



Biotechnology and safety to manage xenogenetic elements and antimicrobial resistance from urban to space water cycles



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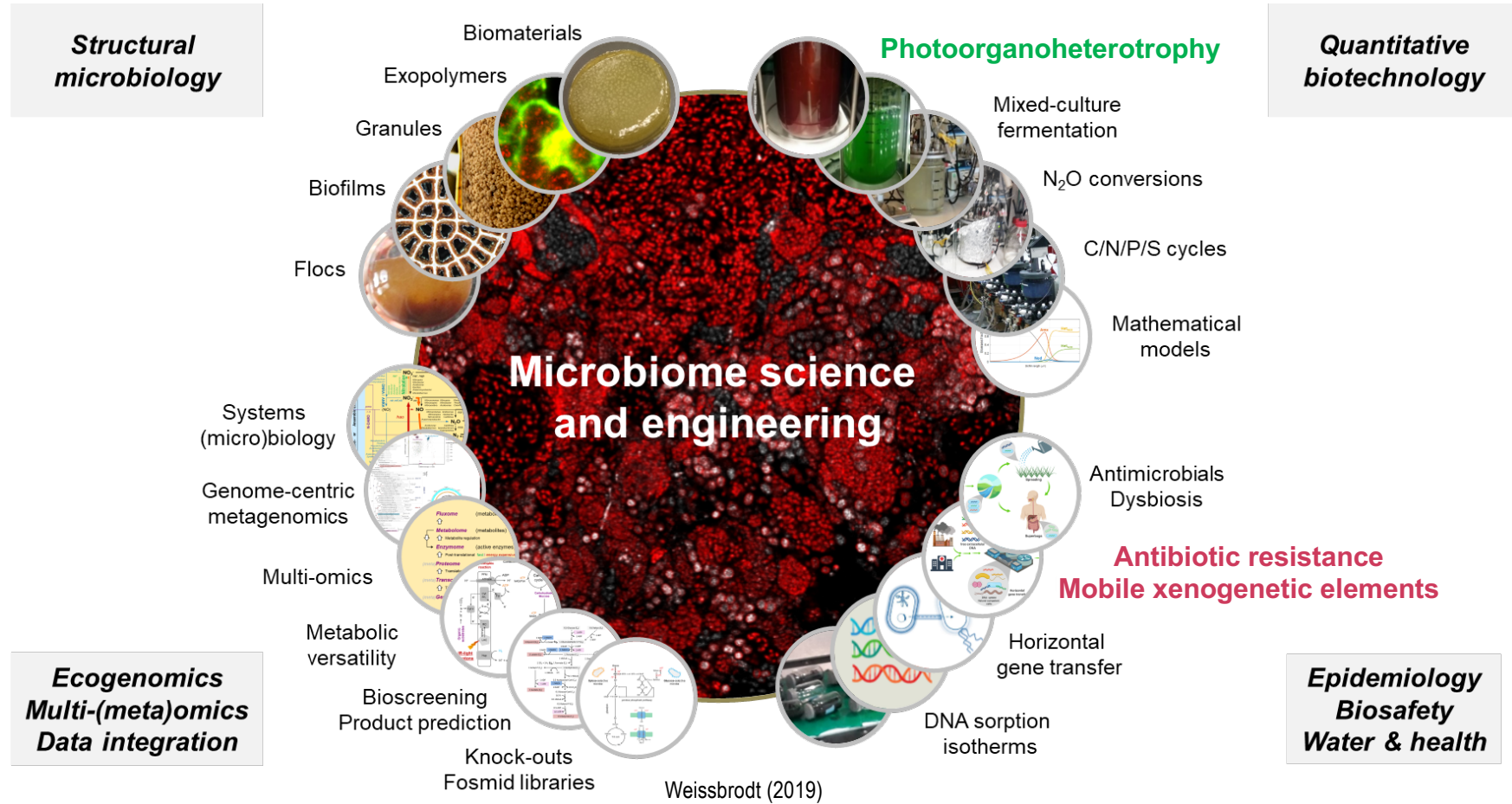
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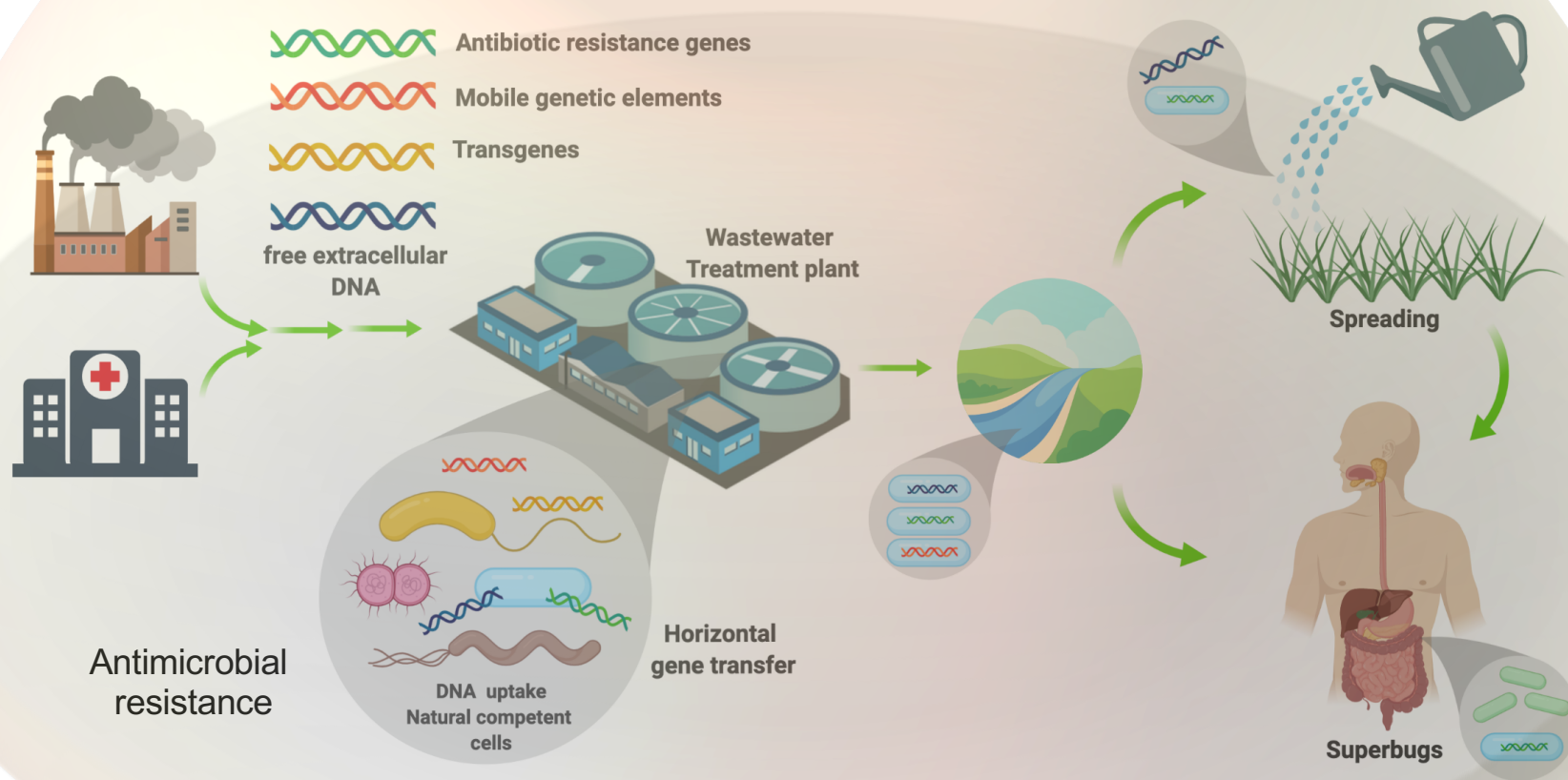
Environmental life science & engineering

Water resource recovery and wastewater-based epidemiology



Context

Xenogenetic elements in open urban water systems. Translation to closed space water cycles.



Calderón-Franco (2018)

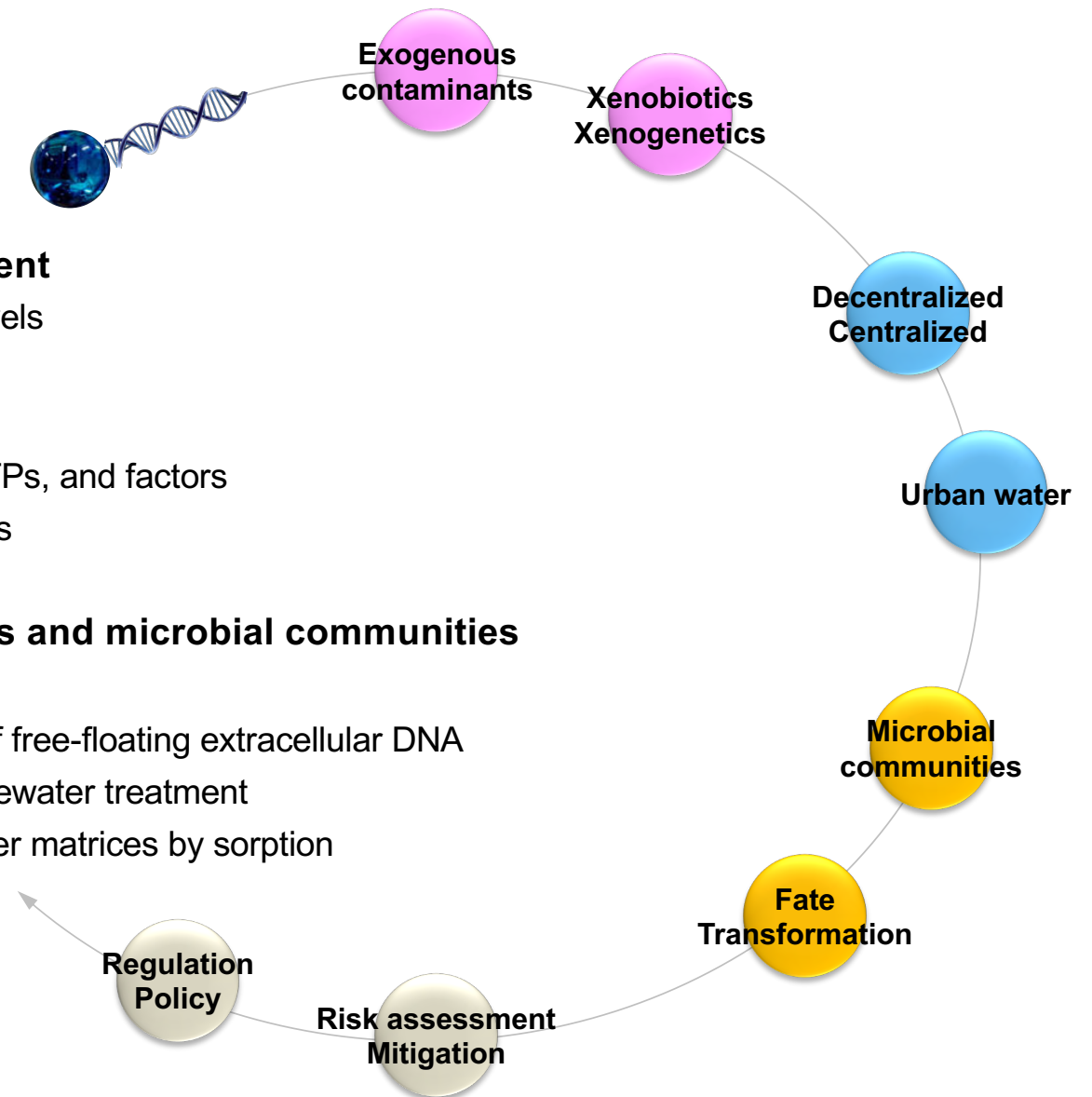
Research question

Can we capture the fate of biocontaminants that replicate across urban water systems?

- **Decentralized sanitation**
 - Blackwater treatment
- **Centralized wastewater treatment**
 - AMR, WWTPs
- **Fate of extracellular DNA vs. intracellular DNA**
 - AMR, MGEs, synthetic genes

Investigations

Wet-lab and dry-lab



- **Anaerobic digesters for blackwater treatment**

- Effect of microaerophilic conditions on ARG levels

- **Wastewater treatment plants**

- Status of ARGs in influent and effluent of WWTPs, and factors
- Tracking ARGs across process units in WWTPs

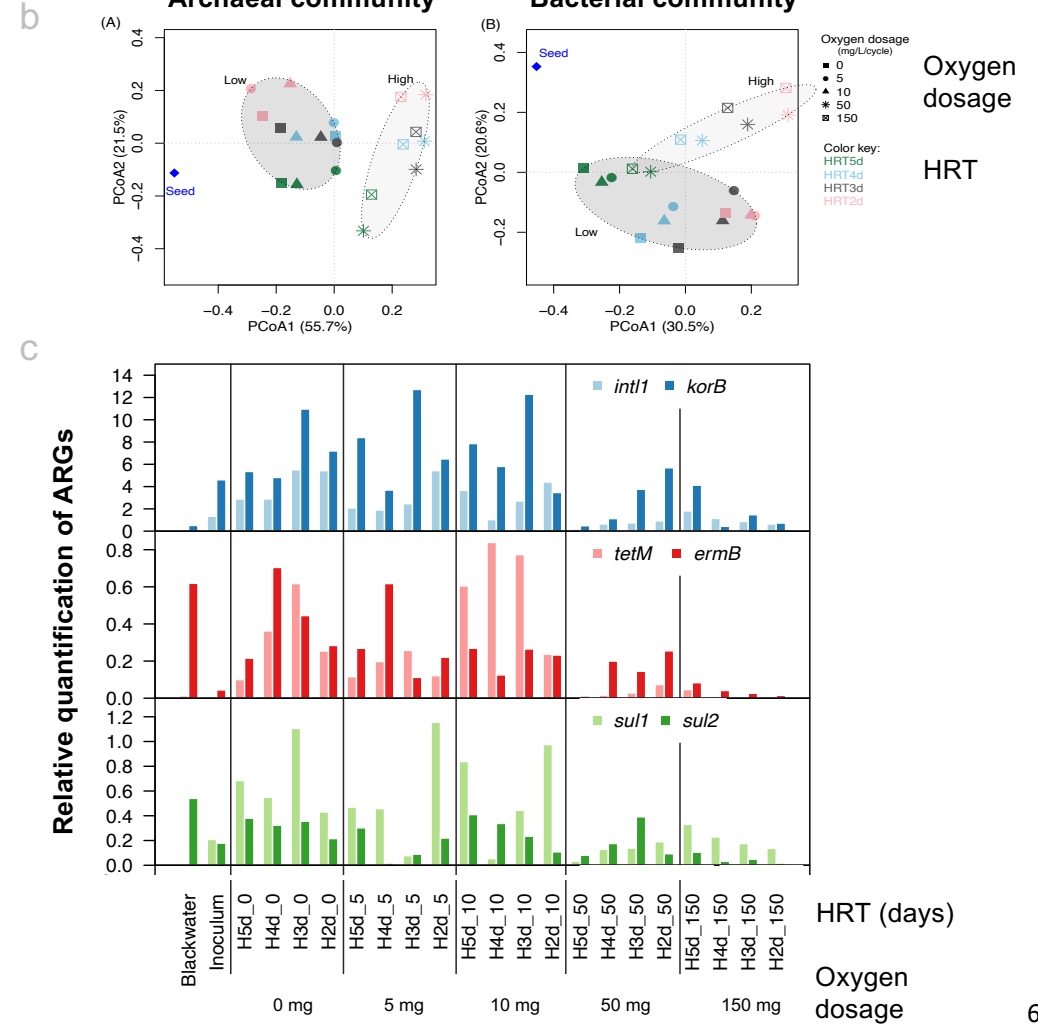
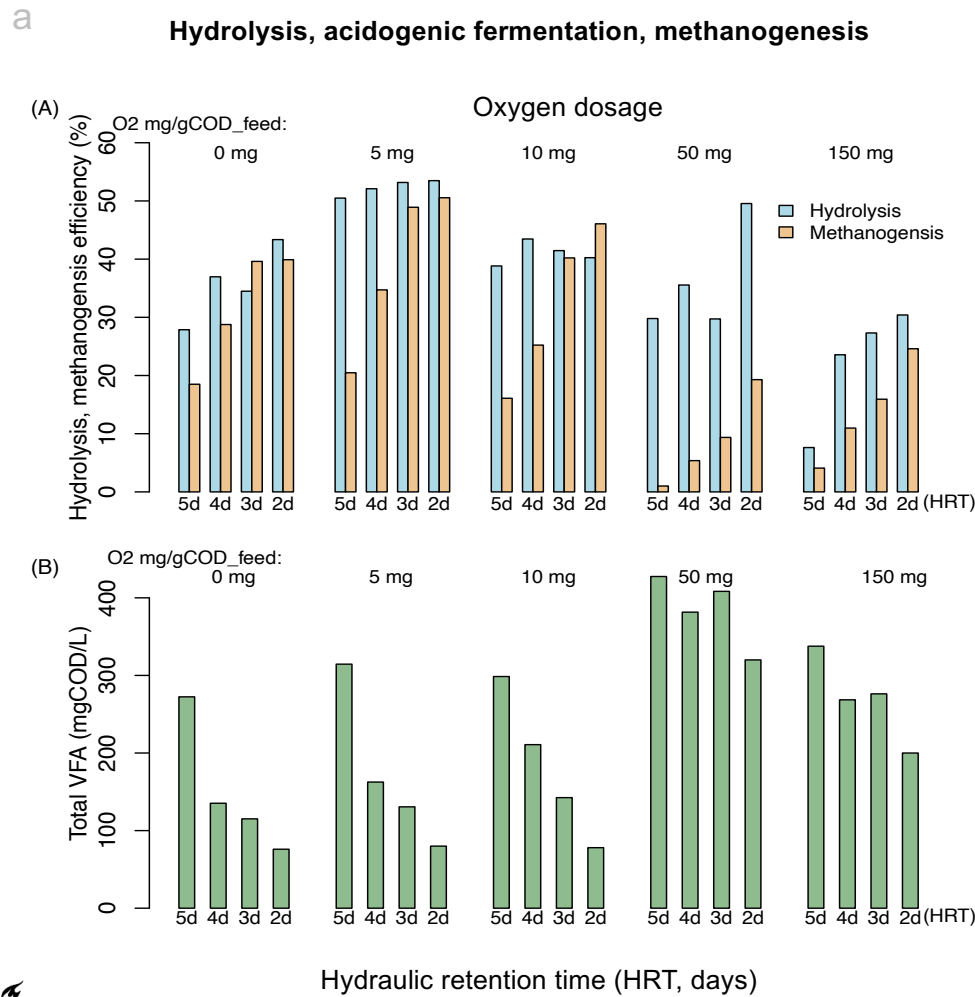
- **Fate of AMR in biological aqueous systems and microbial communities**

- Impact of sterilization techniques on DNA
- Isolation and metagenomics characterization of free-floating extracellular DNA
- Transfer of ARGs and MGEs in biological wastewater treatment
- Removal of environmental DNA from used water matrices by sorption

Decentralized sanitation

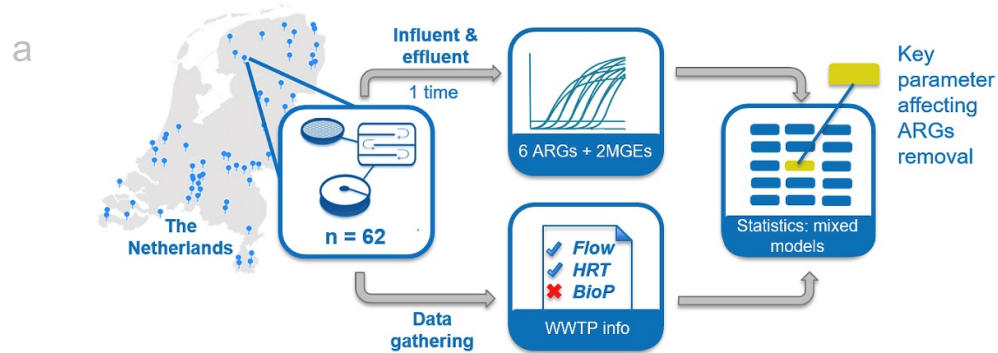
Microaeration levels do impact ARG levels during anaerobic digestion of blackwater

Guo et al., ahead of submission

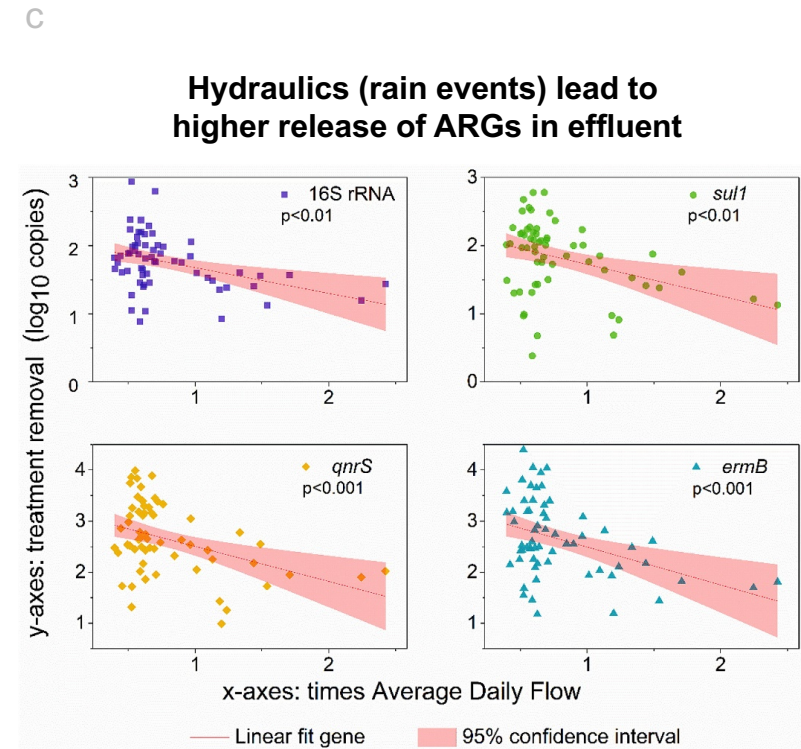
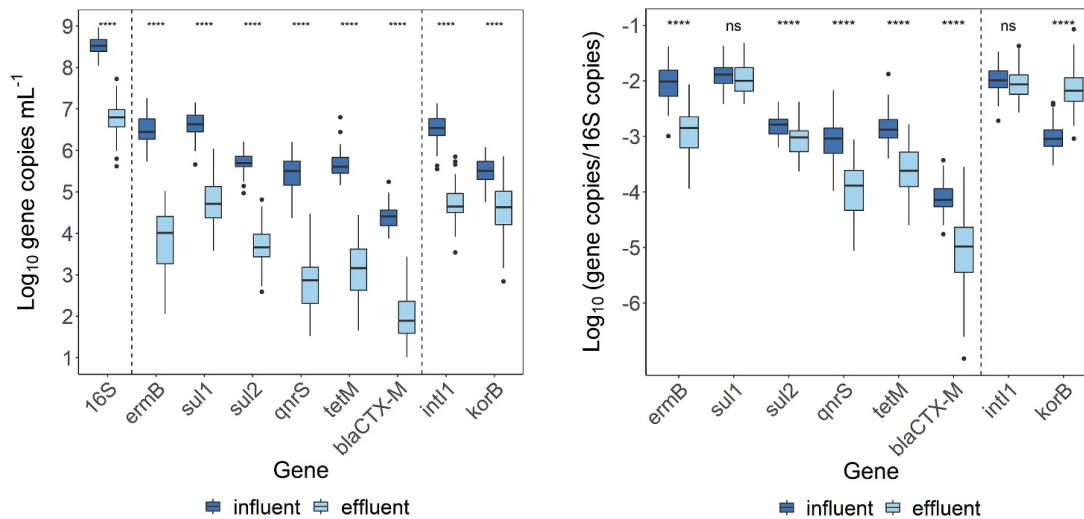


Centralized sewage treatment

WWTPs do not enhance the AMR problem, but AMRs need to get removed from effluents



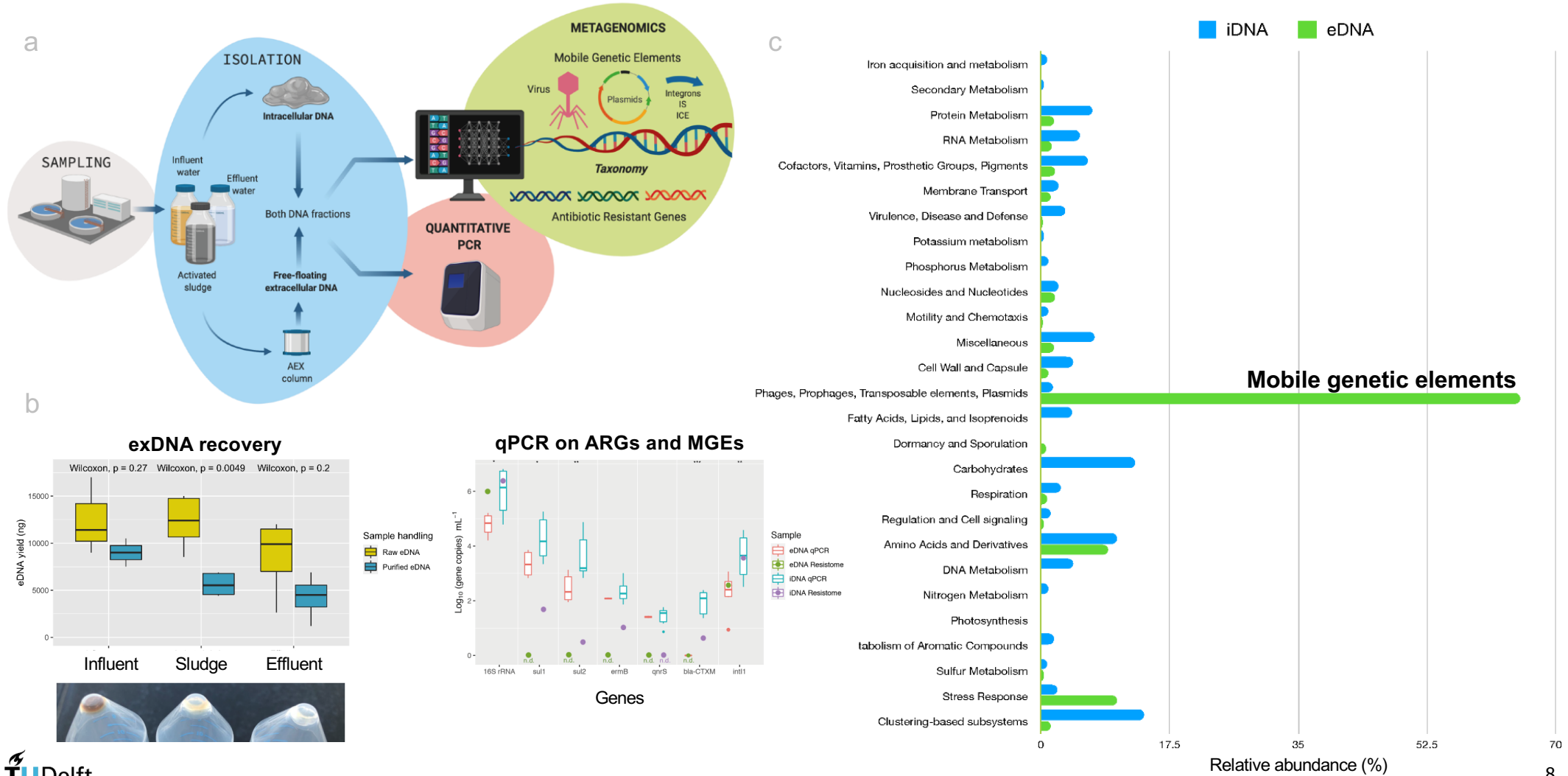
b Most ARGs markers decrease from WWTP influent to effluent



Free-floating extracellular DNA

Calderón-Franco *et al.* Water Research, 2020, 116592, in press

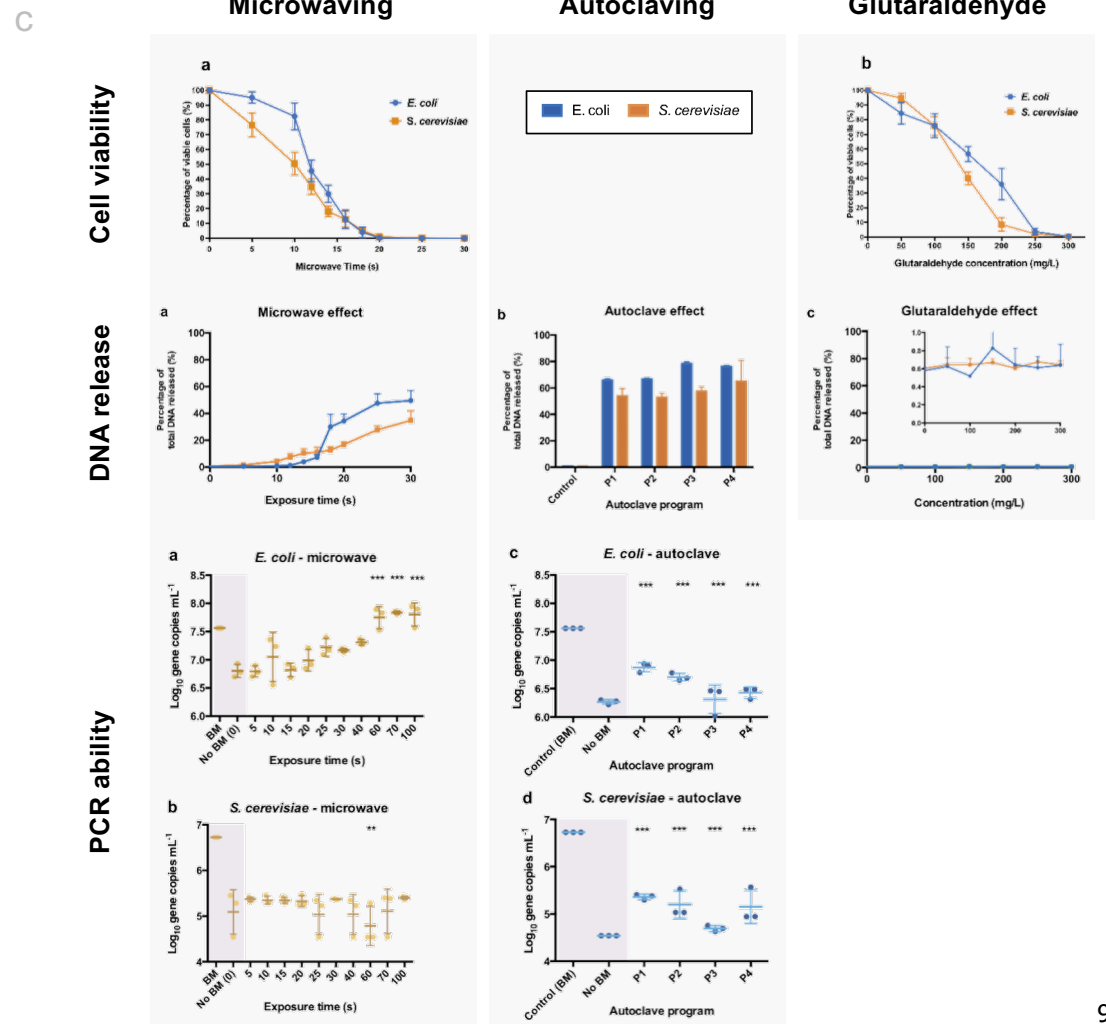
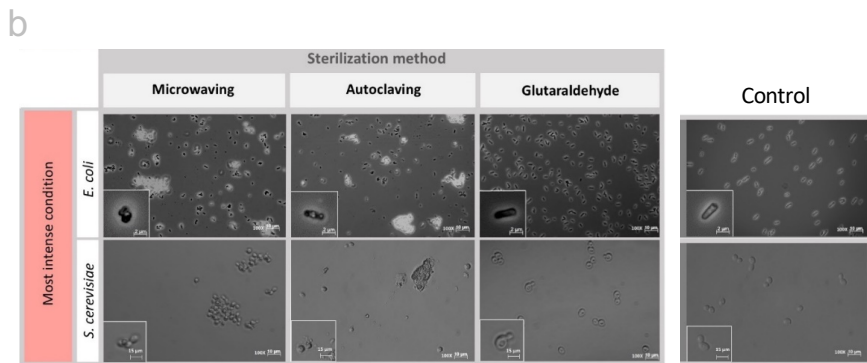
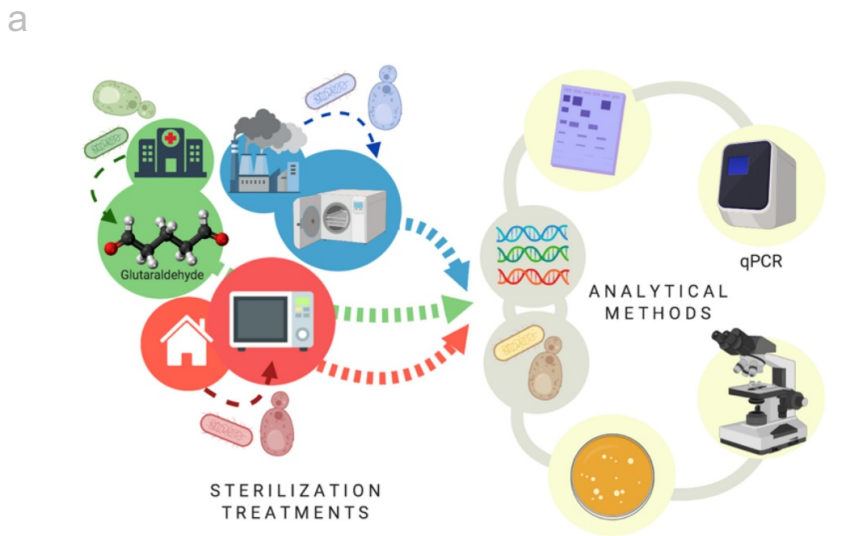
A novel method for isolation from wastewater matrices and metagenomics characterization



Mitigation

At the source: sterilizations do not suppress the release of xenogenetic elements

Calderón-Franco *et al.* Front. Bioeng. Biotechnol. 2020, 8: 171



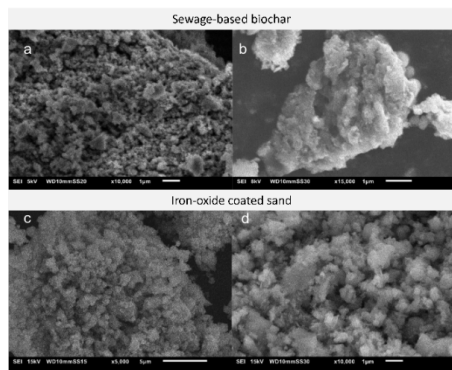
Mitigation

End of pipe: How to remove xenogenetic elements? What about regrowth?

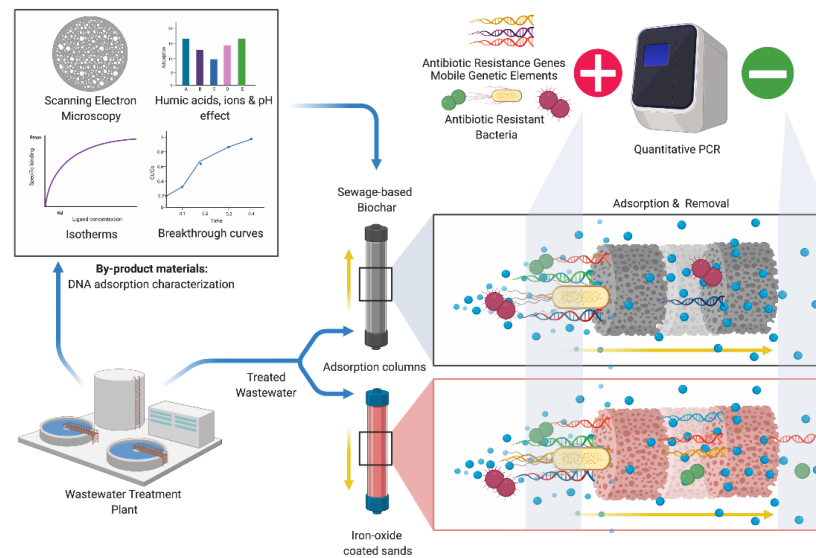
Calderón-Franco *et al.* bioRxiv, 2020.09.17.302018

- Advanced oxidation and sorption processes
- Treatment process circularity: sewage sludge biochar vs. iron oxide coated sand

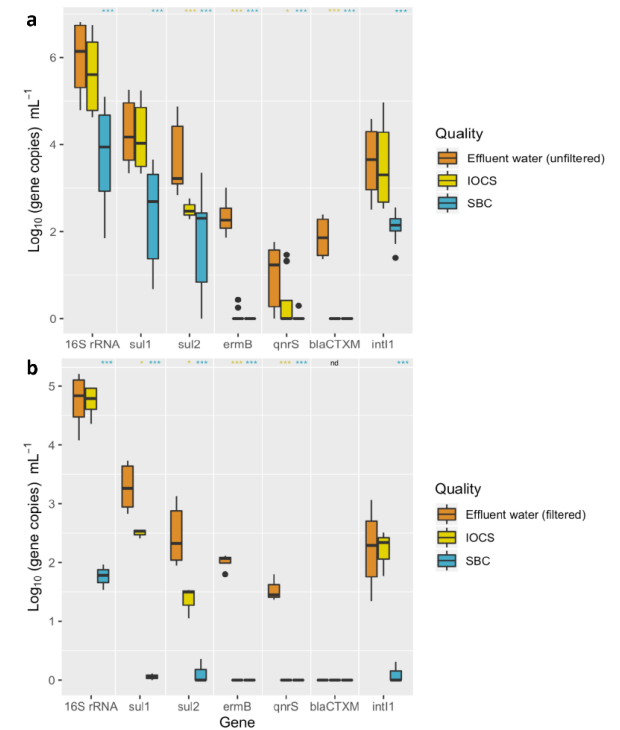
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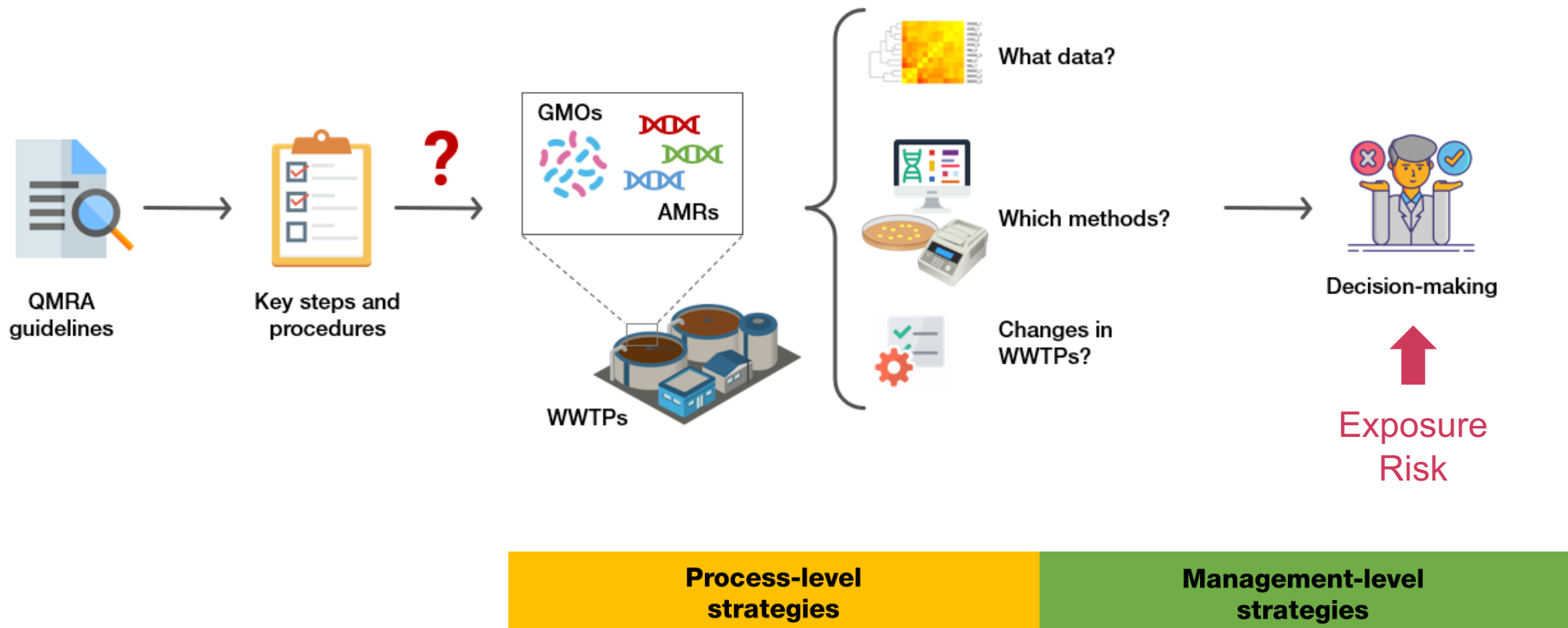
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Xenogenetic risk assessment

How to assess exposure / risk? How to derive decision / policy?

- 1 Characterization of key QMRA elements
- 2 Translation of scientific data into GMOs and AMR assessment
- 3 Management support



Take home

Xenogenetic elements in the biotechnology & safety context of water security

1. AMR is **complex** in (urban) water systems. **ARGs/MGEs** drive AMR, both from intra/extracellular DNA. Process **hydraulics** and **solid/liquid separation** require special attention to manage biocontaminants.
2. AMR relies on microorganisms that express the genes. AMR **phenotypes** need to get unraveled.
3. **Mitigation methods** need reappraisal to **contain AMR** microbial and xenogenetic pollutions.
4. Contrary to chemicals, **AMRs replicate** and **re-grow**, complexifying their management across water cycles.
5. Knowledge gained from **urban water cycles** can be transferred to **decentralized systems** for **terrestrial remote areas** and **space missions**.



AMR crew

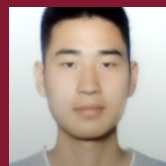
Thank you !



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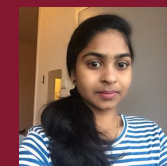
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Claudia
Herrera Mexicano
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Aisha
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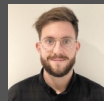
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