Impact of pharmaceutical residues in soils

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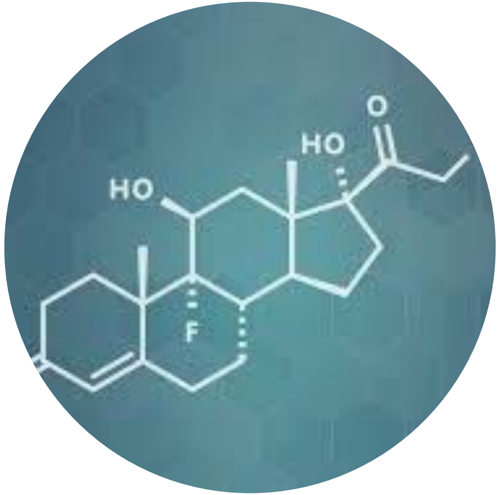

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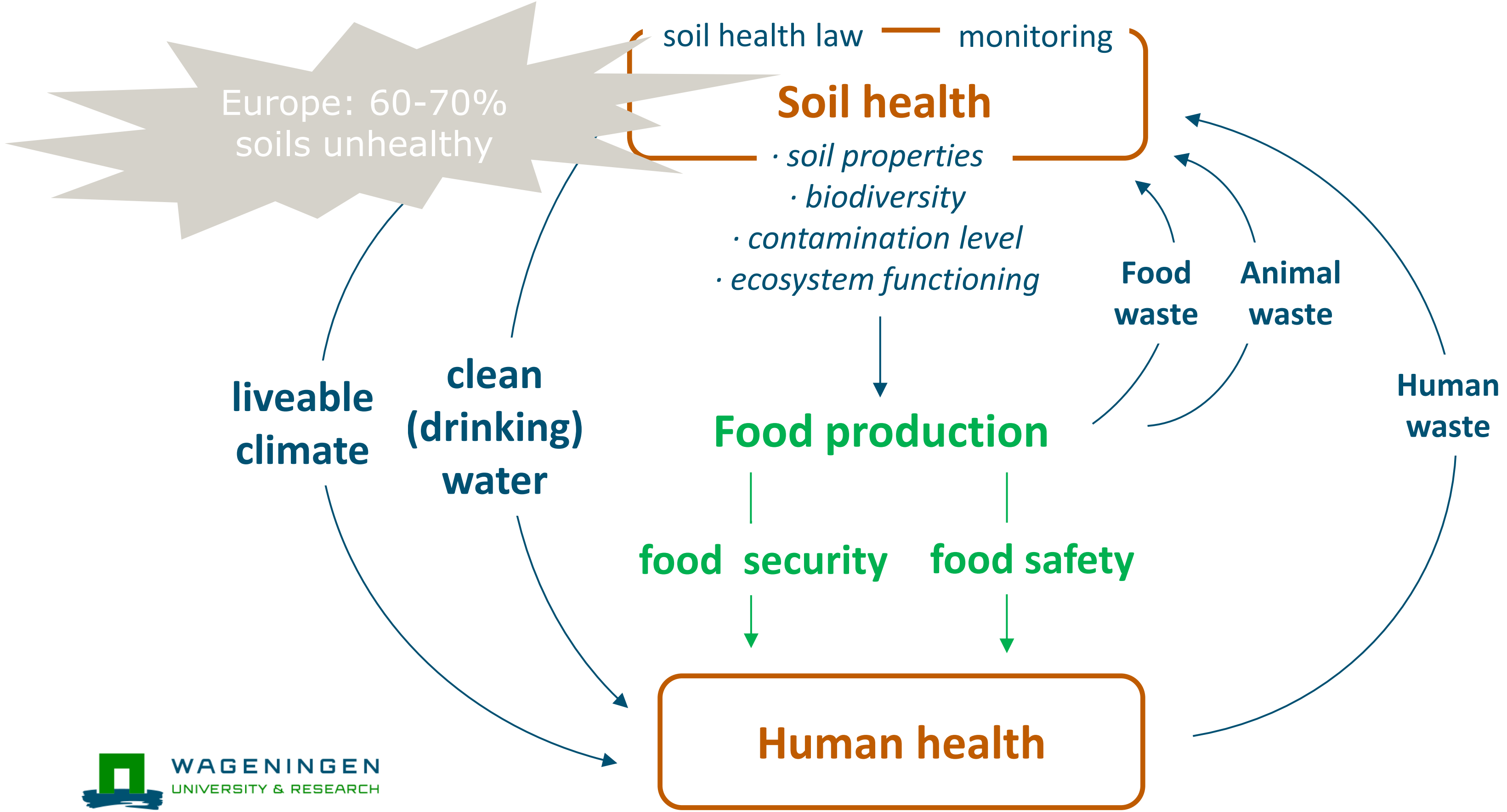
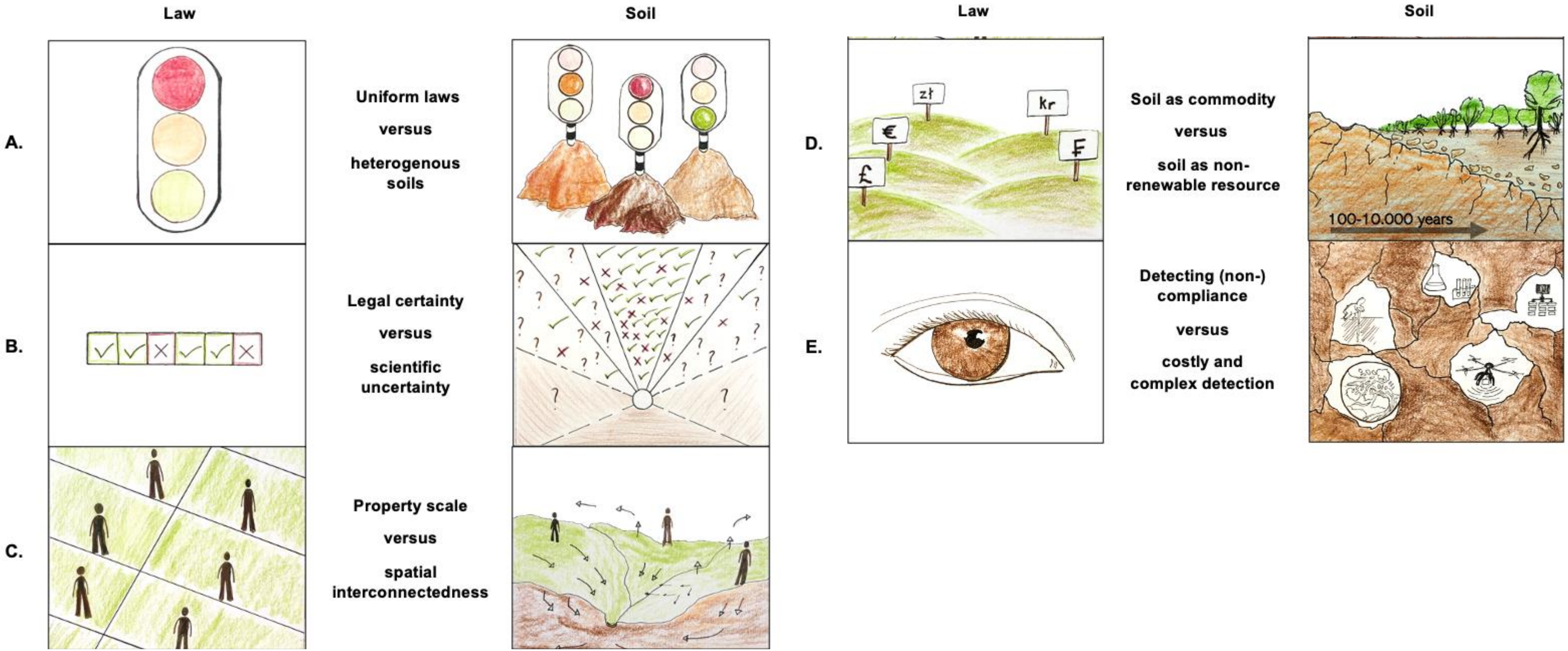
Soil health is essential for human health

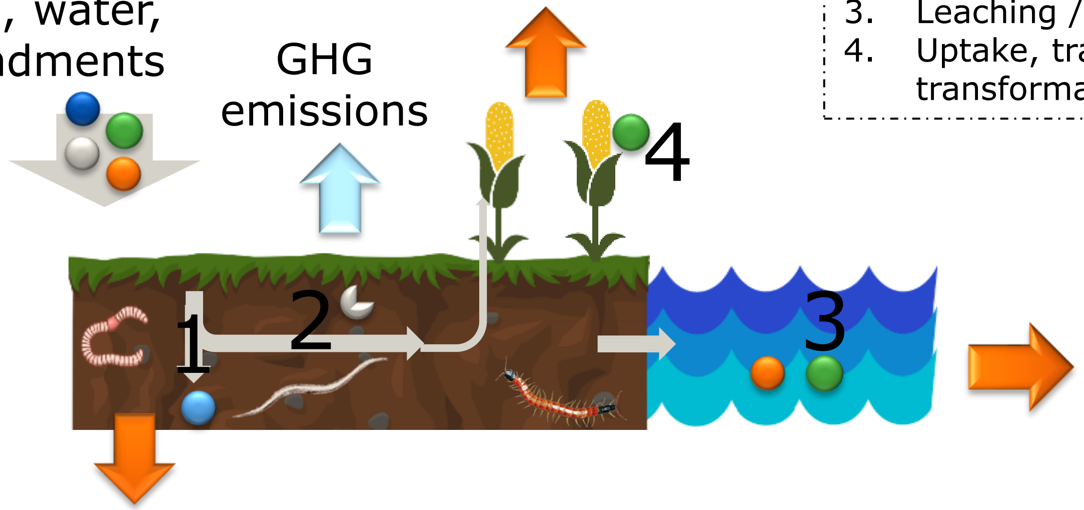


Why is legal protection of soils so challenging?



Alblas et al. 2025. European Journal of Soil Science, accepted

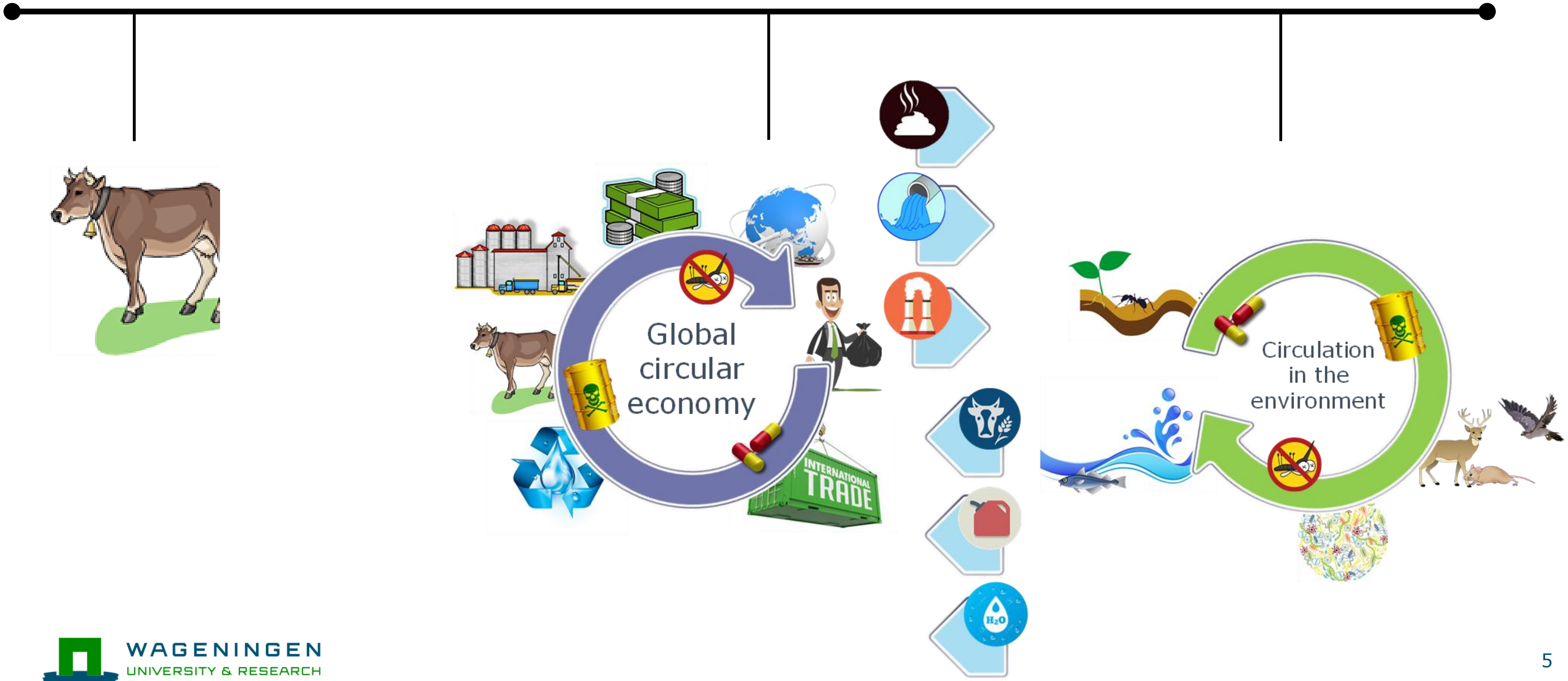
Pharmaceuticals are present in soils



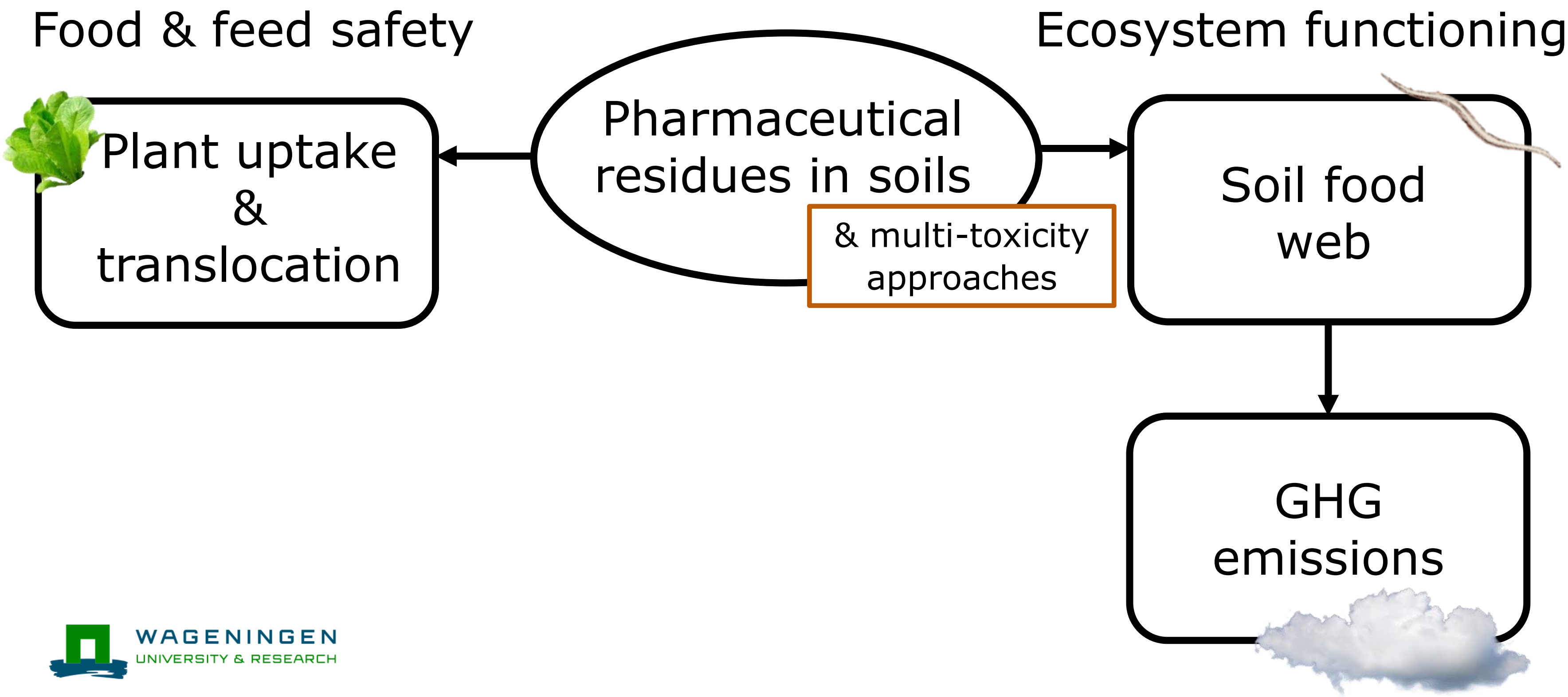
1. Adsorption to soil particles
2. Degradation / possible inactivation / transformation
3. Leaching / run off to water
4. Uptake, translocation, transformation in crops

Berendsen et al. 2021. Chemosphere, Vol. 279, 130495

Pharmaceuticals residue analysis @WFSR



Study aim: Impact of pharmaceutical residues in soils



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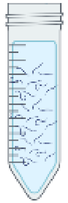
Example 1: Impact of hormones on nematodes

1. *In-vitro* impact of hormones on nematodes



2. Impact of hormones on nematodes in soil with crops

& uptake of hormones and transformation products in crops

-> Ecotoxicological indicator: 3 species bacteria-feeding soil nematodes

-> Selection of hormones: literature data soil, water, manure (0.5 up to 1400 µg/kg)

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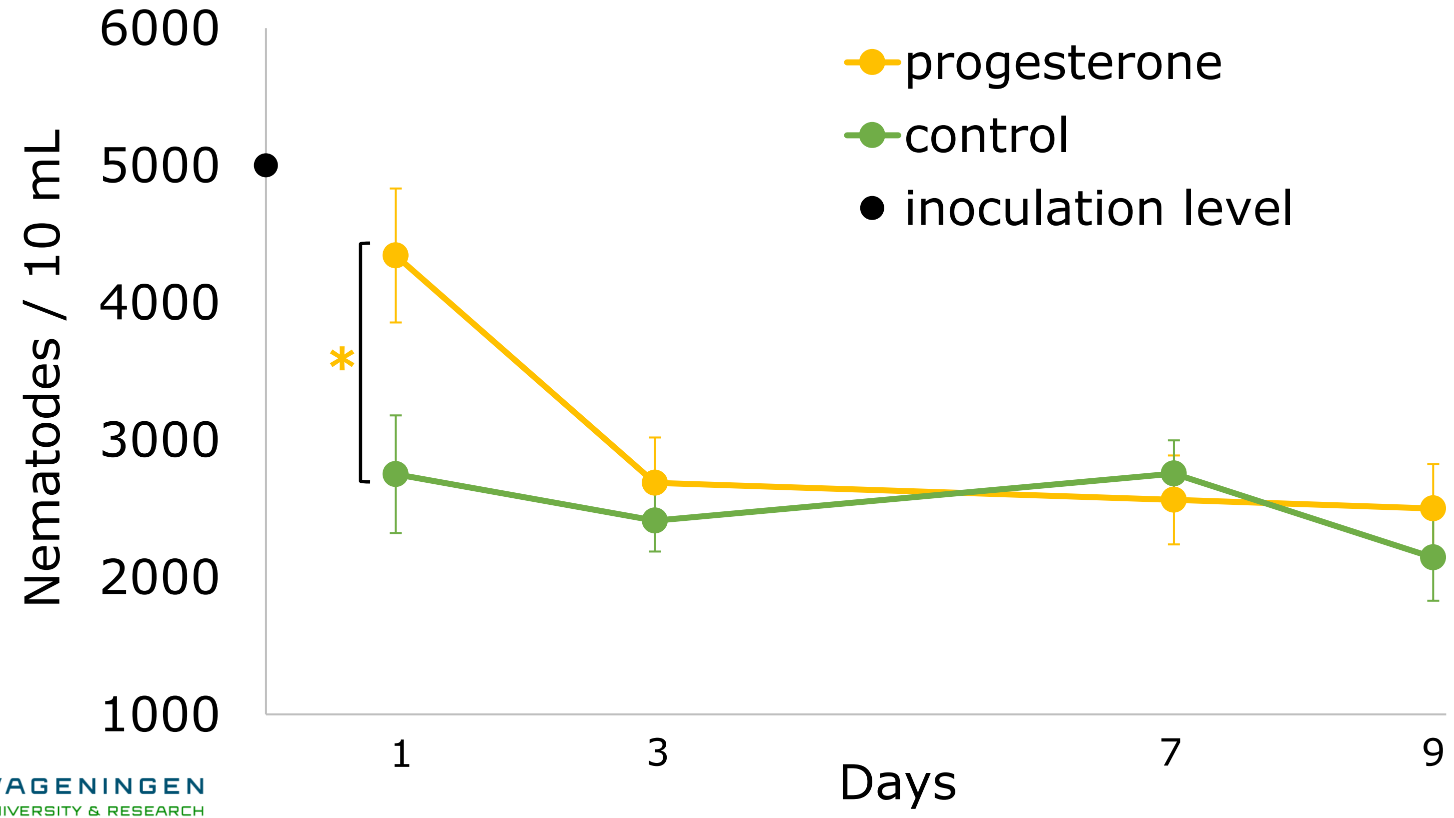
Hormones effect nematodes *in-vitro*



Set-up of pot experiment

- Sandy soil, Wageningen
- Non-fertilized organic grassland >10y
- Autoclaved, re-inoculated
- Lettuce
- Estradiol

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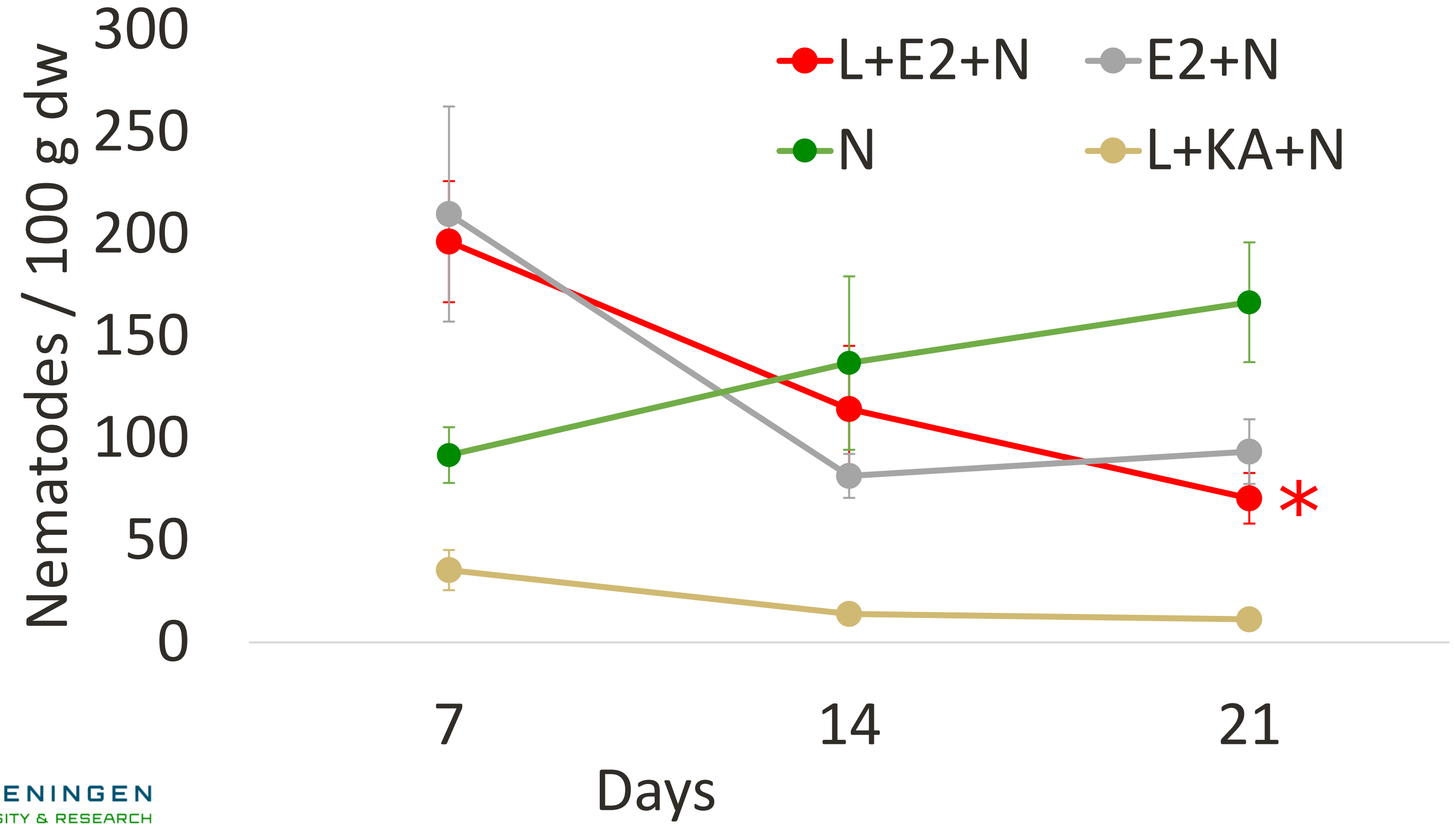
Estrogens effected nematodes in soil



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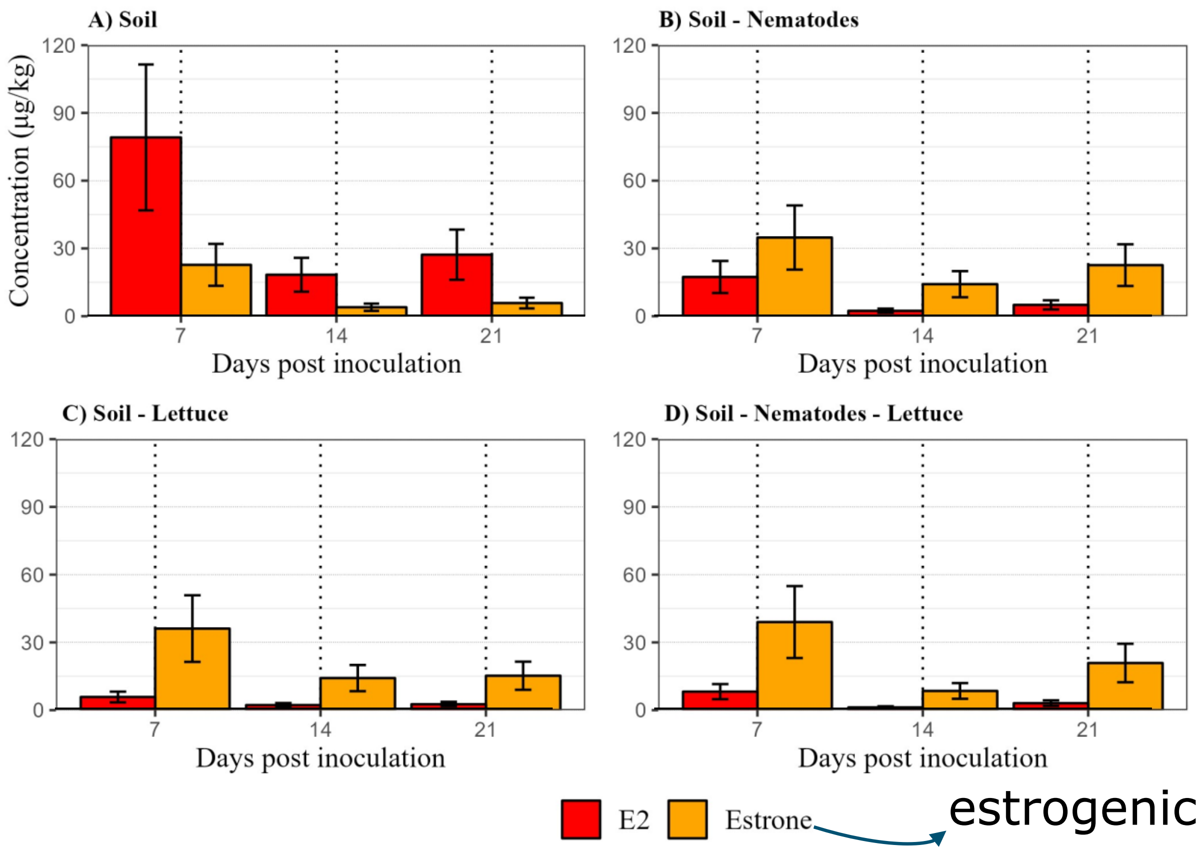
Estradiol is metabolized in soil; more conversion with biota

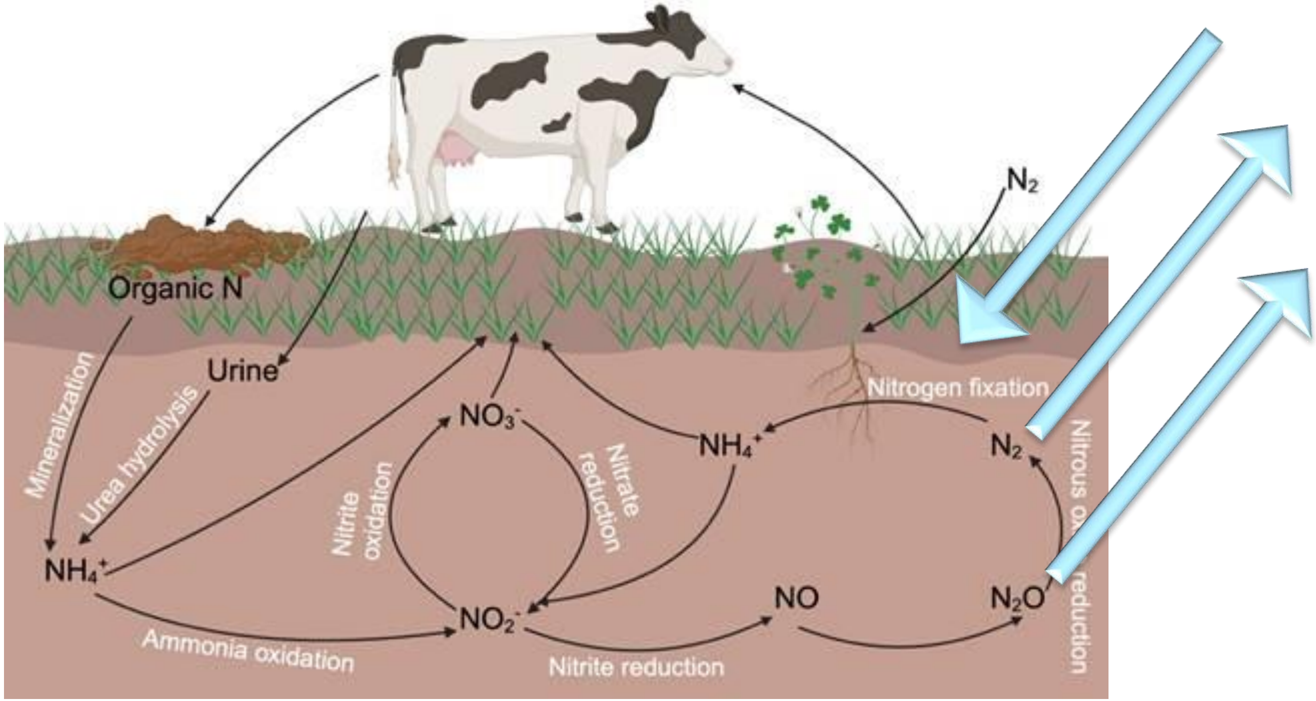


estrogenic highly active

Conclusions Example 1

- Hormones are present in soil, water and manure in high (0.5-1400 µg/kg) amounts
- *In-vitro*, bacterivorous nematode abundance is directly affected by hormones, confirming nematode utility as ecotoxicological indicators for hormone contamination
- In soil, bacterivorous nematode abundance is negatively affected by application of estradiol, indicating impact on soil health
- Hormones are taken up by lettuce and translocated to the edible parts, indicating potential food safety risks

Example 2: Impact of antibiotics on GHG emissions



Set-up of the experiment

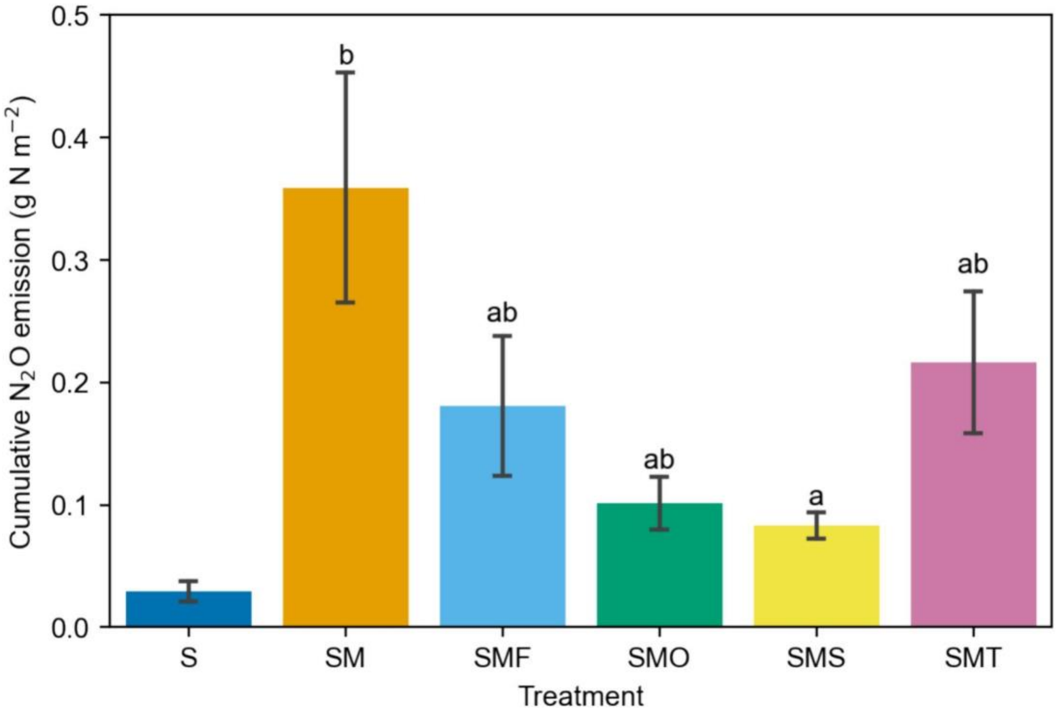
N-cycling and N2O emissions:

- Spiked cattle manure (flumequine, oxytetracycline, sulfadiazine, tylosin and blanc)
- Sandy grassland soil
- Incubated 31 days, fluxes of soil N_2O measured

Persistence

- Incubated, concentrations AB measured

Sulfadiazin and Oxytetracyclin reduced N_2O emissions



S Soil
M Manure
F Flumequine
O Oxytetracyclin
S Sulfadiazin
T Tylosin

Yang et al. 2024. Applied Soil Ecology, Vol. 202, 105577

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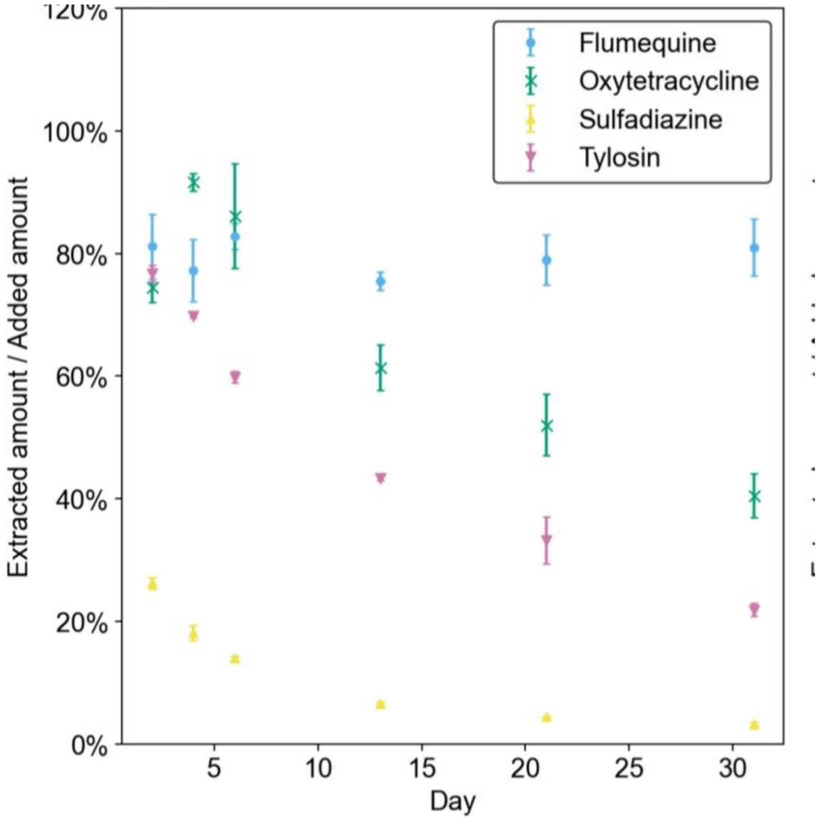
Flumequine was very persistent while sulfadiazin broke down fast



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Conclusions Example 2

- Impacts of antibiotics in manure on soil N cycling and N_2O emissions are type-dependent
- The impact on N_2O emissions is not explained by persistence: persistent AB may have non-substantial effect, while non-persistent compounds can still affect soil microbes, even after a single manure application

Example 3: Multi-toxicity impact of organic contaminants and microplastics

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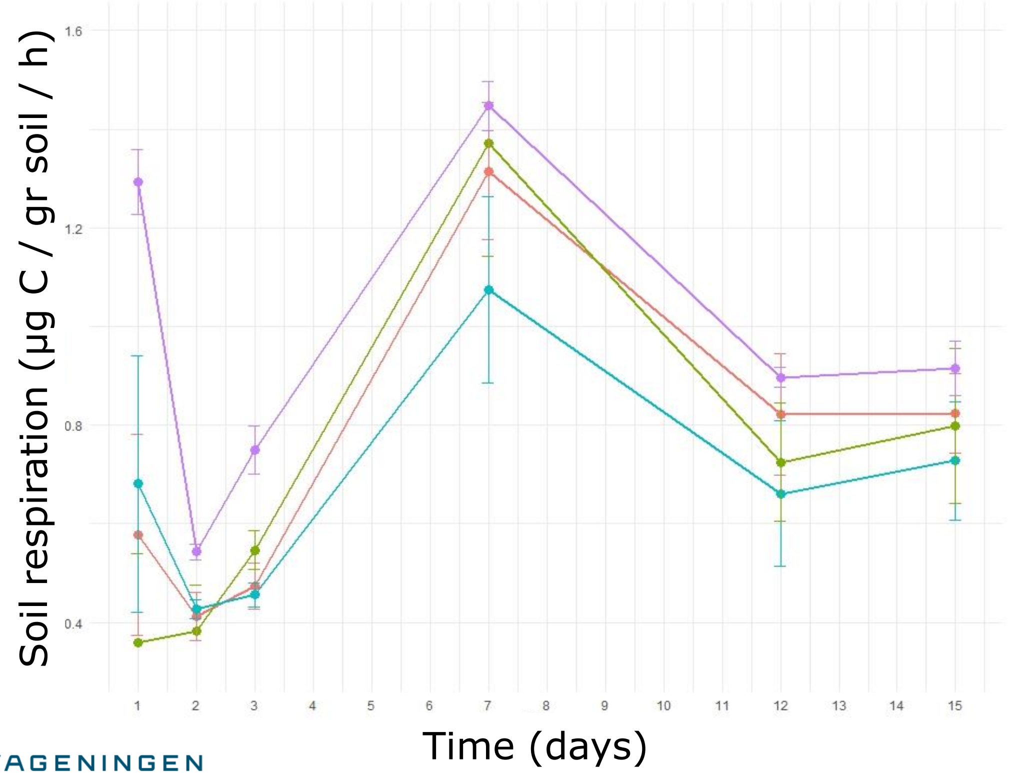
Example 3: Multi-toxicity impact of organic contaminants and microplastics

Set-up experiment:

- Polypropylene Microplastics
- Contaminant mix:
  - Diclofenac
  - 17β-estradiol
  - Terbutryn
  - Ciprofloxacin
  - Diuron
- W and W/O soil biota

Multi-toxicity effects in presence of biota



-- Contaminant mix + microplastics
-- Contaminant mix only
-- Solvent control
-- Microplastics only

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(Putative) Conclusions Example 3

- Multi-toxicity effects are different from individual effects
- Microbial respiration increased when adding both plastics and organic contaminant mix to soils, each of them separate had no effect
- Degradation of compounds was tested with and without microbes, data processing ongoing
- Microbial community analysis ongoing

Further challenges on impact in soils

- Impact of different substances and substance combinations
    - mixture effect, concentrations, time points, repeated / long-term exposure
- Interactions in the ecosystem, controlled and especially in the field
- Adaptation and mitigation of effects:
    - fertilization practices
    - pretreatment of side-products
    - harnessing of soil biota
    - factors influencing plant uptake, development of in-vitro and in-silico models

Related project writing:
"**Effectivity and safety of soil amendments**"
Looking for partners and ideas!!!

Thank you!

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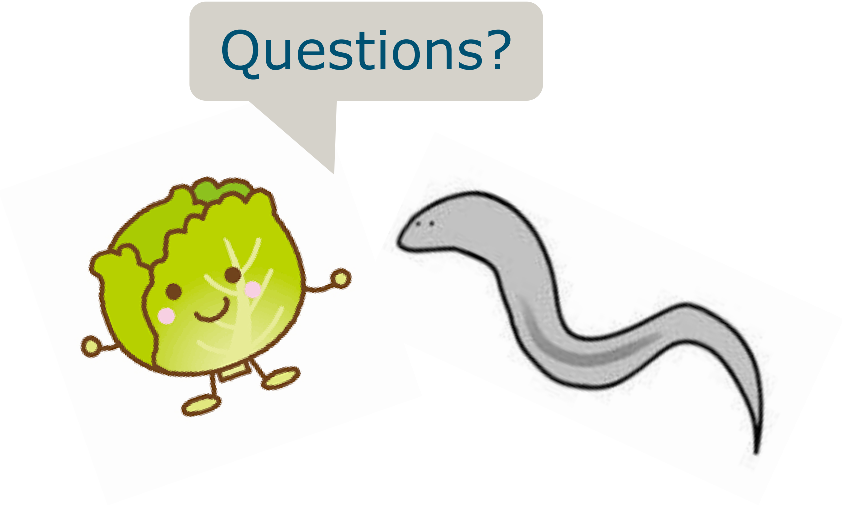

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