neurodevelopmental toxicity

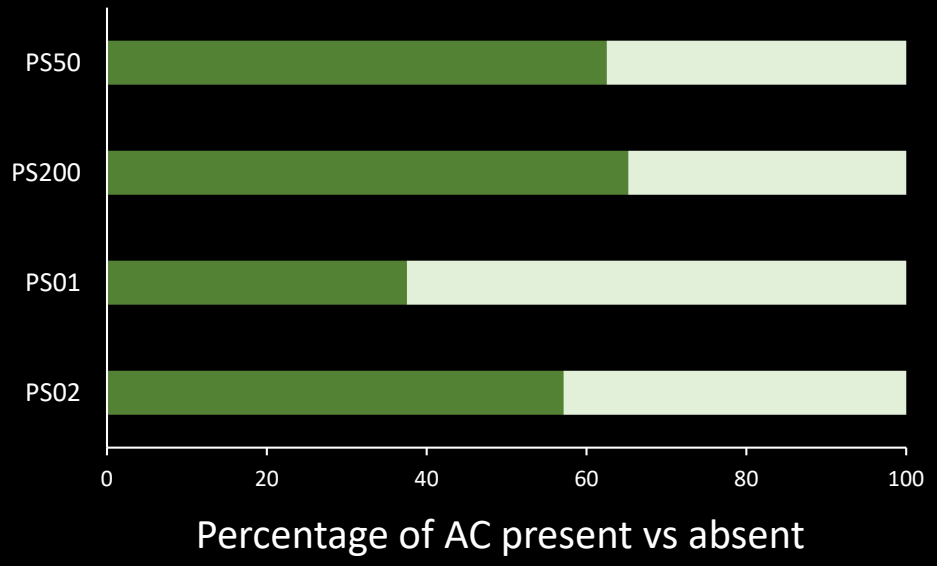
Abnormal behaviour: Ag-NPs, TiO_2-NPs



Micro- and nanoparticles | Neurodevelopmental toxicity

Abnormal neuro- and eye development: Ag-NPs, TiO_2-NPs, PS-MNPs



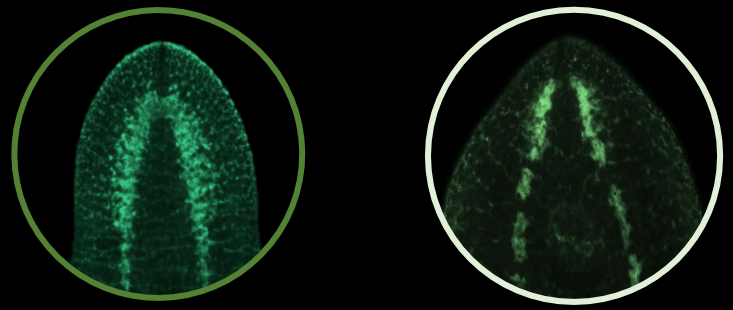


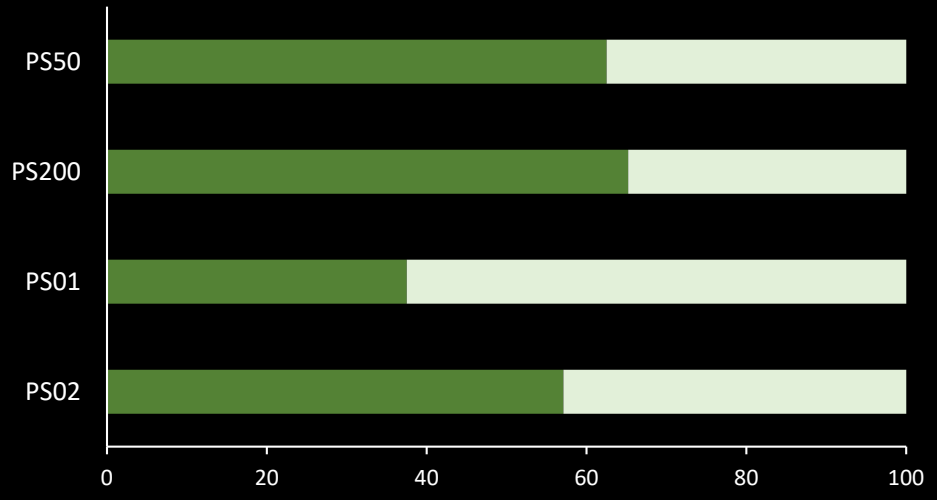
Particle selection
- Polystyrene
- Spherical
- 4 different sizes
  - PS50 – 50 nm
  - PS200 – 200 nm
  - PS01 – 1 µm
  - PS02 – 2 µm

Tytgat et al. (In preparation)

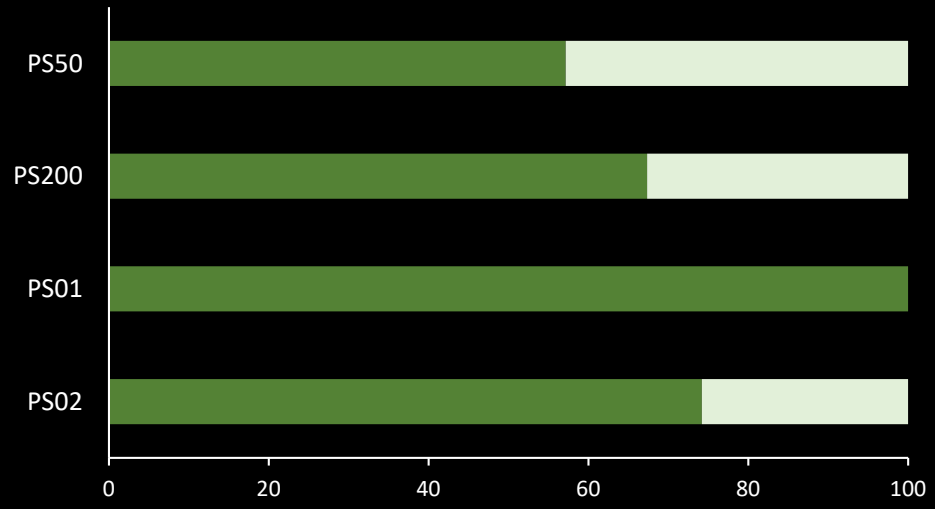
Micro- and nanoparticles | Neurodevelopmental toxicity

Abnormal neuro- and eye development: Ag-NPs, TiO_2-NPs, PS-MNPs





Percentage of AC present vs absent

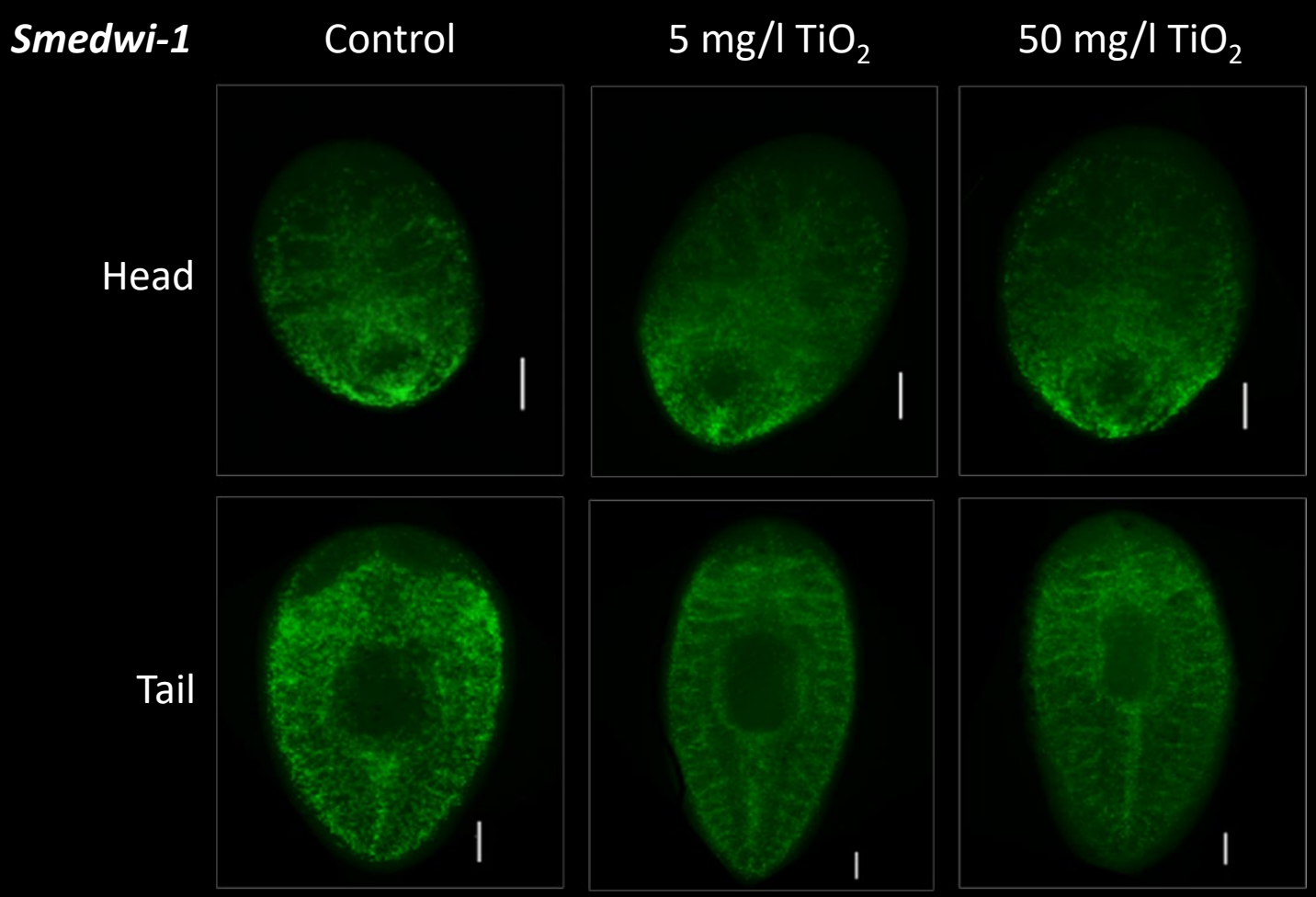


Percentage of eyes present vs absent

Tytgat et al. (In preparation)

Micro- and nanoparticles | Neurodevelopmental toxicity

Affected stem cell dynamics: Ag-NPs, TiO_2-NPs, PS-MNPs



Leynen, Tytgat et al. 2024 (Aquatic toxicology)

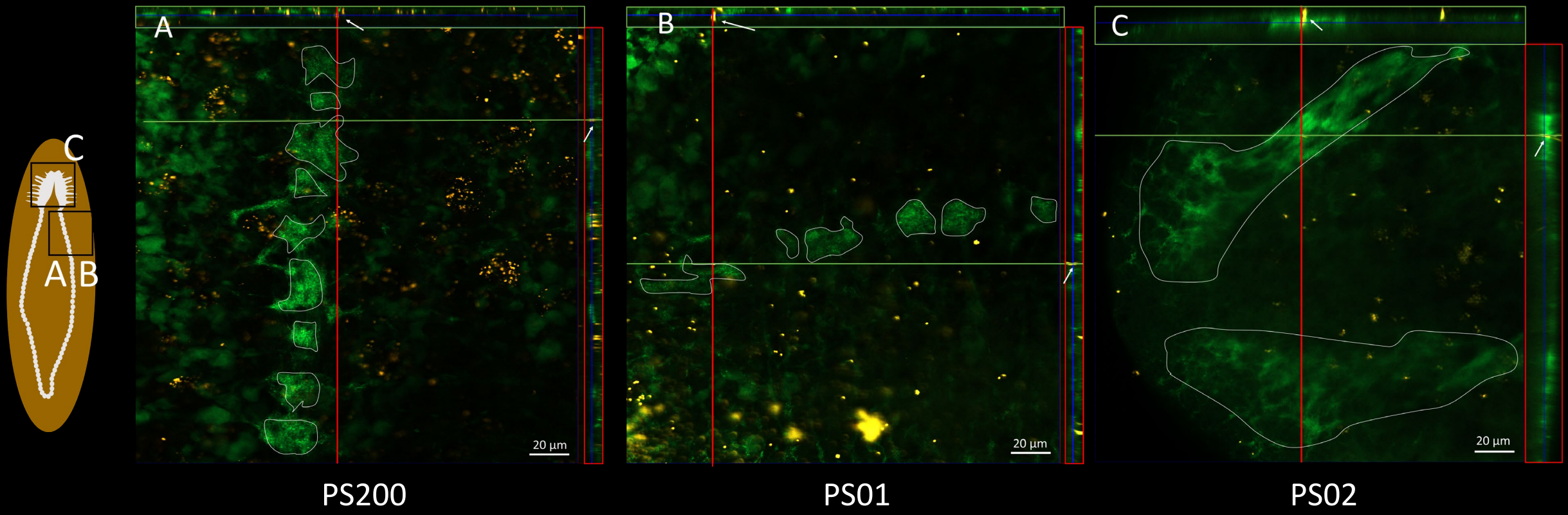
Ag-NPs
↙ SC number (*Smedwi-1*)
↙ SC proliferation (*H3P*)
↙ SC differentation (*NB21.11e-*)

TiO_2-NPs
↙ SC proliferation
↙ SC differentation

PS-MNPs
↙ SC differentation

Micro- and nanoparticles | Uptake

Neuronal uptake: PS-MNPs

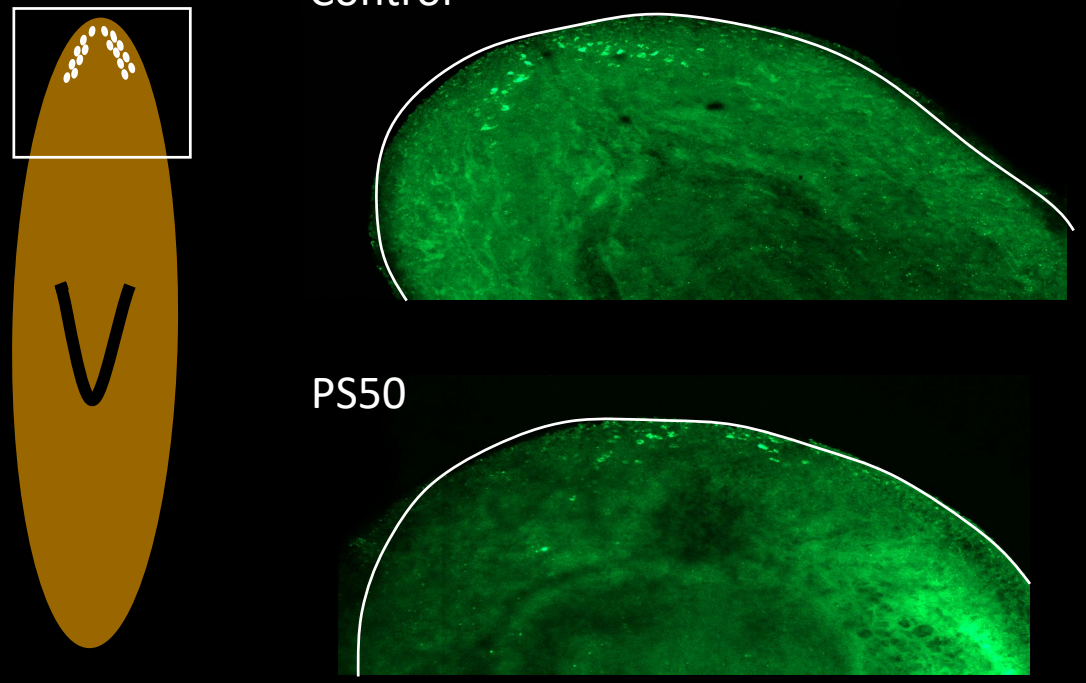


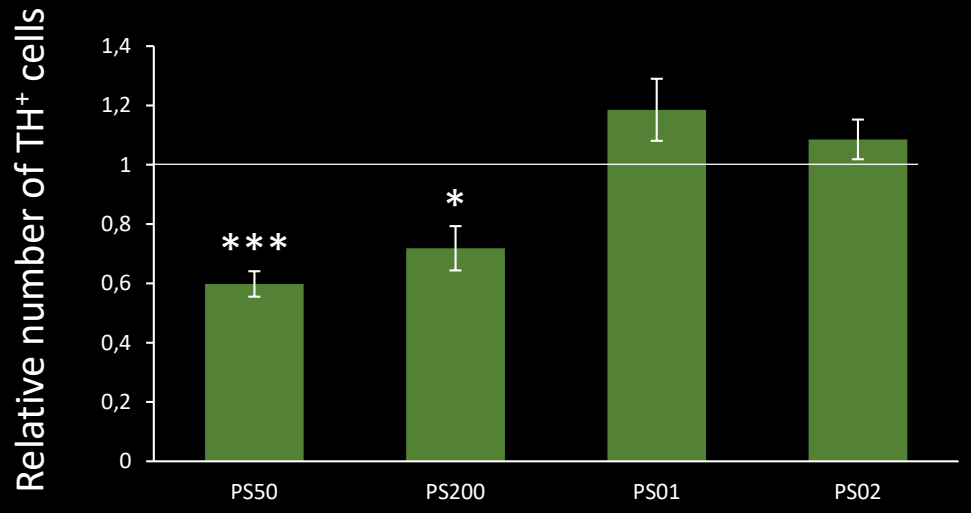
PS200 PS01 PS02

Tytgat et al. (In preparation)

Micro- and nanoparticles | Neurodevelopmental toxicity

Delayed dopaminergic neuron formation: PS-MNPs

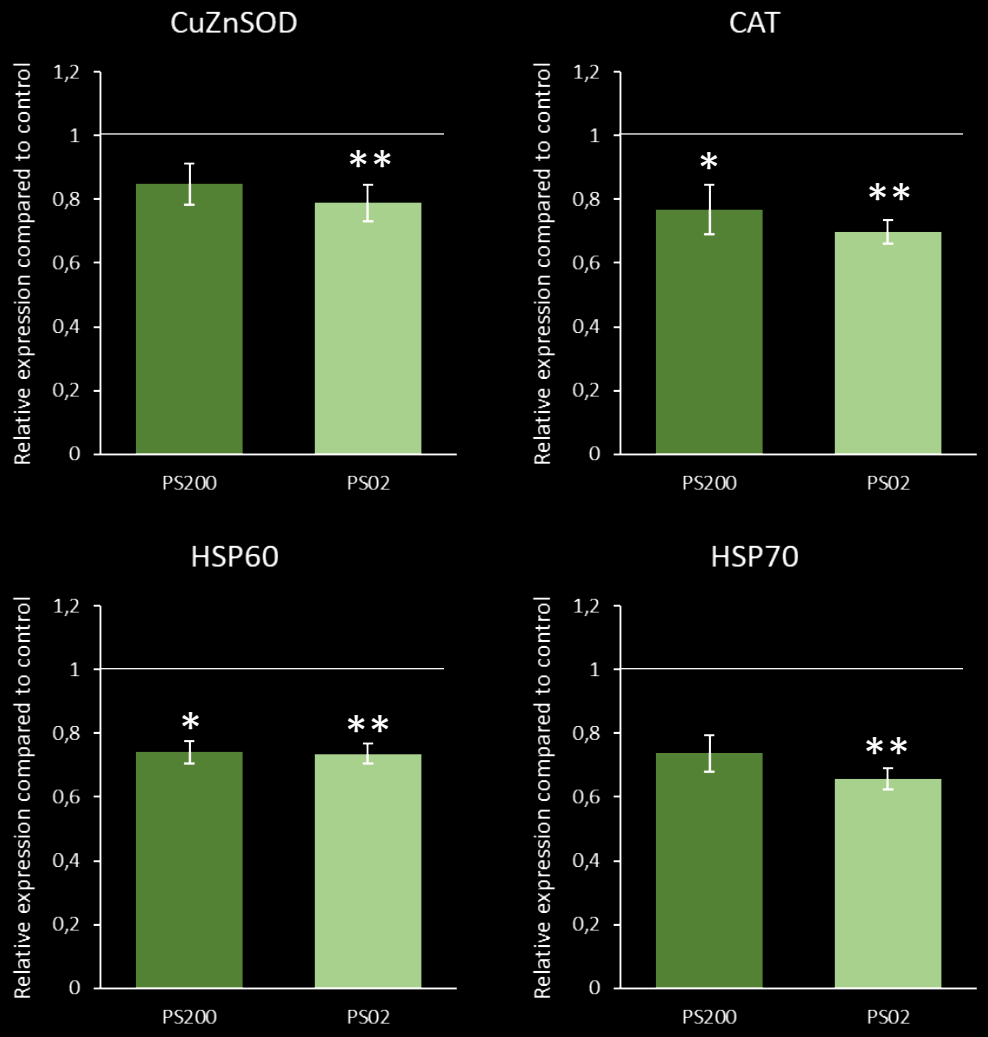




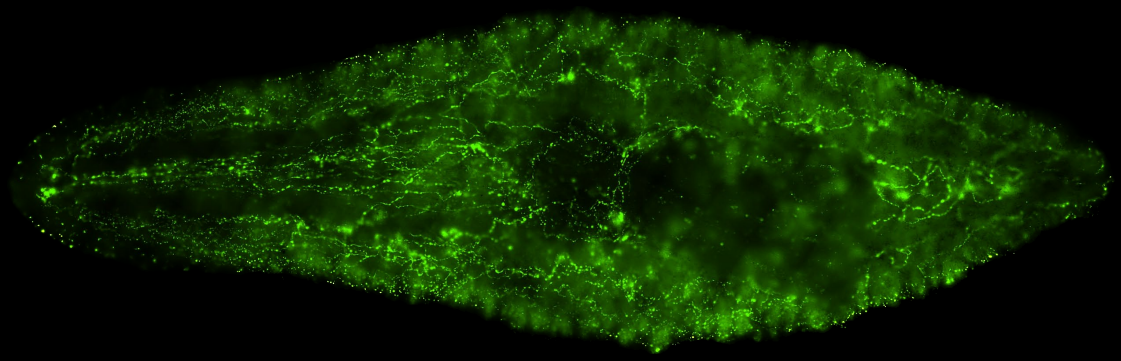
Tytgat et al. (In preparation)

Micro- and nanoparticles | Neurodevelopmental toxicity

Search for in-depth mechanistic insights: PS-MNPs



Tytgat et al. (In preparation)

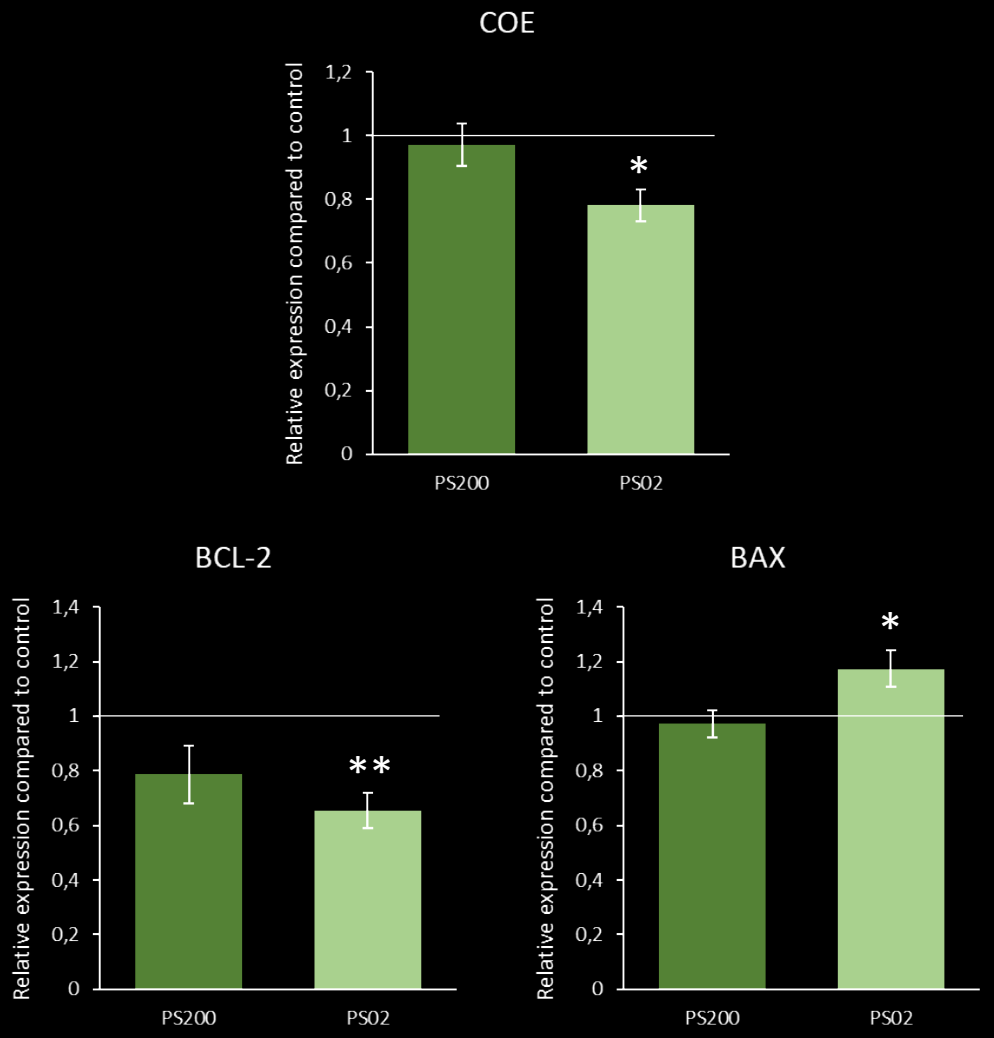


Activation riboflavin containing neuron-like strands

→ Poster B05 | **Martijn Heleven**

Micro- and nanoparticles | Neurodevelopmental toxicity

Search for in-depth mechanistic insights: PS-MNPs



Tytgat et al. (In preparation)

Summary and outlook

Micro- and nanoparticles cause neurodevelopmental toxicity in planarians

We are working towards understanding the in-depth toxicity mechanisms:

→ Related to redox and stem cell dynamics

→ Include particle characteristics

Future: link the detailled cellular location of particles with toxicity outcomes

E.g. particles close to mitochondria → mitochondrial damage → oxidative stress

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General conclusion

The wide variety of micro- and nanoparticle characteristics complicates adequate risk assessment, toxicological advice and policy making.

Planarians allow to study complex adverse outcomes in-depth, including micro- and nanoparticle induced neurodevelopmental toxicity

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Acknowledgements

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