Host-genotype dependent gut microbiota drives zooplankton tolerance to toxic cyanobacteria

Lab of applied microbiology
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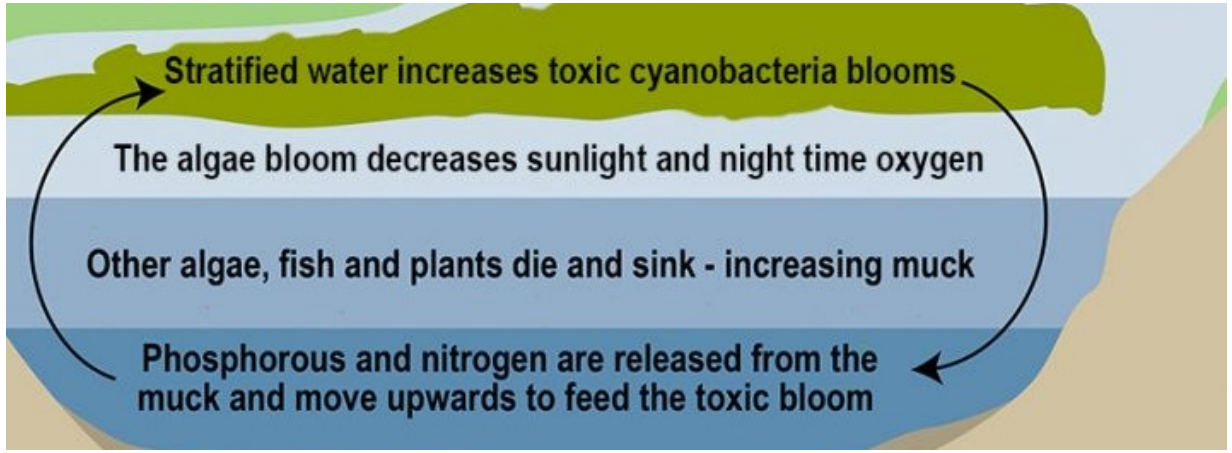
2026.03.12

❖ Algal blooms negatively impact aquatic ecosystems

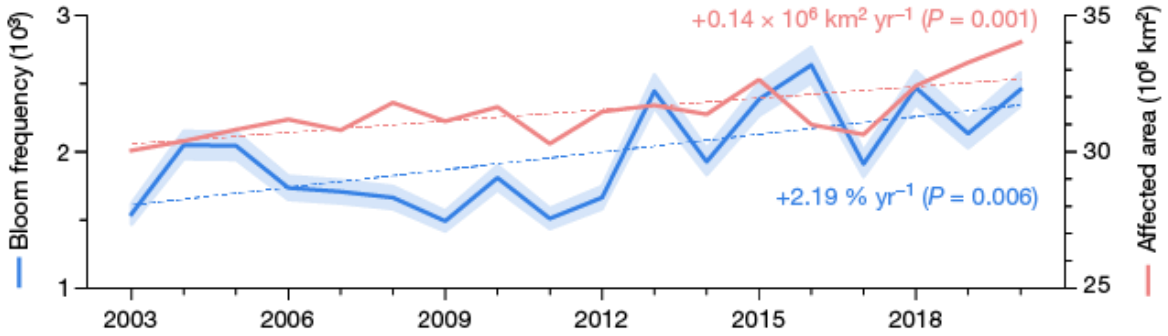
Algal bloom

- Rapid overgrowth of algae or cyanobacteria in aquatic systems

Algal bloom cycle



Increasing frequency of algal blooms

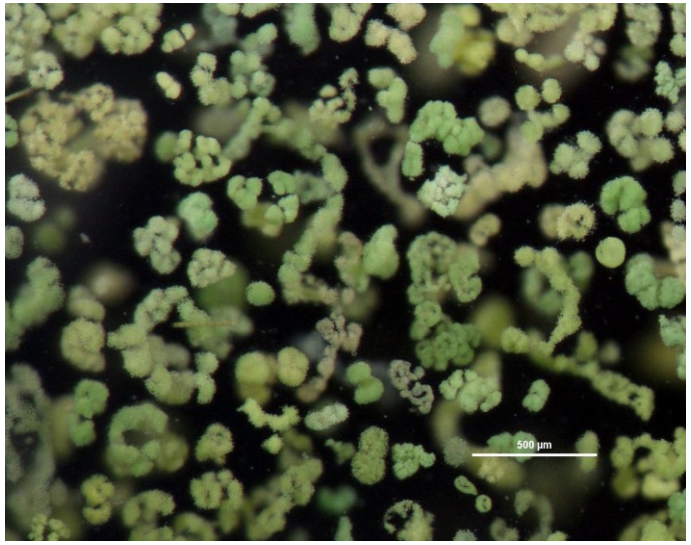


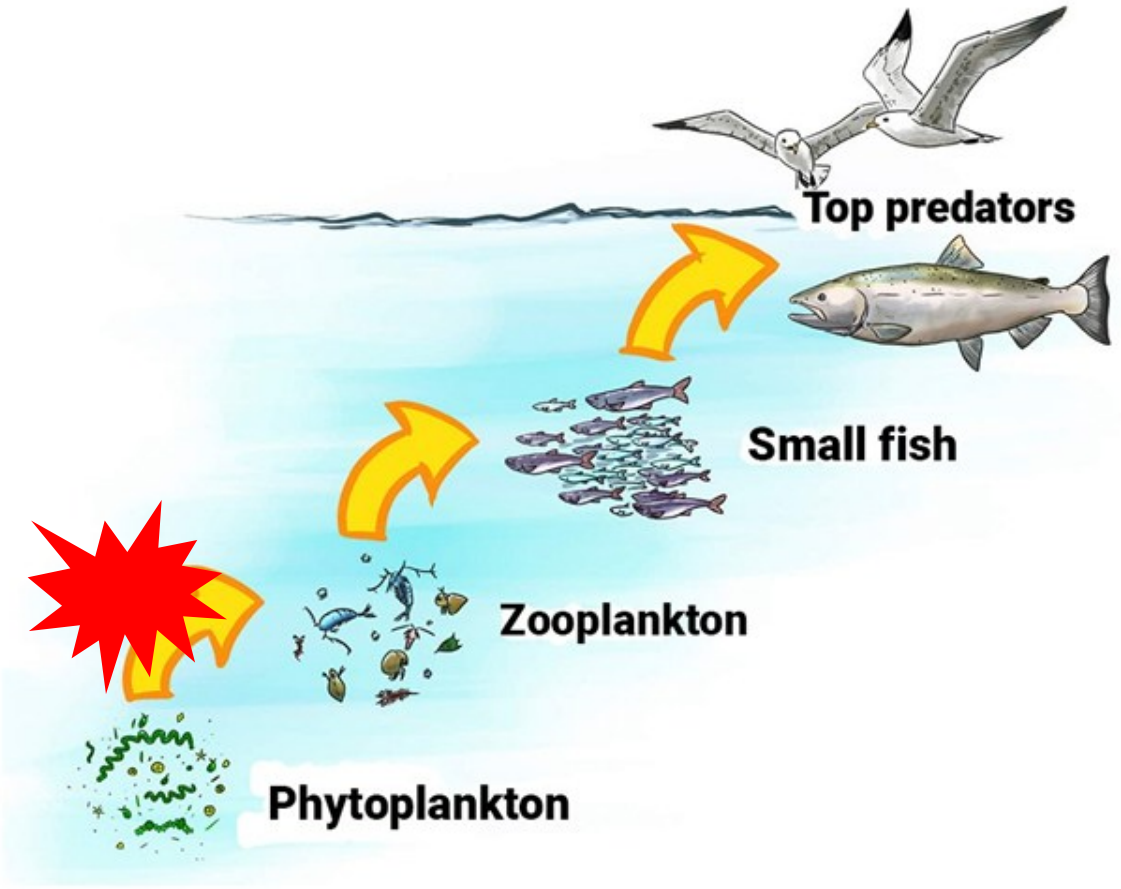
http://websolutions.klassisk.newsroom.cision.com/releasedetail.html?solving-the-blue-green-algae-problem-mechanical-circulation-as-a-way-to-win-the-algae-battle&releaseIdentifier=29E9E1653CDF6012
https://www.shimadzu.eu/industries/environment/water-analysis/algal-bloom/index.html

❖ Algal blooms negatively impact aquatic ecosystems

Microcystis aeruginosa

- Primary causative cyanobacteria of algal blooms
- Produces the potent hepatotoxin microcystin



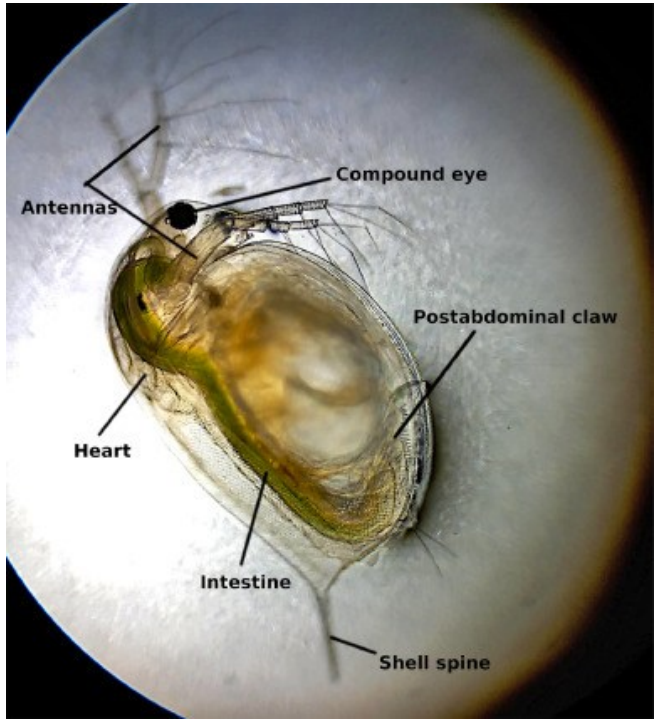


➢ Understanding zooplankton tolerance to toxic cyanobacteria is key to predicting the ecological impacts of algal blooms.

https://biology4me.weebly.com/sc912l172-aquatic-ecosystems.html
https://www.shimadzu.eu/industries/environment/water-analysis/algal-bloom/index.html

❖ Test organism and research objective

Daphnia magna



- A major grazer of phytoplankton
- Parthenogenetic reproduction
  → genetically identical clones
- Sensitive to various chemicals

Background

- Gut microbiota associated with *Daphnia magna* may influence host physiological traits.
- They also have the potential to contribute to adaptation to environmental stress.

Approach

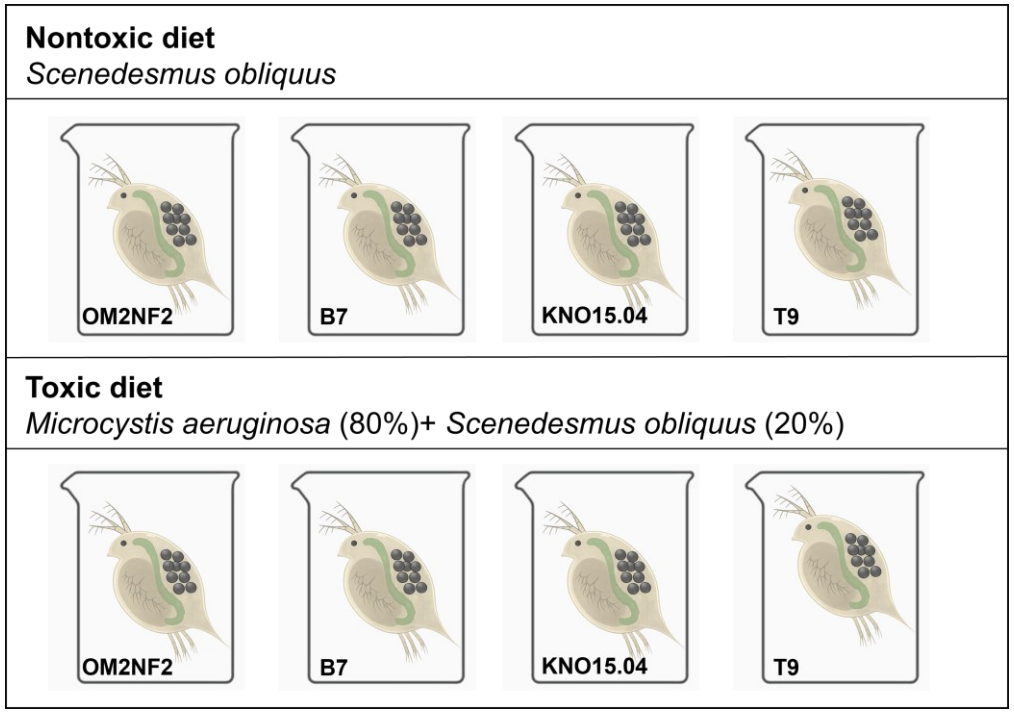
- Gut microbiota transplantation + metagenomic analysis

Objective

- To determine whether tolerance to toxic cyanobacteria in Daphnia magna is mediated by gut microbiota.

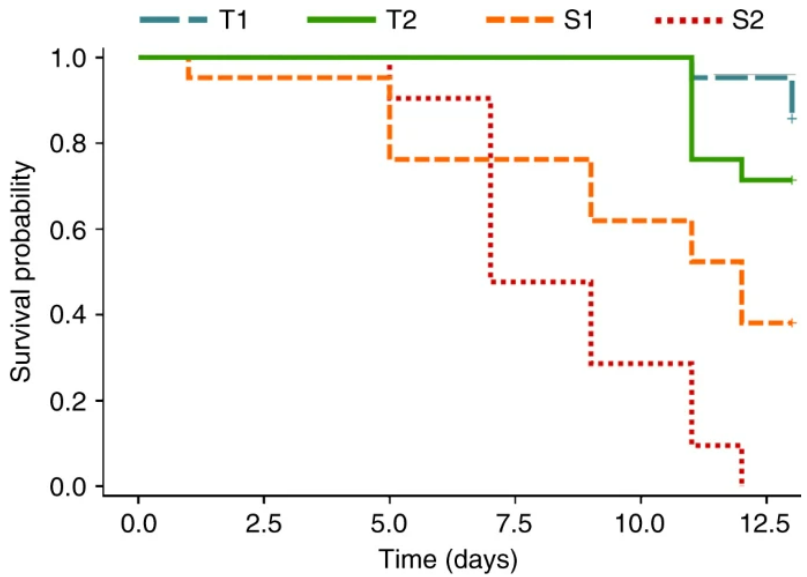
❖ Survival of *Daphnia magna* depending on genotype

- Exposure to toxic and non-toxic diets for two weeks



Survival rate assessment

- Survival rate under a toxic diet

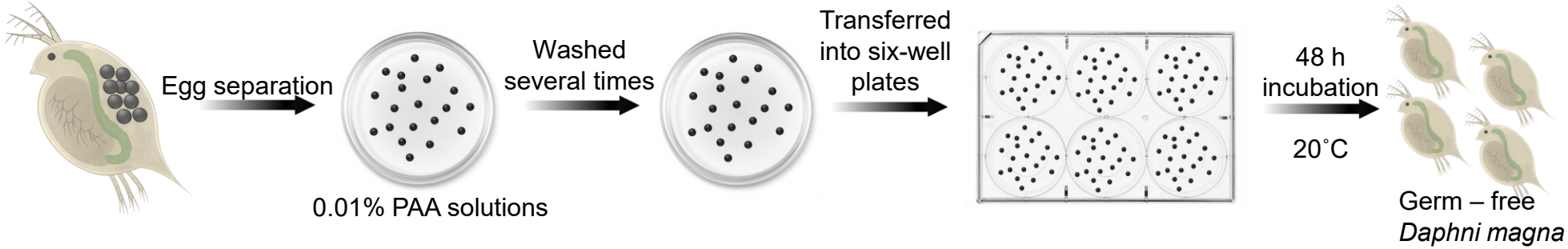


- S/T grouping based on survival rate

Genotype	Tolerance to toxic cyanobacteria	Abbreviation
OM2NF2	Susceptible	S1
B7	Susceptible	S2
KNO15.04	Tolerant	T1
T9	Tolerant	T2

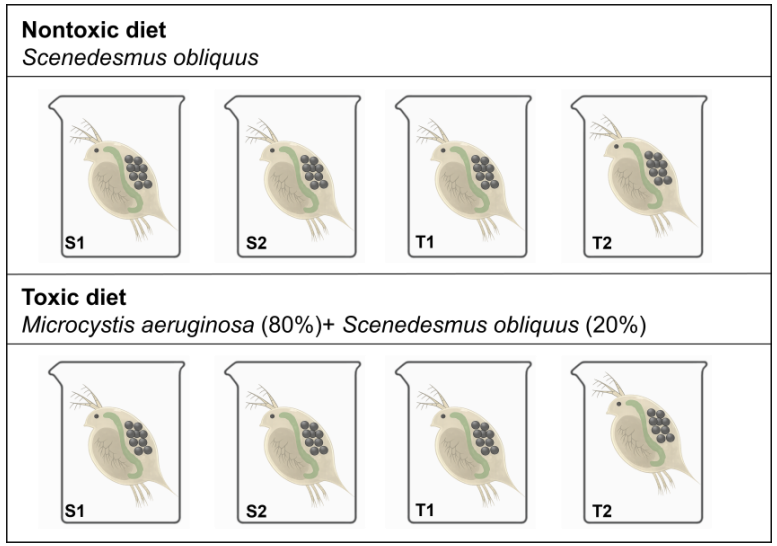
❖ Gut microbiota transplant to test its role in cyanobacteria tolerance

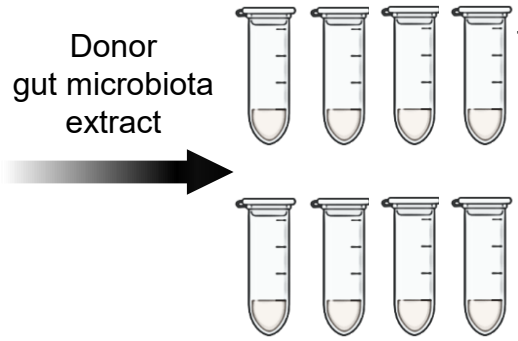
Preparation of germ-free *Daphnia magna*



Donor group

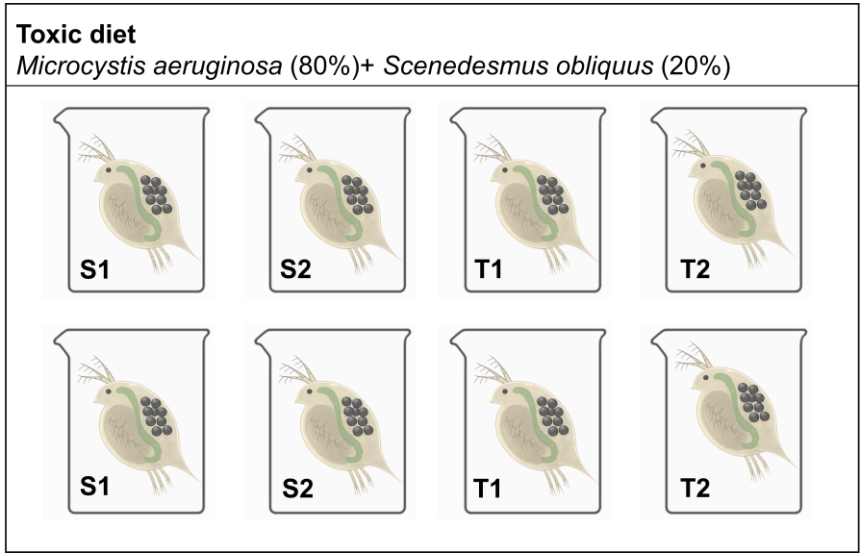
Six - months exposure (12 generations) to toxic/non-toxic diets



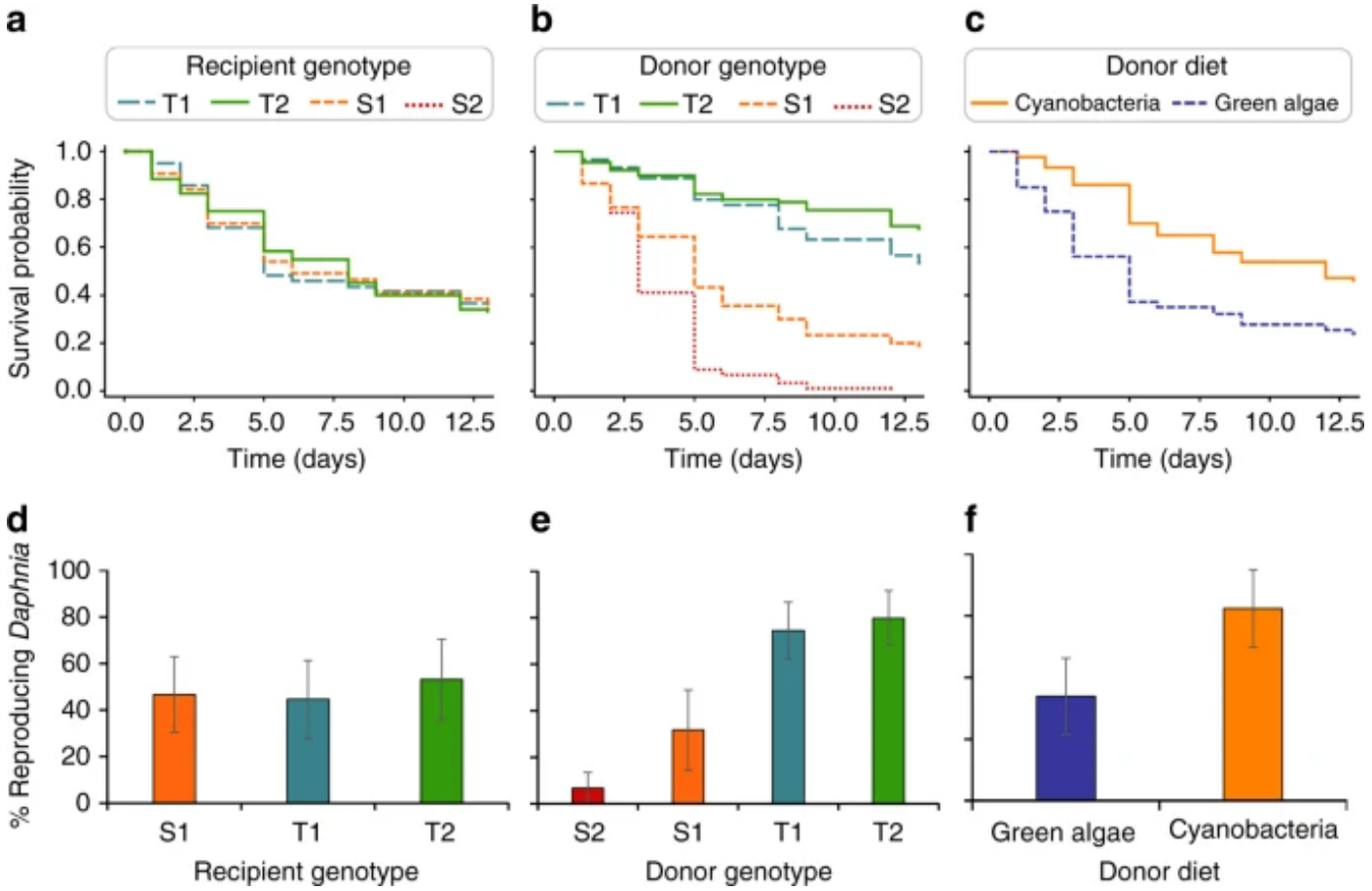


Recipient group

Two - weeks exposure to toxic diets



❖ Gut microbiota transplant to test its role in cyanobacteria tolerance

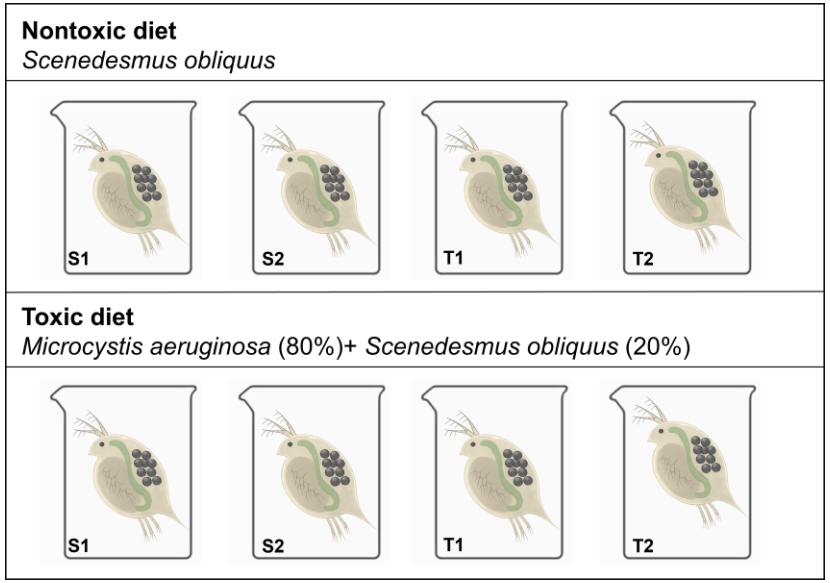


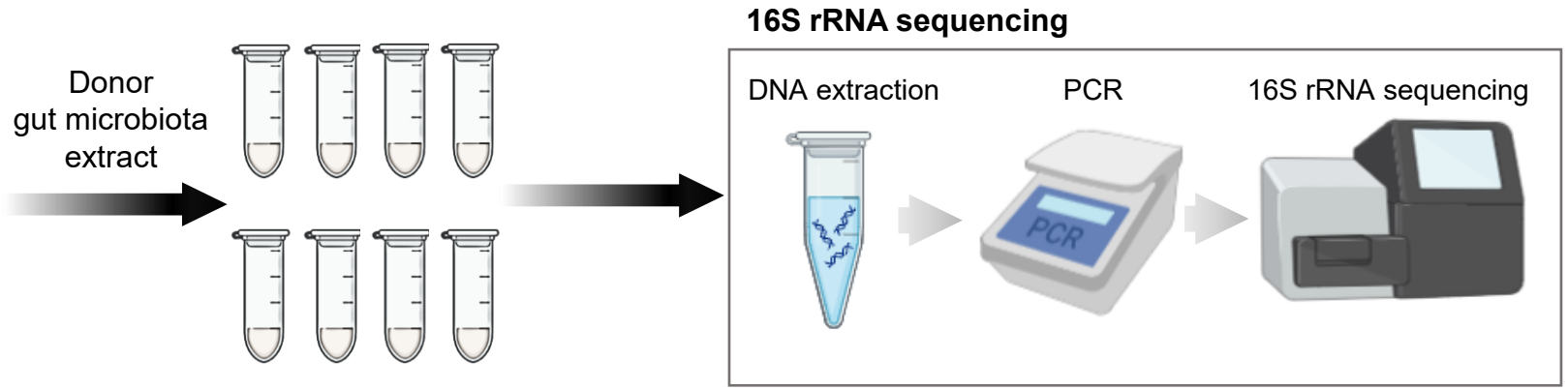
➢ Tolerance depends on donor genotype–associated gut microbiota, not host genotype.

❖ Microbial community analysis of genotype and diet effects on gut microbiota

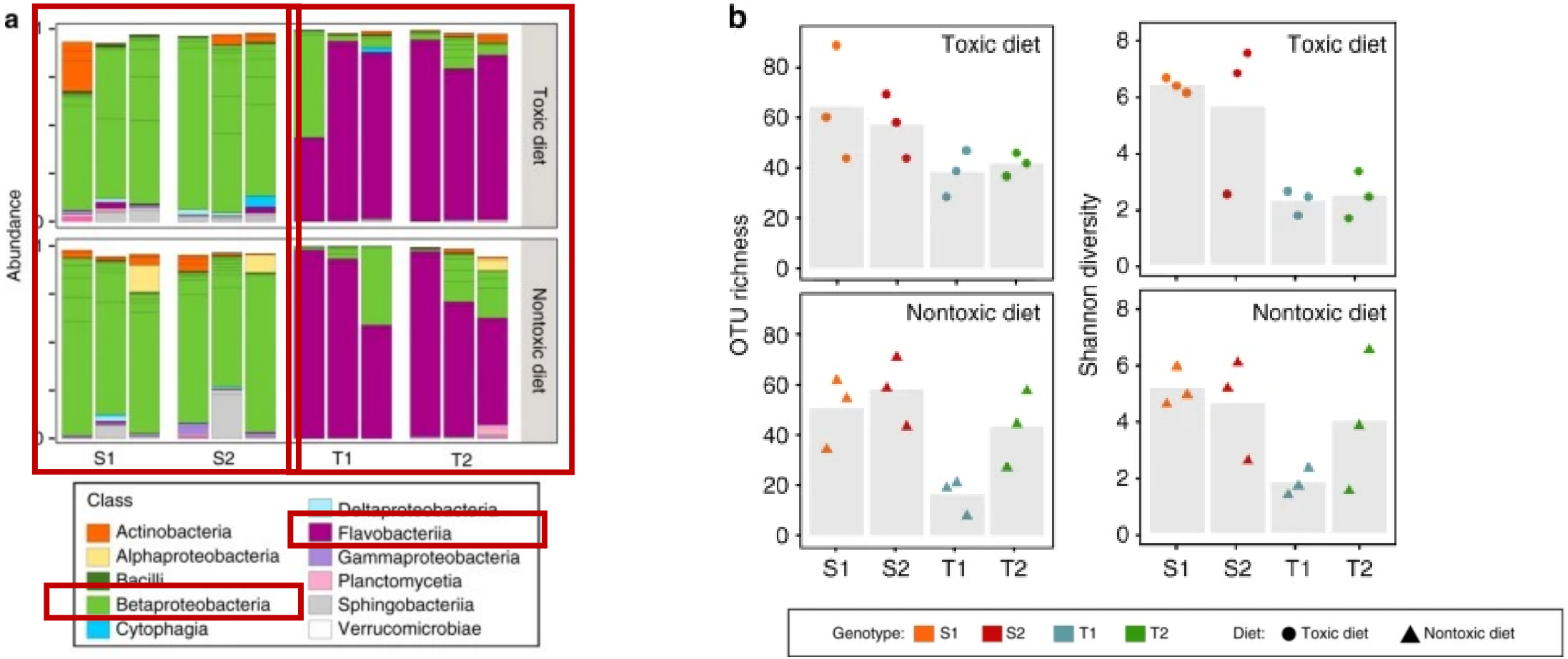
Donor group

Six - months exposure (12 generations) to toxic/non-toxic diets





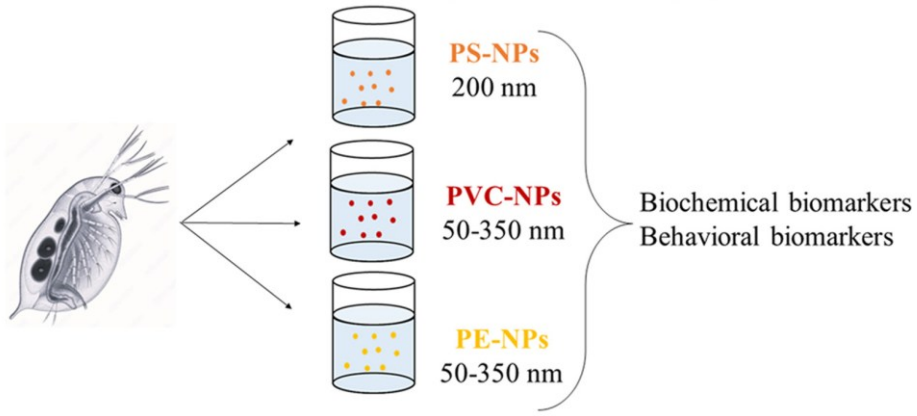
❖ Microbial community analysis of genotype and diet effects on gut microbiota

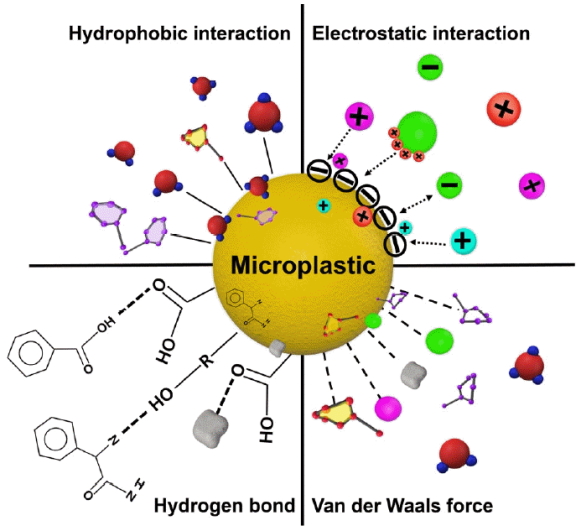


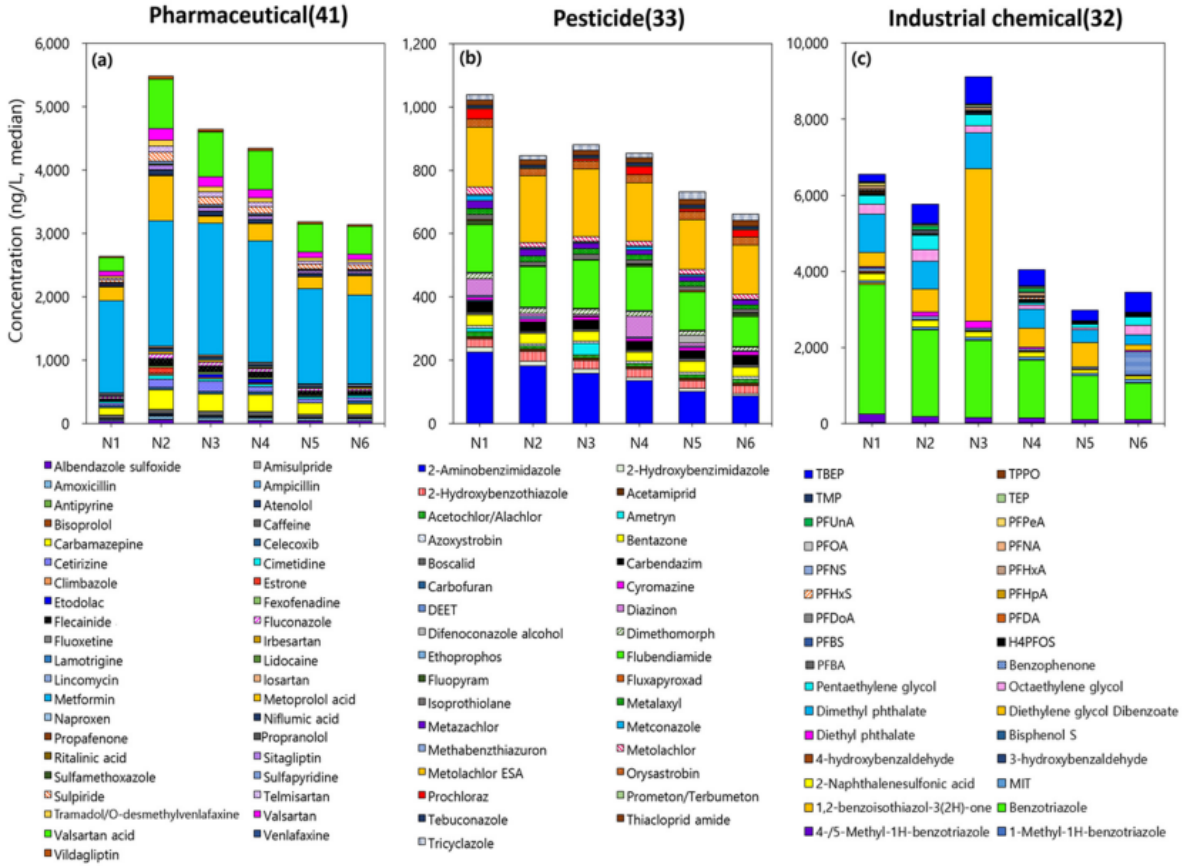
➢ Gut microbiota taxonomic composition is driven more by host genotype than diet.

- Tolerance to toxic cyanobacteria is primarily mediated by the gut microbiota.
- Host genotype is a major determinant of gut microbiota composition, thereby influencing cyanobacterial tolerance.
- Dietary conditions influence microbiota functional responses rather than taxonomic structure, contributing to host adaptation.
- Overall, the gut microbiota emerges as a key driver of host adaptation to environmental stress.

❖ Microplastic–mediated alteration of gut microbiome and toxicity in *Daphnia magna* under realistic freshwater exposure conditions





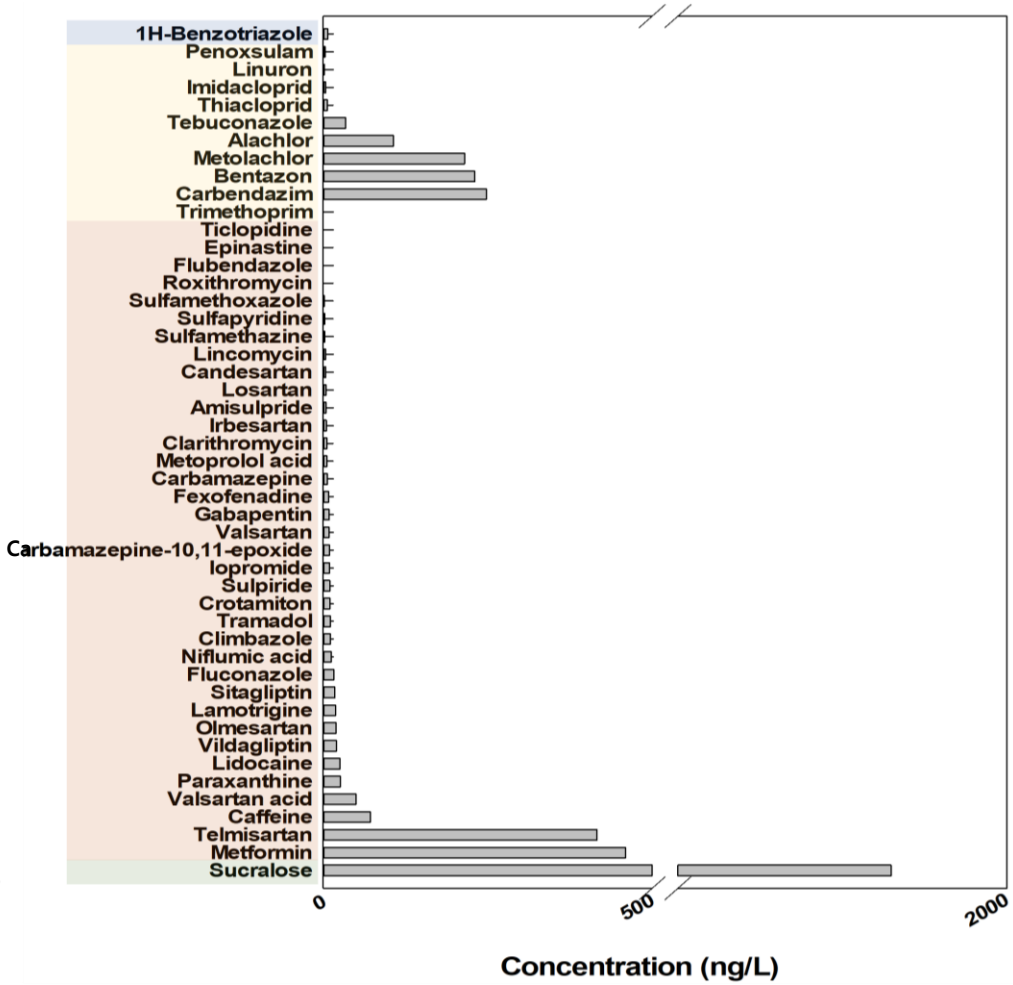


박나리, 강대호, 전준호. (2021). 낙동강 중하류에서의 미량오염물질 출현 및 농도. 환경분석과 독성보건, 24(1), 1-12.
김보경, 김남연, 이은희. (2023). 수 환경 속 미세플라스틱의 다양한 오염물질 흡착 거동 및 생태독성. 대한환경공학회지, 45(11), 528-539.
Andrea et. al. Sublethal effects induced by different plastic nano-sized particles in Daphnia magna at environmentally relevant concentrations, Environmental Pollution, Volume 343, 2024

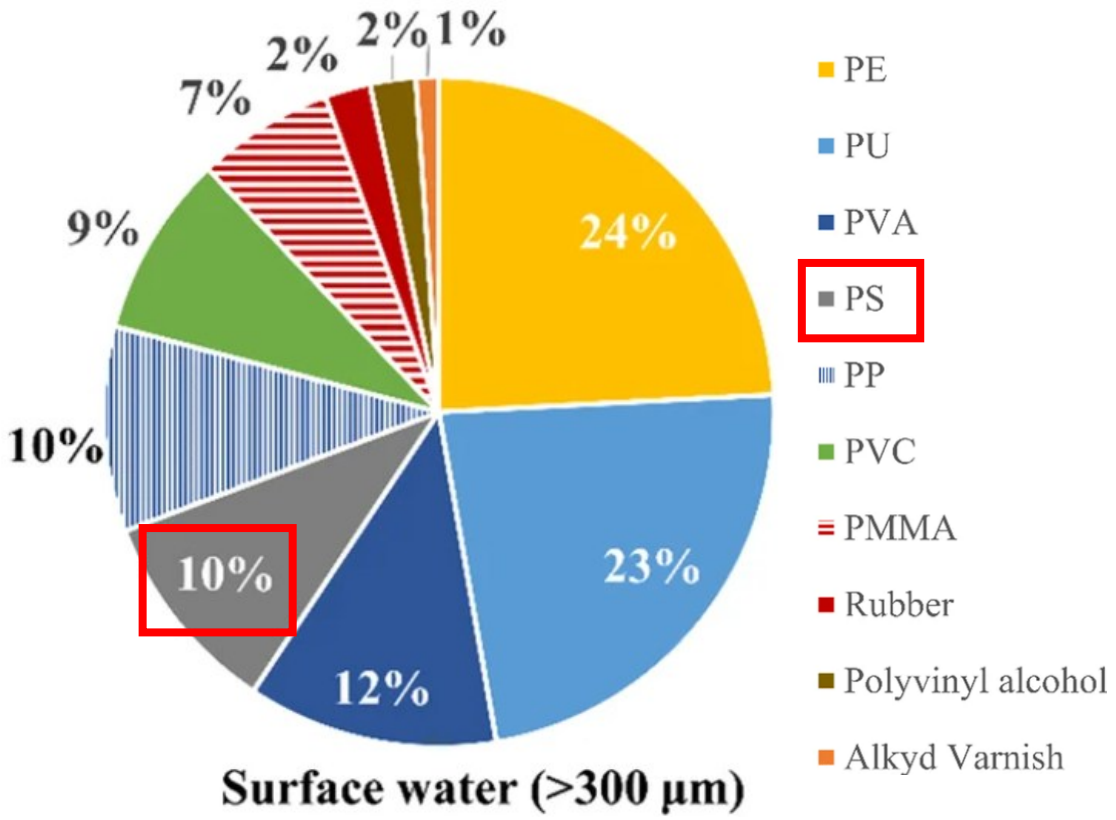
❖ Freshwater sampling and micropollutant analysis

Sampling from 10 sites along Oncheon stream, Busan

Suspect & Non-Target Screening (SNTS) analysis

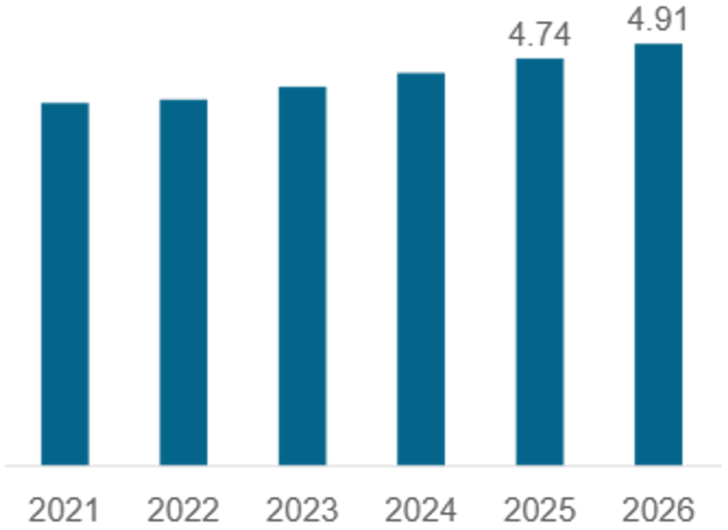


❖ Environmental occurrence of microplastics



❖ Polystyrene

Asia pacific polystyrene market size



https://www.hotwiresystems.com/what-is-polystyrene-eps-xps-different-uses-of-polystyrene/

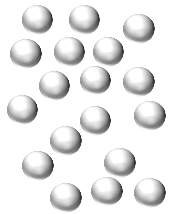
Bao, M., Huang, Q., Lu, Z. *et al.* Investigation of microplastic pollution in Arctic fjord water: a case study of Rijpfjorden, Northern Svalbard. *Environ Sci Pollut Res* **29**, 56525–56534 (2022)

폴리스티렌 시장 규모, 점유율 및 성장 | 글로벌 리포트 [2034]

❖ Interactions between polystyrene nanoparticles and micropollutants

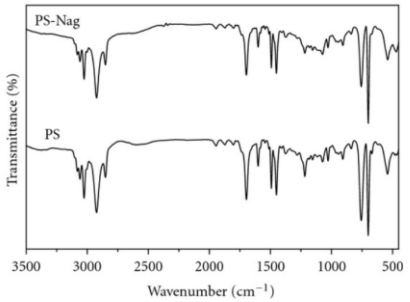
Fresh water sample

Polystyrene nanoparticle (PS-NP)

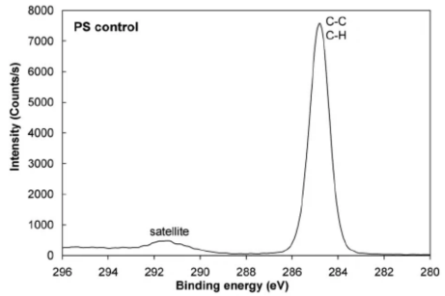


PS-NP – Fresh water interaction

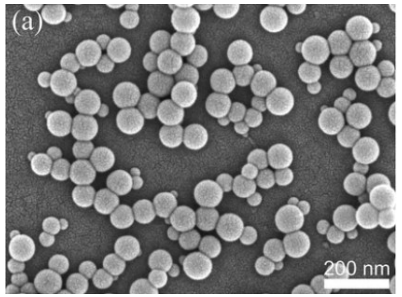
FT-IR



XPS



SEM



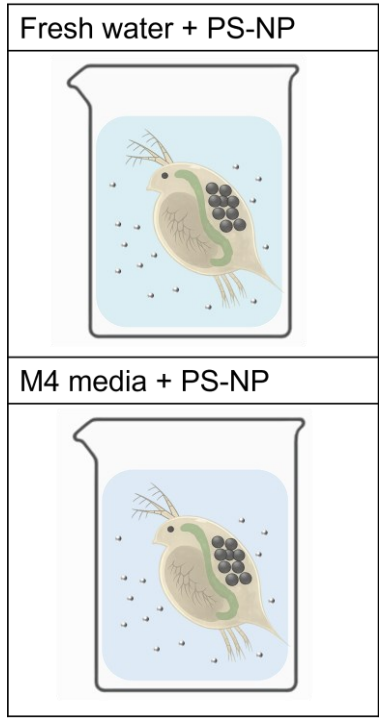
Encapsulation of Silver Nanoparticles into Polystyrene Microspheres, Amar S. Kumbhar and George Chumanov, Chemistry of Materials 2009 21 (13)
Recek, N., Mozetic, M., Jaganjac, M., Milkovic, L., Zarkovic, N., & Vesel, A. (2014). Adsorption of Proteins and Cell Adhesion to Plasma Treated Polymer Substrates. *International Journal of Polymeric Materials and Polymeric Biomaterials*, *63*(13), 685–691.

❖ Toxicity test

Environmental conditions

vs

Laboratory conditions



Acute toxicity test

Chronic toxicity test

Physiological and behavioral responses

- Heart rate
- Thoracic limb activity
- Swimming behavior

Growth and reproductive performance

- Body size
- Molting
- Reproduction rate

Biochemical and molecular responses

- Enzyme activity
- Gene expression

Microbiome responses

- Gut microbiota composition

➢ Investigating the combined ecotoxicological effects of microplastics and micropollutants in freshwater environments.

Thank you for listening ☺